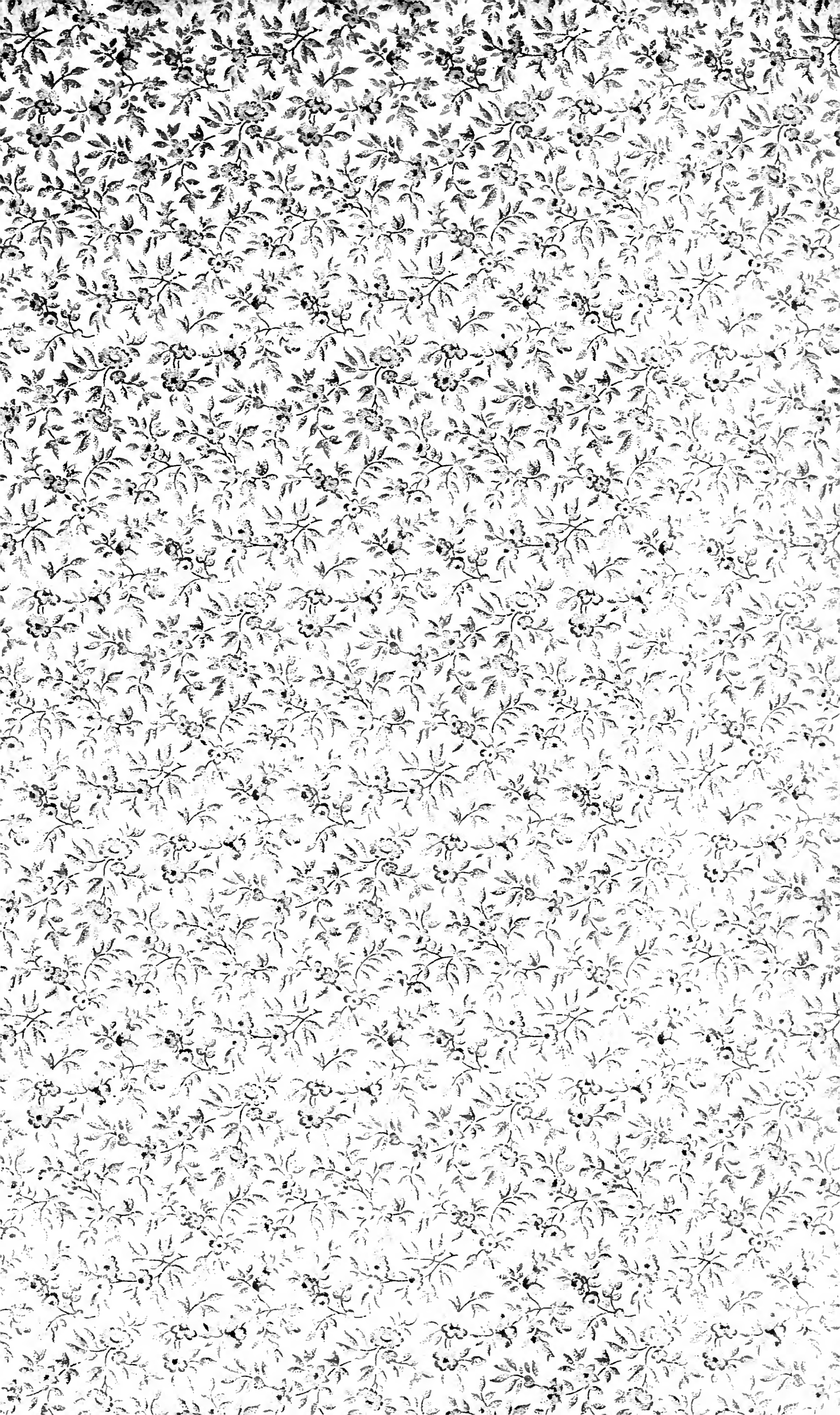

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POPULAR SCIENCE MONTHLY.

NOVEMBER, 1883.

"THE GREEK QUESTION."*

By JOSIAH PARSONS COOKE,

PROFESSOR OF CHEMISTRY IN HARVARD COLLEGE.

THE question whether the college faculty ought to continue to insist on a limited study of the ancient Greek language, as an essential prerequisite of receiving the A. B. degree, has been under consideration at Cambridge for a long time; and, since the opinions of those with whom I naturally sympathize have been so greatly misrepresented in the desultory discussion which has followed Mr. Adams's Phi Beta Kappa oration, I am glad of the opportunity to say a few words on the "Greek question."

This question is by no means a new one. For the last ten years it has been under discussion at most, if not at all, of the great universities of the world; and, among others, the University of Berlin, which stands in the very front rank, has already conceded to what we may call the new culture all that can reasonably be asked.

Let me begin by asserting that the responsible advocates of an expansion of the old academic system do not wish in the least degree to diminish the study of the Greek language, the Greek literature, or the Greek art. On the contrary, they wish to encourage such studies by every legitimate means. For myself I believe that the old classical culture is the best culture yet known for the literary professions; and among the literary professions I include both law and divinity. Fifty years ago I should have said that it was the only culture worthy of the recognition of a university. But we live in the present, not in the past, and a half-century has wholly changed the relations of human

* Remarks made at the dinner of the Harvard Club of Rhode Island, Newport, August 25, 1883.

knowledge. Regard the change with favor or disfavor, as you please, the fact remains that the natural sciences have become the chief factors of our modern civilization; and—which is the important point in this connection—they have given rise to new professions which more and more every year are opening occupations to our educated men. The professions of the chemist, of the mining engineer, and of the electrician, which have entirely grown up during the lifetime of many here present, are just as "learned" as the older professions, and are recognized as such by every university. Moreover, the old profession of medicine, which, when, as formerly, wholly ruled by authority or traditions, might have been classed with the literary professions, has come to rest on a purely scientific basis.

In a word, the distinction between the literary and the scientific professions has become definite and wide, and can no longer be ignored in our systems of education. Now, while they would accord to their classical associates the right to decide what is the best culture for a literary calling, the scientific experts claim an equal right to decide what is the best culture for a scientific calling. Ever since the revival of Greek learning in Europe the literary scholars have been working out an admirable system of education. In this system most of us have been trained. I would pay it all honor, and I would here bear my testimony to the acknowledged facts that in no departments of our own university have the methods of teaching been so much improved during the last few years as in the classical. I should resist as firmly as my classical colleagues any attempt to emasculate the well-tried methods of literary culture, and I have no sympathy whatever with the opinion that the study of the modern languages as polite accomplishments can in any degree take the place of the critical study of the great languages of antiquity. To compare German literature with the Greek, or, what is worse, French literature with the Latin, as means of culture, implies, as it seems to me, a forgetfulness of the true spirit of literary culture.

But literature and science are very different things, and "what is one man's meat may be another man's poison," and the scientific teachers claim the right to direct the training of their own men. It is not their aim to educate men to clothe thought in beautiful and suggestive language, to weave argument into correct and persuasive forms, or to kindle enthusiasm by eloquence. But it is their object to prepare men to unravel the mysteries of the universe, to probe the secrets of disease, to direct the forces of nature, and to develop the resources of this earth. These last aims may be less spiritual, lower on your arbitrary intellectual scale, if you please, than the first; but they are none the less legitimate aims which society demands of educated men: and all we claim is that the astronomers, the physicists, the chemists, the biologists, the physicians, and the engineers, who have shown that they are able to answer these demands of society, should be intrusted with the training of those who are to follow them in the same work.

Now, such is the artificial condition of our schools, and so completely are they ruled by prescription, that, when we attempt to lay out a proper course of training for the scientific professions, we are met at the very outset by the Greek question. Greek is a requisition for admission to college, and the only schools in which a scientific training can be had do not teach Greek, and, what is more, can not be expected to teach it.

This brings us to the root of the whole difficulty with which the teachers of natural science have been contending, and which is the cause of the present movement. We can not obtain any proper scientific training from the classical schools, and the present requisitions for admission to college practically exclude students prepared at any others. At Cambridge we have vainly tried to secure some small measure of scientific training in the classical schools: first, by establishing summer courses in practical science especially designed for training teachers, and chiefly resorted to by such persons; and, secondly, by introducing some science requisitions into the admission examinations. But the attempt has been an utter failure. The science requisitions have been simply "crammed," and the result has been worse than useless; because, instead of securing any training in the methods of science, it has in most cases given a distaste for the whole subject. True science-teaching is so utterly foreign to all their methods that the requisitions have merely hampered the classical schools, and the sooner they are abandoned the better. Both the methods and the spirit of literary and scientific culture are so completely at variance that we can not expect them to be successfully united in the same preparatory school.

We look, therefore, to entirely different schools for the two kinds of preparation for the university which modern society demands—schools which, for the want of better distinctive names, we may call classical and scientific schools. In the classical school the aim should be, as it has always been, literary culture, and the end should be that power of clothing thought in words which awakens thought. Of course, the results of natural science must to a certain extent be taught; for even literary men can not afford to be wholly ignorant of the great powers that move the world. But the natural sciences should be studied as useful knowledge, not as a discipline, and such teaching should not be permitted in the least degree to interfere with the serious business of the place. In the scientific school, on the other hand, while language must be taught, it should be taught as a means, not as an end. The educated man of science must command at least French and German—and for the present a limited amount of Latin—as well as his mother-tongue, because science is cosmopolitan. But these languages should be acquired as tools, and studied no further than they are essential to the one great end in view, that knowledge which is the essential condition of the power of observing, interpreting, and ruling natural phenomena.

In such a course as this it is obvious that the study of Greek would have no place, even if there were time to devote to it, and we can not alter the appointed span of human life, even out of respect to this most honored and worthy representative of the highest literary culture. Of course, no one will question that the scholar who can command both the literary and the scientific culture will be thereby so much the stronger and more useful man; and certainly let us give every opportunity to the "double firsts" to cultivate all their abilities, and so the more efficiently to benefit the world. But such powers are rare, and the great body of the scientific professions must be made up of men who can only do well the special class of work in which they have been trained; and, if you make certain formal and arbitrary requisitions, like a small amount of Greek, obstacles in the way of their advancement, or of that social recognition to which they feel themselves entitled as educated men, those requisitions must necessarily be slighted, and your policy will give rise to that cry of "fetich" of which recently we have heard so much.

Now, all the schools which prepare students for Harvard College are classical schools. We do not wish to alter these schools in any respect, unless to make them more thorough in their special work. As I have already said, the small amount of study of natural science which we have forced upon them has proved to be a wretched failure, and the sooner this hindrance is got out of their way the better. We do not wish to alter the studies of such schools as the Boston and Roxbury Latin Schools, the Exeter and Andover Academies, the St. Paul's and the St. Mark's Schools, and the other great feeders of the college. No—not in the least degree! We do not ask for any change which in our opinion will diminish the number of those coming to the college with a classical preparation by a single man. We look for our scientific recruits to wholly different and entirely new sources. For, although we think that there are many students now coming to us through the classical schools who would run a better chance of becoming useful men if they were trained from the beginning in a different way, yet such is the social prestige of the old classical schools and of the old classical culture that, whatever new relations might be established, the class of students which alone we now have would, I am confident, all continue to come through the old channels.

This is not a mere opinion; for only a very few men avail themselves of the limited option which we now permit at the entrance examinations—nine, at least, out of ten, offering what is called maximum in classics.

We look, then, for no change in the classical schools. Our only expectation is to affiliate the college with a wholly different class of schools, which will send us a wholly different class of students, with wholly different aims, and trained according to a wholly different method. At the outset we shall look to the best of our New England high-schools for a limited supply of scientific students, and hope by constant pressure to improve the methods of teaching in these schools, as our literary colleagues have within ten years vastly improved the methods in the classical schools. In time we hope to bring about the establishment of special academies which will do for science-culture what Exeter and St. Paul's are doing for classical culture. We expect to establish a set of requisitions just as difficult as the classical requisitions—only they will be requisitions which have a different motive, a different spirit, and a different aim; and all we ask is, that they should be regarded as the equivalents of the classical requisitions so far as college standing is concerned. We do not at once expect to draw many students through these new channels. To improve methods of teaching and build up new schools is a work of years. But we have the greatest confidence that in time we shall thus be able to increase very greatly both the clientage and the usefulness of the university.

Is this heresy? Is this revolution? Is it not rather the scientific method seeking to work out the best results in education as elsewhere by careful observation and cautious experimenting, unterrified by authority or superstition? Certainly, the philologist must respect our method; for of all the conquests of natural science none is more remarkable than its conquest of the philologists themselves. They have adopted the scientific methods as well as the scientific spirit of investigation; but, while thus widening and classifying their knowledge, they have rendered the critical study of language more abstruse and more difficult; and this is the chief reason why the time of preparation for our college has been so greatly extended during the last twenty-five years. Nominally, the classical schools cover no more ground than formerly, but they cultivate that ground in a vastly more thorough and scientific way.

These increased requirements of modern literary culture suggest another consideration, which we can barely mention on this occasion. How long will the condition of our new country permit its youths to remain in pupilage until the age of twenty-three or twenty-four; on an average at least three years later than in any of the older countries of the civilized world? It is all very well that every educated man should have a certain acquaintance with what have been called the "humanities." But when your system comes to its present results, and demands of the physician, the chemist, and the engineer—whose birthright is a certain social status, which by accident you temporarily control—that he shall pass fully four years of the training period of his life upon technicalities, which, however important to a literary man, are worthless in his future calling, is it not plain that your conservatism has become an artificial barrier which the progress of society must sooner or later sweep away? Is it not the part of wisdom, however much pain it may cost, to sacrifice your traditional preferences gracefully when you can direct the impending change, and not to wait until the rush of the stream can not be controlled?

INFLUENCE OF THE ENVIRONMENT ON RELIGION.

By Professor JAMES T. BIXBY.

WHILE religious phenomena are in some respects singularly constant, they are, nevertheless, as noted for their diversity. While certain essential elements are common to almost all faiths, on the other hand, every individual faith has something peculiar to itself. It not only differs in some respects from other religions, but, as we trace down its history, we find it varying from itself.

The Hindoos, Persians, Greeks, Romans, Kelts, Teutons, and Slavs, are shown by philological research to have come originally from a single stock—the primitive Aryan. Their ancestors originally dwelt together in a common home in the neighborhood of the Caspian Sea; and in this ancient time their religion was, probably, one and the same faith, i. e., in substance. Yet how widely diverse have the faiths of these nations come to be, in the four to five thousand years since that ancient home was little by little deserted! How has this diversity come about? What are the forces or influences that differentiate religions? We may divide them roughly into two kinds: 1. The external variables. 2. The internal variables. In this paper I shall try to sketch the first; i. e., those environing influences about man, about a special race or nation, that tend to produce variation in the course of the development of religion.

1. I would mention the varied influences of outward nature. The diverse phenomena of the world naturally diversify the direction and character of faith. The religious capacities common to all men evolve a stock of religious feeling which lies latent and fluent, as it were, in the soul—like an electric charge in the battery—until some experience of the man occurs to elicit its discharge and give it direction. The form and path of faith are determined, in much, by the kind of natural objects with which the spiritual faculty is most closely or impressively brought in contact. Where the spirit of man is frequently confronted with Nature in its power, beauty, or wrath—where sky, sun, mountain, or river, is an important factor in the daily experience and fortune—there arise naturally the corresponding forms of religion—Nature-worship, fetichism, and pantheism. Where, how-

ever, it is dreaded and mysterious *animate* things—the gloomy, awe-inspiring forest, the venomous serpent, the terrible lion—that most agitate man's heart, there we see, as in Africa, e. g., and among the American aborigines, tree-worship and beast-worship abounding.

There are certain great natural phenomena that are common to all countries, familiar with all tribes and nations, such as sun, moon, stars, earth, rain, wind, etc. These are, therefore, the objects universally divinized. In some countries, where the scenery is very slightly diversified, these few objects, personified over and over again, in varied aspects and under various symbols, seem to constitute the whole pantheon, the whole mythology. It was thus in Egypt, e. g., whose numberless gods represent, after all, but about half a dozen great natural objects. But when we pass out of the level plains of such countries as Egypt and Babylon, to countries where the mountains rise to stupendous and frowning heights, and bowlders and cliffs abound, we have a new class of divinities added to the objects that man worships. The mountaineer, gazing aloft to the white peak, saw, far up, the shining morn strike the cheek of virgin snow, and in his guileless faith it became an abode of the gods ; or a deity itself, holding aloft the heavenly dome. If on the soft sandstone of a hill, before petrifaction, bird or beast had left its tracks, then the place, like the Enchanted Mountain of Georgia, was deemed haunted. If the mount, like Kineo, in the north of Maine, happens to have the shape of a moose, then it is reputed to be the queen and progenitor of the moose-tribe turned to stone.

When the barbarian cries out in joy or pain beneath the rocky wall, he hears a mysterious voice answering him back—a voice that belongs to no material creature, and that must, therefore, belong to some divinity or departed spirit. So the sounds that come from caverns, or the roar of the billows on the sea-shore, are thought to be produced by the spirits that have their haunt there ; and the kobolds and water-nixies are accordingly added to the lists of the gods popularly believed in. The strange phenomena of volcanoes, or the explosion of confined gases in certain rocks, in their ebullition through springs, would suggest the idea of mighty superhuman beings who lived beneath the earth, and to whose activity the volcano's eruptions were due. The Koniagas think that, when the craters of Alaska send forth fire and smoke, the gods are cooking their food and heating their sweat-houses. So among the Australians, the volcanic rocks found in various places suggest the belief that sulky demons, the *igna*, have made great fires and thrown out red-hot stones ; and the Nicaraguans offered vessels of food and even human victims to Popogatipec, i. e., smoking mountain, to appease her when there was a storm or an earthquake.

Wave and frost are great sculptors of rude images, bearing near enough likeness to man or beast to impress profoundly the imagination of the uncultivated. All along our Northern coasts and in our Western mountains are to be found such figures—like the Stone-face, at the White Mountains; the Bishop Rock, at Campobello, on the Maine coast; and the Master of Life, at the entrance to Lake Superior. So in the North and West of our country there are many erratic bowlders, some oval, or glistening with native copper or mica scales, or balanced on convex prominences so that they readily oscillate. In unenlightened but pious minds, such curious figures naturally inspire veneration and worship as the abodes of spirits, as was the case with the Ojibways, Ottawas, and Dakotas; or they give rise to wild myths of transformation, such as the Indian legends abound in. So, where the rocky and mountainous aspect of nature produces cataracts or dangerous rapids, and the waters roar and toss their white manes in the air, these places—as, e. g., Niagara, the mouth of the Wabash, or the Brear Beaux Falls on the Wisconsin—became to the savage the haunt of spirits or demons, who must be propitiated with offerings of tobacco and meat.

And this mention of tobacco may serve to turn our thoughts to remembrance of the influence of trees and plants in drawing forth religious veneration. Wherever plants are found, like tobacco, or the Peruvian coca, the snake-root, the Indian hemp, the wine of Bacchanal worship, that had a special effect; whether stimulating, narcotic, poisonous, or curative, they were held to possess supernatural power, and were used for various magic rites and became sacred. The *soma* of the ancient Aryans even became exalted to a place among the gods, and to drink it was the means of gaining immortality. So, likewise, the mysterious whisperings of the wind in ancient forests, or the inexplicable movements of some half-blown-down tree, as the heat of the sun contracted or lengthened its twisted roots, and caused it alternately to rise and fall, have more than once attracted the superstitious awe of the barbarian, and supplied new objects for his adoration.

Thus do the peculiarities of natural objects supply molds in which the metal of religious faith, already lying latent, readily sets. And not only directly, but indirectly, do they shape the forms of faith. The rushing river, e. g., not merely attracts the reverence of the primitive man to itself, but by its swift and treacherous motion, its sinuous course, and snake-like hiss and gleam, it is personified as a mighty divine serpent, and next makes sacred by association the serpents of the country about. The sky, personified by the ancient Egyptian as a heavenly goose, enveloping and hatching the cosmic egg, made sacred henceforth all geese to the pious dwellers by the Nile. In climes like Egypt, where the skies are rainless and the whole aspect of nature equable, almost unchanging, there the gods are marked by calmness of bearing and serenity of nature. We must go to the slopes of the Himalayas or the ridges of the Apennines to find the howling Rudra, with his attendant Maruts, the pounders, rushing wildly through the glens, or to see the bullocks slain in honor of Jupiter Tonans, the Thunderer. In cold and temperate climes it is the enlivening and warming sun that is loved and adored; but, in the sultry air of the tropics, the sun and the sky of day become evil and destructive deities, and affection is transferred to the refreshing sky of night.

So, also, in their ideas of heaven and hell, there is a natural contrast between the faith of the man of the tropics and the man of the Arctic zone. To the first, the future home of the good is some abode of coolness, some garden of the Hesperides, or a breezy Olympian height, and the place of punishment a place of fire. To the Icelander, hell is the place of cold, worse far to him than fire, and heaven, some comfortable hall surrounded by a hedge of flame. Again, in hot climes, where the soil of the river-bottoms is deep and rich, and nature teems with productiveness, there the gods are credited with the same sensuous nature; religious ideas are apt to revolve about the mysteries of procreation, and the worship of the people is apt to include not a few impure rites and symbols.

The numerous gods of fertility among the agricultural Egyptians —Chem, Min, Chnam, Osiris—the sexual rites of Babylonia, and the numerous objectional symbols in Hindoo worship, illustrate this. On the contrary, under the clear skies and bright moon and the pure streamlets of Greece, it is the virgin goddesses of the most exacting purity, Dianas and Pallas Athenes, rather than loose-zoned and wanton mistresses, that are suggested. Aphrodite and Cybele, and Dionysos indeed, were, later, members of the Olympian court; but they came from regions farther east, where they were tinged with an earthly and sensuous dye, such as we do not find in the native worship of Hellas.

The tribes of Northern Asia, wandering amid the bleak wastes of Mongolia or the gloomy forests of the Ural, their frail shelter shaken by the riotous winds, whose mysterious sighs and howlings often make them quake with terror, come naturally to be believers in dim, mysterious, supernatural powers, with which their own lot is bound up, and readily devote themselves to whatever occult and magic rites the shaman may produce. The Shemite, on the broad plains of Chaldea or the sandy wastes of Arabia, found nothing to arrest his eyes till they rested on the glistening skies, brilliant, in that clear air, with a brilliancy beyond anything that we know: and he became thus, most naturally, a devout star-worshiper; invested the chief celestial objects with the most exalted attributes, and raised them, in his fervid adoration, to more and more absolute majesty and incomparable power, till at length the idea of the divine was exalted into monotheism.

The Aryan, on the contrary, grew up among the mountain pastures of Bactria, where the clouds are often about his feet, and the heavens are not so far away. The earliest Vedic hymns are marked by a sense of the nearness of the gods, and men are seen mingling with them, familiarly, as friends. Nature did not oppress man with dreadful earthquake or hurricane, vast and fatal desert, or frowning mountain; but by its pleasing diversity it stimulated, without overwhelming, his soul. That portion of the Aryans that, upon their migration from the old Bactrian home, reached the shores of the Ægean, found there a land that fostered still more these traits. Here nature was picturesque and diversified, without the stupendous magnitudes that overawe the soul. Above him, the sky was bluest of the blue. The marble hills formed continual pictures. The streams rippled cheerily down their songful beds. The wavelets chased each other playfully in the light zephyrs. All the aspects of earth and sea and sky were bright and gladsome, and conspired to stimulate the imagination of the Greek.

Hellenic religion came thus, by right, to be a happy and luxuriant faith, full of pretty fancies, putting man at ease with the divine, and personifying the gods under the most familiar and graceful shapes:

> "Sunbeams upon distant hill,
> Gliding apace with shadows in their train,
> Might, with small help from fancy, be transformed
> Into fleet oreads, sporting visibly."

The wind was fancied a divine harper, who makes music in the tree-tops, and drives the flocks of the sun—the fleecy clouds—where he wills. The murmuring spring was imaged as a gentle nymph; and within each fine tree was an imprisoned dryad. In short, the diversified and charming scenery supplied an unequaled wealth of religious and mythic lore. And, as man, in this climate, exempt from the debilitating heats of the tropics and the stunting of too severe cold, reached the ideal of bodily perfection, the human form became, not unnaturally, to the Greek, the noblest type under which he could represent the divine. The gods were humanized—stronger and more beautiful beings, to be sure, than ordinary men, but possessed of the same forms, members, and passions.

The course which the Norsemen took when they, in their turn, went forth from the common Aryan home, was less propitious. It led them to a land where the summer was short and the sun soon had to wage a bitter and losing war for long months with frost and snow; a land where the fiords were heavily sealed with ice, and man had a bitter task to keep the wolf of starvation and death from his door. The sternness and gloom of the land were reflected in the Northman's thought and faith. Woden, the stormful, Thor, the thunderer, and Loki, the vengeful and cunning destroyer, become the chief figures in his myths. The interest centers in the struggles of the Aesir, the deities of light and beneficence, against the frost-giants and their allies or servants—the midgard-serpent, the fenris-wolf, and the dreaded Hel—varied personifications of darkness, cold, and death.

Delighting himself, as the Norseman did, in the vigorous exercise and the hearty feasting, to which the frosty air stimulated, his gods likewise were boisterous and stalwart beings, riding on the tempest, amusing themselves by feats of strength, reveling in the crash of battle, and gathering the fallen heroes into the bright Valhalla, there to reward them for their courage with foaming cups of mead, and the barbaric delights of ceaseless combats, in indestructible bodies. Thus, instead of the Graces and the beautiful Apollo of Greece, we find in Scandinavia deities as blustering and uncouth as the Northland itself, but manly and good-hearted. While in Greece the primitive Aryan faith takes on a more æsthetic and refined aspect, in Germany and Scandinavia it becomes more tragic and intense.

Let us follow next the steps of that part of the Aryans who turned their steps southward into the languorous plains of India, and we shall see a different change. The first thing we notice is, that Dyans—the shining one, the bright sky of day—loses his ancient pre-eminence. His supremacy in the thoughts of the Aryan emigrants is first taken by Varuna—the night-sky. In the hot clime of India, the bright sky of day was no longer so pleasant to them, and Varuna seemed a kinder deity, and therefore became more popular. But soon he also is superseded by Indra, the rain-god, who, with his glittering lance—the lightning—pierces and releases the imprisoned waters. For in India, then, as to-day, the coming of the rainy season after the long drought is by far the most important of all nature's changes. It was not long before Indra, therefore, by his terrible might and his beneficent prowess in slaying the drought-serpent, became, with his coadjutors, the Maruts, the beating winds, the chief object of Vedic adoration. And soon we notice an equally significant change. The vigorous Aryan, in the debilitating heats of the Indian plains, became a victim of lassitude. He lost his healthful delight in the good things of sense and earth. The languid air lulled him in dreamy reveries. Meditation takes the place of service in the commandments of religion ; and asceticism, instead of the divine blessings, becomes the pious practice. So great and so rapid is the change that comes over their faith that, before many centuries have passed, pessimistic views of life become so seated in the race that the illusiveness of the world and the essential wretchedness of life become cardinal doctrines of faith ; and the great desire of men's heart's is not for renewed lease of life, but for the means of obtaining exemption from the misery of *rebirth.* And so it has been with other nations and races. The physical characteristics of the countries they have dwelt in have powerfully modified the aspect of their religion. The races inhabiting the most barren and unfavorable quarters of the globe—such as the Patagonians, Hottentots, Kamschatkans—have suffered correspondingly in their possibility of religious progress. Conversely, it is that intermediate zone between the tropical and the temperate—the land of the olive, the fig, and the orange—where the mean temperature is not lower than 60° Fahr. nor more than 75° Fahr., that has been the home of the great founders of religions—Zoroaster, Moses, Buddha, Mohammed, Confucius, and Christ. Moreover, we may notice, as Peschel has pointed out, the suggestive fact that it is in the wide expanses and awe-inspiring solitudes of the desert, where the imagination, while vividly excited, is yet not distracted and divided among the manifold wonders of nature—shimmering leaf and gnarled trunks, writhing mists and rattling thunder, and the weird sounds of forest or sea-beach—that suggest and develop the polytheistic gods, but can give itself up entirely to the impressions of a single Majesty and Infinity—it is, I say, amid these noble yet simple aspects of nature, that the great monotheistic religions, Judaism, Mohammedanism, and Christianity, have been originated. It was at Sinai that Moses promulgated his stern prohibitions of idolatry and polytheism. It was by a Bedouin foster-mother that Mohammed was reared, and as a shepherd and caravan-merchant, traveling across the Arabian deserts, that he passed his early life. And it was in the desert that Christ listened to the preaching of John the Baptist, and passed the forty days in which he prepared himself for his great career.

2. In the second place, we must notice, as of equal if not greater influence in giving diversity to religious faith, man's experiences with himself and with his fellows. It is an old maxim that it is "in the experiences of life that each individual finds or loses his god." Starting on the lowest range of the soul's experience, we notice the effect of the dreams, trances, swoons, ecstasies, and other abnormal phenomena of human nature, in giving direction and variety to religious conceptions. While I regard it as a grave error to derive religion *solely* from these morbid phenomena, nevertheless they have undoubtedly done much in awakening the spiritual powers of man, and in giving shape to his religious instincts. Life, in its most familiar and natural phases, is a mysterious thing—a wonder which doubtless filled the primitive man with ill-understood awe, as it has made even the pride of modern science stand abashed before it. And its more eccentric and exceptional aspects would especially set men to marveling, and suggest explanations which we may to-day laugh at, but without really having penetrated into the heart of the mystery any more than our remotest ancestors. Thus, among almost all peoples the shadow has been looked upon as a second self, and as one of the causes if not the cause of life. The breath, likewise, with whose cessation life ends, has been especially identified with the soul, the principle of life, as is shown by the same or similar words employed in most languages, as their names—*atman* in Sanskrit ; *nephesh* and *ruach* among the Hebrews ; *wang* among the Australians ; *anemos* and *anima* in Greek and Latin—indicate. As in dreams the savage seems to see his distant kinsmen, to visit remote localities, to behold again the long-dead parent or grandparent ; so he comes to believe that the soul, an impalpable form within the fleshly organism, is capable of leaving the body when it pleases, of taking long journeys and flashing with incredible

swiftness from place to place, of possessing its will and consciousness independently of the body, and continuing to exist and appear after the death of the body.

This conception of the soul once formed, the abnormal facts of disease, insanity, epilepsy, and hysteria, come readily to be explained by the invasion into these bodies of other spirits than their own—celestial or demoniac, superhuman or infra-human, according to the phenomena observed. These notions, once diffused, give rise, in their turn, to a whole cycle of kindred animistic theories and religious practices—such as divination by dreams, exorcisms of demons, dervish-dancings, and other artificially produced swoons and ecstasies, and fetichistic magic of all sorts. Sneezing, hiccough, and all painful diseases, are to the savage the work of some spirit that has crept into his body. Fasting, as occasioning vivid visions, becomes a method of seeing one's tutelar deity, as among our Indians, or as the proper rite to fit the priest for initiation into his sacred office, as generally in savage tribes.

When it is evil spirits that do their work in man, they must be cast out by invoking some beneficent and more powerful god. Hence exorcism, witchcraft, medicine-men. When it is good spirits that do their work in man, we have inspired seers and priestesses—divine oracles, like those of Delphi and Dodona. Out of a belief that the spirits of the dead still maintain an interest in those they have left, and are causers of good and evil to them, come propitiation of them by gifts and prayers, and ancestor-worship—so prevalent in ancient China, Egypt, and Rome, as among many African and Polynesian tribes still—is developed.

Next, perhaps (as happens in many cases), the departed chieftain or patriarch, still looked upon as protecting his descendants and tribesmen, becomes the guardian deity of the tribe, or the ruler of the hidden land to which the ghosts of the dead must journey. As still further evolutions from this root, we find the belief in the resurrection of the body and the transmigration of souls, the custom of embalming, and the varied ideas of the nature of the future life found in different nations.

3. Next, we must notice the great influence of man's intercourse with his fellows. Under this third head I would call attention to the action of the political condition or environment, as a differentiating factor. In ancient times, the connection between religion and government was far closer than we see almost anywhere to-day. That separation between church and state, that independence of politics and faith so prevalent everywhere to-day, was unknown to antiquity. The state and the church were one. The king was high-priest by virtue of his office, and the priest as much a state or civic official as judge or warrior-chief. Not infrequently, the same individual held both what we now distinguish as secular and sacred offices. Among the ancient Aryans—as with the early Hindoos, Greeks, and Romans—religion

was a domestic rite. Each home had its altar and its sacred fire, whose flame must never be allowed to go out. And so the word *hestia* or *vesta*—the *fixed* place for the family hearth-fire—came to represent the divine mother, the guardian of the family, who, if duly honored, would preserve it in honor and prosperity. It was the office of the father or grandfather, the living head of the family, to pour on the sacred flame the offerings of meal and butter, to offer the incense and pour out the libations, and to salute with prayer and praise the beneficent god of light, at his morning rising; or when, by neglect properly to feed the deity of the hearth, the god had left them, it was the duty of the father to bring him back, by the friction of the sacred sticks.

As families increased to tribes, and tribes were consolidated, the chief of the tribe, the patriarch of the community became, of course, the proper officer to perform the religious rites for the greater social body; as was the case in ancient Egypt, Assyria, Greece, and Rome, and is still the case in China to-day. The gods were conceived of as belonging to and concerned only with the tribe or nation that worshiped them; often, indeed, were imagined inseparable from a particular land; and he who went away from it was beyond the protection of his accustomed gods.

Thus David, in his well-known appeal (1 Samuel, xxvi, 19), says to Saul, If men have stirred thee up against me, they are cursed, for they have driven me out this day from dwelling in Jehovah's heritage, saying to me, Go, serve other gods. The idea that *all* lands might be under the care of one god, and the people of different nations might be of one religion, was a conception slow in arising. Whoever belonged to a tribe or nation was bound to worship the gods of that nation. When a man was adopted into a nation, or a woman married into another *gens* or tribe, such a person was held to adopt the divinities and tutelar deities of their new companions also. The promise of Ruth to Naomi, "Thy people shall be my people, and thy God my God," was not an exceptional but a necessary conjunction. To disown or ignore the gods of one's fathers was to disown one's nationality.

Conversely, the god of a special people *must* protect and favor his own. In the historical books of the Old Testament, e. g., we see many times appearing the idea that Jehovah's honor is so bound up with that of his people that he could not neglect to protect and bless them, no matter how great his wrath against their trespasses. The existence of foreign gods was not at all disbelieved, nor their power denied. But they were looked upon as naturally confining their favors to their own land and people. It was proper that their own people should worship them, but to foreigners they would be indifferent or hostile. To introduce strange gods into the state was therefore a dangerous experiment, entailing the risk of alienating their rightful divine protectors.

Similarly, the idea of seeking proselytes to one's own religion was, at first, quite antagonistic to the instincts of faith. The favor of Brahma, the blessings of Jehovah, were *privileges* of the chosen people of these gods; especial boons, which were not to be rashly cheapened by admitting foreigners to them. The *sudra*, however, desirous of knowing and worshiping the Brahmanic deities, was never allowed to read the Veda, or join in the most holy ceremonies.

Now, from this local character of ancient divinities it is evident what greater influence political conditions would have on religion than is possible in our day, when state and church are so independent of each other. In races, like the Aryan, where the early organization was into small communities with a patriarchal or *quasi*-republican government, where both the diversified face of the land and their own free spirit kept a host of small cities and states in independent existence, there the loose coalescence which comes through commerce, and identity of speech and civilization into a national life and religion, does nothing to destroy the various local gods, and we have, as in India, Greece, and Germany, a bewildering pantheon of divinities, many most similar to one another, because originally representative of aspects of the *same natural* objects or phenomena. Their religion was as full of variety and as lacking in centralization as their political system.

The first result on religion of advance toward national unity is, therefore, a great multiplication of deities. But soon other forces are called into play. Wherever, by conquest, intermarriage of princes, or treaties of alliance, two or more small states are thoroughly merged into a larger, there a *coalescence* of their gods and *diminution* of the number of the divinities are apt to take place. While their fetich-gods—divinities of merely local origin, mountain, earth, tree, cavern, river—would be different, the elemental gods—deities of sun, moon, sky, wind, and storm—would be common to both, and have more or less common features. They would, therefore, be readily identified, and their worship, under a name and ritual compounded, very likely, from the traditions of both tribes, would gain in popularity, while the more local gods, worshiped only by parts of the new nation, would fall into oblivion.

Again, when an ancient nation was subjugated, it was not believed to be due merely to the weakness of the people, or their inferior courage or military skill; but the people's tutelar deities were supposed to have withdrawn their protection, or to have been shown inferior in their guardian power to the gods of the victorious people. The people often, therefore, *voluntarily* abandoned their own deities, to secure the more effective protectorship of the victorious gods. In the wake of the great armies of Assyria and Rome, faith after faith of antiquity was left a wreck of its former self, its sacred prestige ruined, and its gods degraded into subordinates of the triumphant foreign deities.

The conquerors sometimes relentlessly stamped out the worship of the conquered. Often, out of policy or pity, they gave it a *quasi*-recognition; and then came about an amalgamation of beliefs.

These international religions tended to subdue the ethnic distinctions and local worships, and to give prominence to the higher and more universal deities. Thus, the great monarchies of antiquity, through their very tyranny and the absoluteness of the royal power in them, broke the path for the universal religions. The Roman Empire was the forerunner that made straight the way for Christianity. Sargon of Assyria is no more famous for his conquests than for his systematization of the Mesopotamian religion. And in Egypt we find its *religion* unified step by step with the *government*. The rival cycles of gods and goddesses, the varied triads of its different epochs, the confusing medley of divinities, great and small, of whom, now one, now another, is said to be the supreme, can never be comprehended until we recognize that the *political unity* of Egypt was not *original* or constant, but a growth, through the consolidation of the forty-two distinct *nomes* or districts which occupied the length of the valley.

Each of these little kingdoms, or duchies, as we may call them (resembling, in their relations to one another, the little duchies of Germany before Prussia swallowed them up so effectually), had its capital, its hereditary duke, its special deity or deities, and its shrine or great temple. We find the names of the Egyptian gods followed by the name of their special home, as Neith of Sais; Aman-Ra, chief in Aptu, i. e., Thebes. When gods of the same name or origin were worshiped in different places, they were regarded as more or less different deities, and often had different characteristics or symbols.

Thus we find four Sets mentioned in one inscription and six Anubises in another. Though originating from the same natural object, different aspects of the divine power were deified in each. When at length these independent districts were united in a single empire and a close social unity, the deities were naturally consolidated more or less.

Out of political comity and national sympathy, the people of each nome would admit the deities of other sections as also venerable and worshipful; but, in their own grading of the comparative dignity of the various gods, each would put its own local deities in the chief seats, and make the deities of other districts subordinate to them. Hence would arise distinctions among the gods, as, some of the first order, others of the second, others of the third. Those that in one nome, say, that of Thebes, were placed at the head, in another, such as that of Memphis, always jealous of its rival for the dignity of the metropolitanship of Egypt, would be likely to be put down into the second or third class, to make room for the ancient hereditary favorites of the worshipers of that locality.

As, in the political struggles of the country, one nome after another became the seat of the central government—now This, now Thebes, now Memphis, now Tanais—or as the royal house (through some dynastic change, or intermarriage with princesses from a distance) favored one or another local group of gods or particular deity, so the hierarchical order and the very character of the deities shifted. Thus, when the Hyksos came into power, a Semitic dynasty, they favored especially the god *Set*, whom they fancied identical with their own Sedeq or El-Shaddai. They took him for their providential leader, and discouraged the worship of the other gods. But when, by their oppressions, they had stirred up the Egyptians, at length, to revolt, and were driven out of the country, Set, though before an honored deity, was now associated with all that was evil, and was credited with entire malevolence, and made, instead of Apap, the serpent of darkness, the great antagonist of the beneficent Osiris. The hatred of the Egyptians for the very *name* of Set was carried so far that it was chiseled out of the monuments ; the day that had been dedicated to him became the Black Friday of the Egyptians ; and the animals chosen to symbolize him were the most hateful monsters known to them, the crocodile and the hippopotamus : he became, in short, the almighty destroyer and blighter—the great devil of their pantheon.

This is no isolated instance. Repeatedly do we find wars between nations, arraying their gods, in the popular belief, in hostility ; and the only historical record we have of the military conflict is the myth of the wars between the supernatural guardians of the different peoples. Such a myth is that of the wars between the Hellenic gods and the Titans and giants, and the celestial usurpation by which Zeus and Apollo drive Saturn from his throne, banishing the sons of earth to the regions of night and death, burying Enceladus under Etna, and fastening Prometheus by eternal fetters to his rock of punishment. The historical fact beneath this is the struggle between the celestial deities of the Aryan invaders and the rude, burly peasant gods of the peasant aborigines.

Similarly, out of the conflicts of the Iranians with their brother-people, the Brahmans—whom they seem at first to have accompanied in their migration from Bactria—we have a religious change of a notable character. One part of the immigrants, the Iranians, seemed to desire to cease their wanderings and adopt a settled agricultural life ; the other were unwilling to do so, and would not respect the inclosed fields of the Iranians. Hence an hereditary feud, that antagonized them religiously as well as politically. Originally, both the words *devas*, i. e., the bright ones, and *asuras*, the living ones, were used as names of the Aryan gods, both terms being terms of respect and love. But gradually the term *deva* came to be the favorite with the Brahmans, and the term *asura* or *ahura* the favorite with the Iranians. But, after the feud broke out, we find the *asuras* of the Iranians becoming such an object of dislike to the Brahmans that gradually the word ceased to be used for the good gods, to whom the term *devas* was appropriated. And to the Iranians, the *devas* of their foes became so hateful that the word became synonymous with evil spirit—a meaning still retained in our word devil. Out of the throes of this bitter early contest of the Parsees came that trumpet-call to intensest and unceasing struggle against all sin and impurity and wickedness that put the religion of Zarathushtra on such an astonishingly lofty moral plane.

Thus, when two nations stand for a length of time in hostility, neither prevailing, the result is usually to intensify the special peculiarities in the faith of each and widen their diversity. But, when one *conquers* the other, the result is generally to amalgamate the religions of the two peoples, in more or less degree. It is natural, of course, that the faith of the subjected people should be shaped over in the mold of the victor's faith. But the reverse of this is almost equally common, and we repeatedly see, as we follow down the course of history, the race conquered in battle gradually reasserting itself under the new *régime*, and subduing the conquerors, socially and religiously, by infusing among them the customs and faith they had sought at first to trample under foot. Thus, we find the Turanian peoples whom the Iranians subdued in Persia retaliating upon the victors, by unconsciously, as the years went by, introducing into the higher Zarathushtran faith the doctrine of the *fravashis*, or ancestral tutelary spirits, the magical practices and excessive adoration of fire, and the *soma*, or drink of immortality—none of which seemed native to the Aryan religion.

So in the Brahman religion, the idea of the transmigration of souls, quite absent from the early Vedic hymns, becomes, when we reach the time of the collection called the laws of Manu, one of the most prominent features of the religion. Unknown as it is in all other branches of the Aryan family, its rise and prominence among the Brahmans are to be referred to the pre-Aryan occupants of the Ganges Valley, whom the Aryans conquered and absorbed, and from whose belief in it the Brahmans derived it, when, at length, the conquerors and conquered had been fused together into one people. So with the animal-worship of Egypt, so opposite in character to the worship of Osiris and Ra. It is best explainable as a remnant of the religion of the inferior people who inhabited the land of the Nile in far remote ages, and who were subdued by the emigrants from Asia, who brought higher knowledge and a more spiritual faith with them and founded the wonderful civilization that in ancient times distinguished that land. The new faith, unfortunately, could not wean the common people altogether from their grosser faith, but was forced to receive much of it into itself.

Again, we may notice the influence of political considerations, in establishing some of the peculiar institutions of religion, such as that of caste, which has played such a great *rôle* in Hindoo society. In the oldest hymns of the Vedas, we find no mention of it. It arose out of the bitter struggles against the non-Aryan people—the dark race, whom, at last, they succeeded in conquering. The word for *caste-varna* means kind or color, and indicated at first the difference between the whiter conquering race and the darker-tinted race whom they subdued, and with whom they would brook no slightest intercourse nor mixture, no relation but that of a slave to his masters.

This strong antipathy of race and bitter contempt for all who could not fight, nor recite the sacred hymn, petrified into impassable barriers. Pride of birth and intolerance of spirit united to increase these hereditary disabilities, and the priestly class did not fail to fan the fire of superstition that gave them such privileges. But, much as the Brahmans, at first and probably since, have congratulated themselves on the advantages of the institution, the student of history beholds, as its product, the most bitter fruit—an intolerable rigidity, a cumbrous ceremonialism, and the alienation and degradation of the common people. It was no wonder that ere long Buddhism should arise, and in the strength of the popular disaffection sweep over all India, and if, in another century, it lost this conquest, yet should go on in triumphant march over Eastern Asia, till it came to number more souls in its ranks than any other faith.

4. We must notice the great influence of man's varied social conditions in differentiating religious belief. The level of religion with any people corresponds to the general level of social organization and refinement. "Thou art fellow with the spirit that thy mind can grasp," is the pregnant monition of Mephistopheles in Goethe's "Faust." The coarse, imbruted, petty-minded man can not entertain any high or pure notions of God. The negroes of the West Coast represent their deities as black and mischievous, delighting to torment men in various ways. The god of the Polynesian cannibals is believed by them to feed on the souls of the men sacrificed to him, as they themselves do on the bodies. When the negro's fetich does not bring him good fortune, the stock or stone gets a drubbing.

Among tribes that still remain in the predatory state, subsisting by hunting, and continually resorting to plunder and war, we find religion in its crudest forms. Animal-worship, great regard for omens and use of magic, and shamanistic practices of all sorts, swarm in their religions. Their rites are apt to be cruel and their sacrifices bloody, often demanding human victims. The religions of the warlike negroes of the Gold Coast, the Feejee-Islanders, and the hunting tribes of America, illustrate this.

Even where nations have risen to a high level of civilization, but have retained their military habits, as the Assyrians and the Aztecs, e. g., there the sanguinary and revolting character of their religion shows the same influence. On the other hand, where pastoral life prevails, there, as among the Hottentots and Caffres, religion has a milder aspect; while, among those tribes which, besides cattle-breeding and agriculture, have engaged also in industry and commerce, a still more humane spirit characterizes their worship.

A similar difference, though on a less pronounced scale, is seen in the two elements that united to form the Greek nation. The older stock, whose blood ran in the peasantry, were a half-savage people and their gods consequently rude—half-bestial satyrs and centaurs, black Demeters, images of the unsown earth; mountain Titans, uncouth Pan; thievish, tricksy Hermes; the mighty but reckless, wanton Heracles, type of the red and angry sun, gods but half-focused in the minds of their own worshipers, and represented often by rude blocks of wood and stone. But these could not content the spiritual demands of the later comers, the more polished Iranians, finer of temperament, and imbued by their contact with the civilization of Asia Minor with higher tastes. So we find among them more graceful and elevated gods—stately Hera and chaste Artemis, heaven-born Pallas and the beauteous Apollo—noble ideals of the highest manhood and womanhood that they could conceive.

And as civilization still further progresses, as peace and law become the rule in the community, as arts and knowledge increase, the conceptions of the divine and the worship suitable for him rise proportionately. With the exacter study of nature, sorcery and omens become less credible. The gods themselves are seen to be subject to an unchangeable order. Indications of intelligence, of goodness, and of rectitude in the world, point irresistibly to a divine with the high attributes from which alone these effects can proceed. As the reason grows, the crude polytheism in which man at first rested is found environed with perplexities and inconsistencies. Reason pushes steadily toward the universal and the single. If the thunder-cloud was a divine being, why not every *drop* of rain that fell? If the lion or bull was a god, why not every fly and midge? In revolt against such cheapening of the idea of divinity, there would arise, with the development of intelligence, a tendency to absorb the host of gods in fewer and more potent gods. Next, the interaction of nature's processes would be noted. The fire that warms the house is recognized as essentially one and the same force with that which flushes the sky at dawn, flashes from the solar orb, or gleams in the lightning's quick illumination: "Thou Agni," as the Vedic poet at length cried—"thou Agni art Indra, art Vishnu, art Brahman-aspati. Thou Agni art born Varuna, becomest Mitra when kindled. In thee, son of strength, art all the gods."—("Rig-Veda," vii, 30, 31, vii, 1–3.)

As observation widens, then, the diverse parts of nature are more and more woven into one web. The various deities are recognized as but *aliases* under which a single power hides. The unity of the world forbids us to think of it as the prey of numberless capricious and independent personalities. Thus the early scientific investigators, as Anaxagoras and Parmenides, necessarily broke with polytheism, and proclaimed the essential oneness of that power from which all came. Men of philosophic spirit everywhere, whether in India, Egypt, China, or Rome, have pressed behind the confusing throng of pagan pantheons, to reach some elder, more eternal, more majestic, and absolute power behind them all. Nutar = the power ; Tao = the eternal principle ; Akevana Zarvana = boundless time ; Brahma = the supernatural essence of all. The questions, "Whence has all come ? What is the source of all ?" have become more and more urgent. One after another, the idols of ancient belief have been broken by the iconoclastic hammer of fuller knowledge, and the yearning arms of faith, that *must* embrace some adored object, have reached up to purer conceptions of the divine, more worthy of worship.

Or when, on the contrary, civilization is decaying, and the incursions and conquests of barbarians are, from century to century, making society coarser and rougher, as happened in Europe from the fifth to the tenth century, then we see a corresponding degeneration in religion.

How lofty and pure the spiritual truths that Jesus taught ! And, in the simple, ingenuous narratives of the gospel, what an anchor to the Christian Church to keep it, one would think, from ever drifting far away from its original place ! And yet, what melancholy degradation, what gross perversions, did Christianity lapse into among the dissolute Greeks and Romans, the rude Franks and Vandals ! As we study mediæval Christianity, with its belief in witchcraft and all sorts of pious and impious magic ; its melancholy asceticism ; the gross worship of saints, relics, and images, and deifications of Virgin and eucharistic bread and wine ; with its martial, steel-clad bishops, ready to fight in public as in private ; with its exaltation of ceremony above morality, and investment of priest and pope with supernatural power and authority—it seems almost incredible that the glad-tidings of the gospel, the simple faith that started as a message of peace on earth and good-will to men, could ever have been transformed into this. It is only by the irresistible influence of a corrupt society in the first place, and, secondly, of a barbarous society, that it is at all explainable.

The first forms of religion have well been called a kind of primitive philosophy. So, full-fledged philosophy has been the constant pioneer of a purer theology, and the diverse speculations of the intellect, from the days of Ptah-hotep and Lao-Tsee down to those of Hegel and Cousin, have been prominent forces in giving pious hearts their special directions in the religious field. According as the metaphysics of a people varies—following the empiric or the intuitive, the positive or the idealistic type—so will its religion vary. See, e. g., what a different thing Buddhism developed into among the nation of positivists, the Chinese, from the form it took among the idealistic Brahmans.

The student of history, as he looks back at the great religious movements of the world, can discern how each great wave of spiritual feeling was preceded, prepared for, and received its direction from, some philosophic current. Aristotle, e. g., did more to determine the special phase of mediæval Christendom than any of its popes. These four philosophers, Kant, Hegel, Stuart Mill, and Herbert Spencer, surpass in their influence on the religious situation any forty theologians who can be mentioned. Religion at certain epochs, such as that of the Hindoo Upanishads, the Neoplatonism of the second and third centuries, or the mediæval scholasticism, is but philosophy in priestly robe.

As religions develop, the work of conscious thought and reasoning becomes greater and greater. It is these that mold the warm and impressible wax of pious feeling into such different theologic types. It is these that draw up creeds, and that define doctrines with ever-increasing detail; that subtilize over the pre-existent state of great prophets, that invent theories of incarnation and transubstantiation, and that multiply dogmatic distinctions and schemes of salvation, until the sects become multitudinous. And, if this may be said to the discredit of metaphysic speculation, to its credit, on the other side of the account, we may put the fact that it is only through the influence of the philosophic reason that religion is exalted above dull naturalism or sensuous anthropomorphism. It is impossible, by mere observation and induction, to ascend from the imperfect creation to the perfect divine. The finite universe may suggest a being of vast power and astonishing wisdom, but it demonstrates no infinitude. All that we draw from nature and the human is of the relative and transient order, and supplies no warrant to us of any absolute and eternal. Rude and uneducated minds are always found investing Deity with physical characteristics and human imperfections. "God is a good man," said Dogberry, and, to the sensuous thought, he is to-day but little more than the magnified image of our own humanity. It is by philosophic training alone that we learn to analyze and carry out to their rational conclusions those principles of reason which demand of us to recognize as most characteristic of God's attributes, beyond anything that either nature or the human body presents, those attributes of infinity, perfection, and absolute existence, which constitute true divinity.

5. Similarly the *moral* condition of a people is a most important variable in its development. Ideas of heaven and hell correspond to the moral elevation of the community. The warlike Maori imagined life after death a constant series of battles, in which the gods are always victorious. The Moslem's paradise excites our disgust by its sensualities; the Greek's, by its trivialities. It is only where the moral nature is elevated that heaven is ennobled to a place worthy the longings of a manly man.

God-fearing armies, as Carlyle tells us, are the best armies. So, as Bagehot has pointed out, those kinds of morals and that kind of religion which tend to make the firmest and most effectual character are sure to prevail, all else being the same ; and creeds or systems that conduce to a soft, limp mind tend to perish. Strong beliefs win strong men, and then make them stronger. Such is, no doubt, another cause why monotheism tends to prevail over polytheism. It at once attracts and produces steadier character. It is not confused by competing rites nor distracted by miscellaneous duties.

As in man, at the outset, the moral and spiritual faculties lie mostly latent, overshadowed by his animal wants and passions, so the gods, in whose image he fashions at first the dimly discerned divine, are beings of physical power and sensuous nature, personifications of giant strength, imperative will, terrible passions, dangerous to arouse—a wanton Mylitta, a thievish Hermes, an implacable Pluto, the Moloch only to be propitiated by giving him the best-beloved child to devour in his sacred flame ; or a burly Thor, whose hammer-blows rive huge valleys in the ground, to whom any deceit by which he may overcome his foes is entirely allowable.

From this low nature range, where morality is not yet known, the conceptions of the gods move up to the philosophic level, and from that to the ethical range. The Hindoo Rita, at first simply the fixed path of the sun or other heavenly bodies, became, as the next step, generalized in *law* or *order* in the abstract ; and then was exalted into the celestial path of rectitude and peace, the eternal power making for righteousness. Osiris, at first the setting sun, becomes next the mysterious principle of life and harmony ; then, the great judge of men's conduct, the source of good.

All nature-religions, derived as they are from the physical world and its processes, and originating in the infancy of civilization, are ethically imperfect. They are not *immoral*, so much as innocent of those distinctions, modesties, and virtues, to which so much regard is later given. But, just because of this, many incidents of their sacred histories come in time to seem impure and revolting. While Zeus was clearly recognized as the sky that fertilizes the earth and quickens nature, the myths of his manifold amours—how, in swan-garb of feathery cirrhus, he approaches and overshadows Leda ; how in a shower of golden, sunlight rain he impregnates Danaë, the imprisoned earth of frosty spring—all these would be intelligible and inoffensive. But when Zeus became the supreme ruler of earth and heaven, the all-holy law-giver, then men could not but soon find these narratives shocking to their moral sense. We do not easily bear the thought that the objects of our worship should be inferior in any respect to ourselves. When this is felt, then the worship must be radically reformed, or it falls before some faith of purer type.

All the great universal religions—Buddhism, Christianity, and

Mohammedanism—are distinguished for their high moral quality, and by this won their glorious victories; and their crystallization in the heart of a noble-minded prophet and reformer was in each case preceded by a great social and moral quickening throughout the community in which they arose. When the depths of the human heart are moved and the imperative claims of justice, truth, and purity once perceived, then the death-knell of mere nature-worship has been rung in that land. As the pagan god, Wäinamöinen, in the Finnish epic of the Kalevala, when he hears of the birth of Christ, enters his canoe and paddles away to the northern wastes of snow and silence, so must the worship of force give way to the more majestic divinity of conscience. The varied influences of man's environment conspire with the aspiring instincts of his in most soul to conduct him constantly out of the imperfect toward the perfect. Whether or not he reach it, it is *that* that must be the goal of his striving.

ISCHIA AND ITS EARTHQUAKES.

By M. CH. VÉLAIN.

THE island of Ischia, which has recently been so terribly rent by an earthquake, is situated in the northwestern part of the Bay of Naples, and near the Phlegrean fields, with which the little island of Procida, likewise volcanic, constitutes a connecting link. It forms a part of the Neapolitan volcanic region, which may be considered as still in a state of solfatarian activity, which is exemplified by the well known solfatara of Puzzuoli, where the sulphur is re-deposited, as far as it is mined, by numerous gaseous emanations, and by the escape of carbonic acid in the *Grotto del Cane* near Lake Agnano. All of these exhalations, which are the mark of a declining volcanic activity, attest that this region, situated on a great line of fracture running northwest and southeast from Vesuvius to Vultura, is still in direct communication with the subterranean sources. The ancients fully recognized this, and regarded all those explosive craters, now transformed into a chain of remarkably picturesque lakes across the Phlegrean fields, as so many doors of Tartarus through which the infernal divinities took souls to the banks of the Acheron. The most celebrated of them, Lake Avernus, "*Atri Janua Ditis*" (the gate of black hell), now smiling and salubrious, then exhaled torrents of suffocating gases which well justified its name, and rendered a stay there mortal to the birds that ventured into its neighborhood.

The Neapolitan volcanic region extends from Vesuvius to Vultura, on the eastern edge of the Apennines, and includes the Phlegrean fields and the connected islands of Ischia and Procida. The volcanic activity of this whole space is now concentrated at Vesuvius, and is manifested at other places in the vicinity only by the emanations and thermal springs of which we have spoken, and from time to time, during periods when the volcano is inactive, by violent shocks, of which the terrible disaster of the 28th of July, at Ischia, has just given an impressive example.

Previous to the Christian era, Vesuvius, covered with a rich vegetation, was wholly inactive. Nothing except the form of the mountain could give a suspicion of the intensity of the fires that were raging beneath it. Volcanic activity, then localized in the Phlegrean fields,

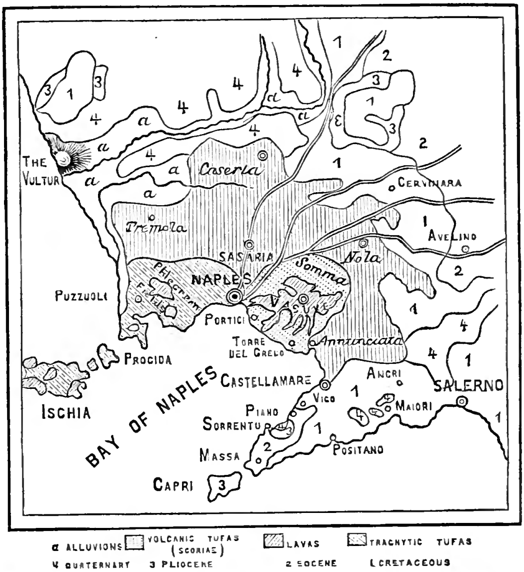

FIG. 1.—BAY OF NAPLES. GEOLOGICAL MAP SHOWING THE RELATIONS OF ISCHIA WITH THE PHLEGREAN FIELDS.

attained its maximum in Ischia, which was its escape-valve during the entire period of Vesuvian quiet. It produced then, through the action of a large number of eruptions taking place within a period of several thousand years, a considerable island, which now rises more than eight hundred metres, or two thousand six hundred feet, above the level of the sea. It is eighty kilometres, or a little less than fifty miles, in circumference at the level of the sea, eight kilometres, or not quite five miles, long from east to west, and eight kilometres, or about three miles, broad. From its center rises Mount Epomeo, which, crowned by an abrupt, semicircular rampart, which is nothing else than the eastern edge of the grand crater, whence have issued all the trachytic projections that now form the greater part of the island, presents the somber aspect of a fire-vomiting mountain. This crater has never given out lavas. Built on masses of pumiceous tufas of slight consistency, the lava-flows have always been produced upon the slope or at the base of the mountain. At each of the orifices of issue the projections forced out by tumultuous jets of gas have formed adventitious cones of dimensions often considerable, like those of il Toppo, il Trippiti, and il Garifoli; and we may count some ten such cones around Epomeo, all of which have been centers of activity and furnished large flows.

The appearance of Ischia was relatively of recent date; it is not placed farther back than the older quaternary. The foundation of the island was begun by submarine eruptions, above which opened the crater of Epomeo, at first appearing above the surface of the sea as an annular reef, from which were thrown out jets of trachytic scoria. The island was raised up in successive stages by the accumulation of the projected matter around the orifice of issue. The proof of this is drawn from the fact that we may still find on the sides of Mount Epomeo, carried to a height of four hundred and seventy metres, masses of marine shells of species yet living in the Mediterranean, encased in clays that have resulted from the decomposition of trachytic tufas under water. The whole of this trachytic mass is itself established on marls and clays, including numerous remains of Mediterranean shells, and has evidently acquired its present relief within the historical epoch.

The most ancient of the recorded eruptions in Ischia was that of Montagnone, to which is ascribed the origin of the vast crater of regular form that still existed before the recent earthquake, in a state of perfect preservation, in the northwestern part of Ischia. About 470 B. C., successive eruptions at Point Comacchia gave rise to the vast flows of Manecoco and Bale, which extended far into the sea and prolonged the point to the north. Numerous efforts have been made since these ancient times to plant colonies on this unstable land, even then fertile and covered with a luxuriant vegetation.

Lyell, who made a long exploration of the island in 1828, relates that first the Erythreans and afterward the Chalcideans, who had settled in the island before the Christian era, were driven away by the incessant earthquakes and the mephitic exhalations escaping from every point. At a later time, 280 B. C., Hiero, king of Syracuse, tried to found a colony there, but it was soon driven away by a formidable explosion preceding the great flows of lava which gave rise to the masses now forming the promontories of Zaro and Camso.

The same fate befell the Grecian colonies which afterward tried at different times to occupy the island. The eruption that forced the retreat of the first Grecian colony gave rise to Monte Rosato, that cone of projections the sudden formation of which is comparable to that of Monte Nuovo. The last-named mountain was raised in September, 1538, in forty-eight hours, at Puzzuoli, after a succession of formidable shocks which occasioned great disasters in the Phlegrean fields and destroyed a great number of Roman buildings. These two mountains of volcanic erection, formed under similar conditions, at two distinct epochs corresponding in each case with a period of repose in Vesuvius, are distinguished by their regular form, which may be compared with that of the classic volcanoes of the chain of the *puys* of Auvergne. Both, terminating in a vast crater, have emitted, like the volcanoes of Auvergne, only a single flow of lava, which seems to have exhausted all their energy. A long period of repose followed. During more than a century "Ischia the Joyous," as it was called, rested in perfect tranquillity. The pleasure-loving Romans made of it the most enchanting resort in the world; all their magnates had villas there.

It is to be remarked that this period of repose was correspondent with a resumption of activity on Vesuvius. The first symptom of an awakening of energy in that volcano was an earthquake, which in the year 68 occasioned considerable damage in the neighboring towns. We know well how, eleven years later, in 79, the hitherto peaceful mountain, covered at the time with rich plantations and forests nearly to its crater, revealed by a sudden explosion the terrible force that was sleeping in its depths. La Somma, reduced to powder, was projected into the air; then a column of thick smoke was seen to rise vertically from the summit of the mountain, and to spread horizontally, covering the country under its immense shadows. The sun was obscured even as far as to Rome, and it was believed that the "great night of the earth" was about to begin. When light was restored, the dismantled mountain had changed its form; the luxuriant forests that had covered it had disappeared, and so had the populous cities of Herculaneum, Pompeii, and Stabiæ, buried, with their inhabitants, under ashes and volcanic *débris*. From this time, Vesuvius does not appear to have emitted any eruption of lava for several hundred years; and this period of quiet at that center seems to have been marked at Ischia by a resumption of the fires of Epomeo, which had enjoyed so long a rest that large forests had grown up to the very edge of its crater. In 1302, after the island had been shaken with a succession of earthquakes during the previous year, the lava gushed out by a new opening near the city of Ischia, and in less than four hours reached the sea, having destroyed everything in its passage as if it had been a torrent of fire. The city was terribly afflicted; large houses and numerous villas were buried, with their inhabitants. The rough surface of this lava stream has resisted all weathering, and still refuses to bear any vegetation. The new eruptive phase was of long duration, and it is remarked that while it continued Vesuvius was quiet. The alternations between the eruptive movements of lava in the two volcanic centers find a natural explanation in the facts that they are both on the same line of fracture, and a subterranean communication probably exists between them.

Epomeo became tranquil after Vesuvius resumed its eruptions; and for long series of years the island of Ischia had no other outlets for the escape of the gases generated in its depths than its thirty or forty thermal springs, which have contributed, together with the pure air and the beauty of the situation, to increase every year the crowd of visitors.

Every indication tends to support the belief that Ischia, a rival to Vesuvius in the height of its volcano, is an ancient cone composed of the matter thrown up by extremely violent submarine eruptions which took place before the present epoch. As the mountain increased in height through the successive accumulations of the trachytic projections from the central crater, the weaker parts of its flanks, yielding to the height of the liquid column in the vent, were cleft in every direction; the injection of lavas into all the fissures thus formed giving rise to the flows we have just mentioned, melted in with and consolidated the structure, which is thus the result of a protracted alternation of projected *débris* and flows of compact lavas. We can in this manner account for the disposition of the grand ravines which, descending from Epomeo, plow the flanks of the mountain to a great depth.

Fig. 2.—Coast of Ischia, seen from the West, Point Comacchia.

The island has, therefore, been progressively raised above the waters, and has grown laterally during the historic period, as is testified by the flows of lava still visible on the Arso and on Monte Tabor, which are prolonged to the sea, and by the numerous secondary cones scattered over its plateaus. It definitely acquired its present relief toward the beginning of this century. Since that time, Mount Epomeo has not given any other signs of its volcanic character than those which the scientific observer might deduce from the analogy of its form with the forms of other volcanoes. Its arid, slashed summit, looking up to the sky, served as the end of the promenade for the numerous visitors who every summer frequented the thermal stations at Casamicciola, Castiglione, and San Lorenzo. Its springs, highly endowed with thermal qualities, and the exceptional fertility of its volcanic soil, on which small shrubs became arborescent, would have sufficed to give to the fortunate, healthful, and gay island great wealth, had not its earthquakes always caused apprehensions.

These disturbances of the earth, the relations of which with the volcanic structure are most evident have repeatedly brought frightful disasters upon Ischia. Hardly a trace of the splendid Roman structures once built upon it now remains; without mentioning specifically all the recorded earthquakes, that of 1881, which is still comparatively fresh in memory, partly destroyed the city of Casamicciola, which has now been obliterated. It gave a warning by which no one knew how to profit. The constitution of the soil of the island, which is com-

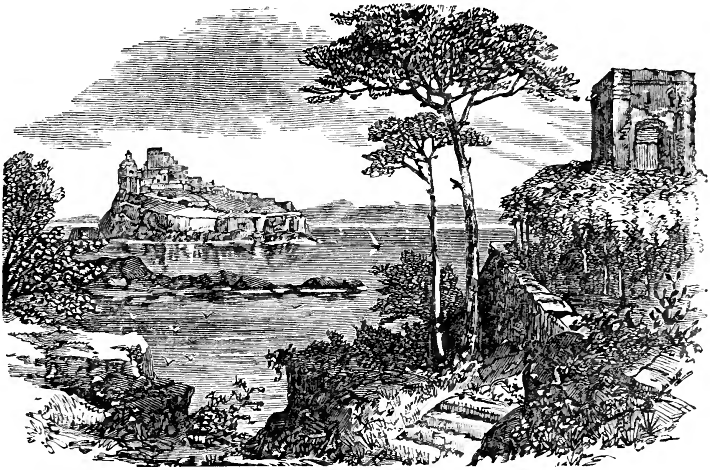

FIG. 3.—CASTLE OF ISCHIA.

posed chiefly of trachytic tufas and unconsolidated loose matters, is a considerable element in promoting these disasters.

The Ischian earthquakes are narrowly localized. Their origin is not doubtful, but is readily traceable to the efforts which the lavas and the gases, strongly compressed under the earth, make to escape. Their effects never extend to great distances. The catastrophe which has just consummated the destruction of Casamicciola, already severely shaken in 1881, is a striking example of them. A violent shock, quick as the firing of a cannon, was enough to unsettle and partly destroy the whole northern slope of the island. Procida, which was near it, was shaken, but only a few rumblings in the earth were felt on the neighboring coast. The phenomena are marked by vertical shocks, acting only upon a definite point, and violent in proportion as they are limited in extent. These shocks are propagated irregularly, without continuity, by sudden starts, across the trachytic tufas forming the subsoil of the island. Slides of the ground are thus produced, which carry off with them cultivated fields and buildings. One is sometimes tempted to compare them, on account of the formidable subterranean sounds that accompany them, and of their suddenness, to mine explosions; but the illustration would be badly chosen, for these movements have never caused a sudden rising of the soil, and there is nothing about them comparable to the disturbances produced by an explosion.

They are rather sinkings down, into a soil already cracked and partly disintegrated by the thermal waters, that have produced all these disasters which we now know have been greater in the neighborhood of the points where these springs are most active and most abundant. Casamicciola, where the hydro-thermal activity of the island is concentrated, has been destroyed forever, for prudence will demand that it never be rebuilt. A single house remains standing in the midst of that disorder of ruins and that accumulation of dead bodies that now cover the site of a watering-place once so prosperous and so thronged. The city of Ischia itself has suffered severely; Loco Ameno exists no more; Forio is almost in ruins; Porto d'Ischia has also been very much tried; and we might say that there is not one of those picturesque villas, hung upon the mountain-side, or hidden in the verdure of the valleys, that has not been damaged; and the number of victims buried under the mass of ruins will probably never be fully ascertained.

We shall have to go very far back in the history of the Neapolitan volcanoes to find an example of another such catastrophe. Since Herculaneum and Pompeii were buried under a cover of ashes and lava, the most recent great disaster we can at all compare with the destruction of Ischia is that of Potenza, which, in December, 1857, cost the lives of more than ten thousand persons. This was in Calabria—that is, in one of the provinces between Vesuvius and Etna, which have frequently been subjected to terrible disturbances.—*Translated for the Popular Science Monthly from La Nature.*

A PLEA FOR PURE SCIENCE.*

By H. A. ROWLAND,

PROFESSOR OF PHYSICS IN JOHNS HOPKINS UNIVERSITY.

THE question is sometimes asked us as to the time of year we like the best. To my mind, the spring is the most delightful; for Nature then recovers from the apathy of winter, and stirs herself to renewed life. The leaves grow, and the buds open, with a suggestion of vigor delightful to behold; and we revel in this ever-renewed life of Nature. But this can not always last. The leaves reach their limit; the buds open to the full, and pass away. Then we begin to ask ourselves whether all this display has been in vain, or whether it has led to a bountiful harvest.

So this magnificent country of ours has rivaled the vigor of spring in its growth. Forests have been leveled, and cities built, and a large

* Vice-Presidential Address delivered before Section B, of the American Association for the Advancement of Science, August 15, 1883. Abridged for The Popular Science Monthly.

and powerful nation has been created on the face of the earth. We are proud of our advancement. We are proud of such cities as this, founded in a day upon a spot over which, but a few years since, the red-man hunted the buffalo. But we must remember that this is only the spring of our country. Our glance must not be backward; for, however beautiful leaves and blossoms are, and however marvelous their rapid increase, they are but leaves and blossoms, after all. Rather should we look forward to discover what will be the outcome of all this, and what the chance of harvest. For, if we do this in time, we may discover the worm which threatens the ripe fruit, or the barren spot where the harvest is withering for want of water.

I am required to address the so-called physical section of this Association. Fain would I speak pleasant words to you on this subject; fain would I recount to you the progress made in this subject by my countrymen, and their noble efforts to understand the order of the universe. But I go out to gather the grain ripe to the harvest, and I find only tares. Here and there a noble head of grain rises above the weeds; but so few are they that I find the majority of my countrymen know them not, but think that they have a waving harvest, while it is only one of weeds, after all. American science is a thing of the future, and not of the present or past; and the proper course of one in my position is to consider what must be done to create a science of physics in this country, rather than to call telegraphs, electric lights, and such conveniences, by the name of science. I do not wish to underrate the value of all these things: the progress of the world depends on them, and he is to be honored who cultivates them successfully. So also the cook who invents a new and palatable dish for the table benefits the world to a certain degree; yet we do not dignify him by the name of a chemist. And yet it is not an uncommon thing, especially in American newspapers, to have the *applications* of science confounded with pure science: and some obscure American who steals the ideas of some great mind of the past, and enriches himself by the application of the same to domestic uses, is often lauded above the great originator of the idea, who might have worked out hundreds of such applications, had his mind possessed the necessary element of vulgarity. I have often been asked which was the more important to the world, pure or applied science. To have the applications of a science, the science itself must exist. Should we stop its progress, and attend only to its applications, we should soon degenerate into a people like the Chinese, who have made no progress for generations, because they have been satisfied with the applications of science, and have never sought for reasons in what they have done. The reasons constitute pure science. They have known the application of gunpowder for centuries; and yet the reasons for its peculiar action, if sought in the proper manner, would have developed the science of chemistry, and even of physics, with all their numerous applications. By contenting themselves with the fact that gunpowder will explode, and seeking no further, they have fallen behind in the progress of the world ; and we now regard this oldest and most numerous of nations as only barbarians. And yet our own country is in this same state. But we have done better ; for we have taken the science of the Old World, and applied it to all our uses, accepting it like the rain of heaven, without asking whence it came, or even acknowledging the debt of gratitude we owe to the great and unselfish workers who have given it to us. And, like the rain of heaven, this pure science has fallen upon our country, and made it great and rich and strong.

To a civilized nation of the present day, the applications of science are a necessity ; and our country has hitherto succeeded in this line, only for the reason that there are certain countries in the world where pure science has been and is cultivated, and where the study of nature is considered a noble pursuit. But such countries are rare, and those who wish to pursue pure science in our own country must be prepared to face public opinion in a manner which requires much moral courage. They must be prepared to be looked down upon by every successful inventor whose shallow mind imagines that the only pursuit of mankind is wealth, and that he who obtains most has best succeeded in this world. Everybody can comprehend a million of money ; but how few can comprehend any advance in scientific theory, especially in its more abstruse portions ! And this, I believe, is one of the causes of the small number of persons who have ever devoted themselves to work of the higher order in any human pursuit. Man is a gregarious animal, and depends very much, for his happiness, on the sympathy of those around him ; and it is rare to find one with the courage to pursue his own ideals in spite of his surroundings. In times past, men were more isolated than at present, and each came in contact with a fewer number of people. Hence that time constitutes the period when the great sculptures, paintings, and poems were produced. Each man's mind was comparatively free to follow its own ideals, and the results were the great and unique works of the ancient masters. To-day the railroad and the telegraph, the books and newspapers, have united each individual man with the rest of the world : instead of his mind being an individual, a thing apart by itself, and unique, it has become so influenced by the outer world, and so dependent upon it, that it has lost its originality to a great extent. The man who in times past would naturally have been in the lowest depths of poverty, mentally and physically, to-day measures tape behind a counter, and with lordly air advises the naturally born genius how he may best bring his outward appearance down to a level with his own. A new idea he never had, but he can at least cover his mental nakedness with ideas imbibed from others. So the genius of the past soon perceives that his higher ideas are too high to be appreciated by the world ; his mind is clipped down to the standard form ; every natural offshoot upward is repressed, until the man is no higher than his fellows. Hence the world, through the abundance of its intercourse, is reduced to a level. What was formerly a grand and magnificent landscape, with mountains ascending above the clouds, and depths whose gloom we can not now appreciate, has become serene and peaceful. The depths have been filled, and the heights leveled, and the wavy harvests and smoky factories cover the landscape.

As far as the average man is concerned, the change is for the better. The average life of man is far pleasanter, and his mental condition better, than before. But we miss the vigor imparted by the mountains. We are tired of mediocrity, the curse of our country. We are tired of seeing our artists reduced to hirelings, and imploring Congress to protect them against foreign competition. We are tired of seeing our countrymen take their science from abroad, and boast that they here convert it into wealth. We are tired of seeing our professors degrading their chairs by the pursuit of applied science instead of pure science; or sitting inactive while the whole world is open to investigation; lingering by the wayside while the problem of the universe remains unsolved. We wish for something higher and nobler in this country of mediocrity, for a mountain to relieve the landscape of its monotony. We are surrounded with mysteries, and have been created with minds to enjoy and reason to aid in the unfolding of such mysteries. Nature calls to us to study her, and our better feelings urge us in the same direction.

For generations there have been some few students of science who have esteemed the study of nature the most noble of pursuits. Some have been wealthy, and some poor; but they have all had one thing in common—the love of nature and its laws. To these few men the world owes all the progress due to applied science, and yet very few ever received any payment in this world for their labors.

Faraday, the great discoverer of the principle on which all machines for electric lighting, electric railways, and the transmission of power, must rest, died a poor man, although others and the whole world have been enriched by his discoveries. And such must be the fate of the followers in his footsteps for some time to come.

But there will be those in the future who will study nature from pure love, and for them higher prizes than any yet obtained are waiting. We have but yet commenced our pursuit of science, and stand upon the threshold wondering what there is within. We explain the motion of the planet by the law of gravitation; but who will explain how two bodies, millions of miles apart, tend to go toward each other with a certain force?

We now weigh and measure electricity and electric currents with as much ease as ordinary matter, yet have we made any approach to an explanation of the phenomenon of electricity? Light is an undulatory motion, and yet do we know what it is that undulates? Heat is motion, and yet do we know what it is that moves? Ordinary matter is a common substance, and yet who shall fathom the mystery of its internal constitution?

There is room for all in the work, and the race has but commenced. The problems are not to be solved in a moment, but need the best work of the best minds, for an indefinite time.

Shall our country be contented to stand by, while other countries lead in the race? Shall we always grovel in the dust, and pick up the crumbs which fall from the rich man's table, considering ourselves richer than he because we have more crumbs, while we forget that he has the cake, which is the source of all crumbs? Shall we be swine, to whom the corn and husks are of more value than the pearls? If I read aright the signs of the times, I think we shall not always be contented with our inferior position. From looking down we have almost become blind, but may recover. In a new country, the necessities of life must be attended to first. The curse of Adam is upon us all, and we must earn our bread.

But it is the mission of applied science to render this easier for the whole world. There is a story which I once read, which will illustrate the true position of applied science in the world. A boy, more fond of reading than of work, was employed, in the early days of the steam-engine, to turn the valve at every stroke. Necessity was the mother of invention in his case: his reading was disturbed by his work, and he soon discovered that he might become free from his work by so tying the valve to some movable portion of the engine as to make it move its own valve. So I consider that the true pursuit of mankind is intellectual. The scientific study of nature, in all its branches, of mathematics, of mankind in its past and present, the pursuit of art, and the cultivation of all that is great and noble in the world—these are the highest occupations of mankind. Commerce, the applications of science, the accumulation of wealth, are necessities which are a curse to those with high ideals, but a blessing to that portion of the world which has neither the ability nor the taste for higher pursuits.

As the applications of science multiply, living becomes easier, the wealth necessary for the purchase of apparatus can better be obtained, and the pursuit of other things besides the necessities of life becomes possible.

But the moral qualities must also be cultivated in proportion to the wealth of the country, before much can be done in pure science. The successful sculptor or painter naturally attains to wealth through the legitimate work of his profession. The novelist, the poet, the musician, all have wealth before them as the end of a successful career. But the scientist and the mathematician have no such incentive to work: they must earn their living by other pursuits, usually teaching, and only devote their surplus time to the true pursuit of their science, And frequently, by the small salary which they receive, by the lack of instrumental and literary facilities, by the mental atmosphere in which they exist, and, most of all, by their low ideals of life, they are led to devote their surplus time to applied science or to other means of increasing their fortune. How shall we, then, honor the few, the very few, who, in spite of all difficulties, have kept their eyes fixed on the goal, and have steadily worked for pure science, giving to the world a most precious donation, which has borne fruit in our greater knowledge of the universe and in the applications to our physical life which have enriched thousands and benefited each one of us? There are also those who have every facility for the pursuit of science, who have an ample salary and every appliance for work, yet who devote themselves to commercial work, to testifying in courts of law, and to any other work to increase their present large income. Such men would be respectable if they gave up the name of professor, and took that of consulting chemists or physicists. And such men are needed in the community. But for a man to occupy the professor's chair in a prominent college, and, by his energy and ability in the commercial applications of his science, stand before the local community in a prominent manner, and become the newspaper exponent of his science, is a disgrace both to him and his college. It is the death-blow to science in that region. Call him by his proper name, and he becomes at once a useful member of the community. Put in his place a man who shall by precept and example cultivate his science, and how different is the result! Young men, looking forward into the world for something to do, see before them this high and noble life, and they see that there is something more honorable than the accumulation of wealth. They are thus led to devote their lives to similar pursuits, and they honor the professor who has drawn them to something higher than they might otherwise have aspired to reach.

I do not wish to be misunderstood in this matter. It is no disgrace to make money by an invention, or otherwise, or to do commercial scientific work under some circumstances. But let pure science be the aim of those in the chairs of professors, and so prominently the aim that there can be no mistake. If our aim in life is wealth, let us honestly engage in commercial pursuits, and compete with others for its possession. But if we choose a life which we consider higher, let us live up to it, taking wealth or poverty as it may chance to come to us, but letting neither turn us aside from our pursuit.

The work of teaching may absorb the energies of many; and, indeed, this is the excuse given by most for not doing any scientific work. But there is an old saying, that where there is a will there is a way. Few professors do as much teaching or lecturing as the German professors, who are also noted for their elaborate papers in the scientific journals. I myself have been burdened down with work, and know what it is; and yet I here assert that all *can* find time for scientific research if they desire it. But here, again, that curse of our country, mediocrity, is upon us. Our colleges and universities seldom call for first-class men of reputation, and I have even heard the trustee of a well-known college assert that no professor should engage in research because of the time wasted! I was glad to see, soon after, by the call of a prominent scientist to that college, that the majority of the trustees did not agree with him.

That teaching is important, goes without saying. A successful teacher is to be respected; but, if he does not lead his scholars to that which is highest, is he not blameworthy? We are, then, to look to the colleges and universities of the land for most of the work in pure science which is done. Let us therefore examine these latter, and see what the prospect is.

One, whom perhaps we may here style a practical follower of Ruskin, has stated that while in this country he was variously designated by the title of captain, colonel, and professor. The story may or may not be true, but we all know enough of the customs of our countrymen not to dispute it on general principles. All men are born equal: some men are captains, colonels, and professors, and therefore all men are such. The logic is conclusive; and the same kind of logic seems to have been applied to our schools, colleges, and universities. I have before me the report of the Commissioner of Education for 1880. According to that report, there were three hundred and eighty-nine,* or say, in round numbers, four hundred institutions, calling themselves colleges or universities, in our country! We may well exclaim that ours is a great country, having more than the whole world besides. The fact is sufficient. The whole earth would hardly support such a number of first-class institutions. The curse of mediocrity must be upon them, to swarm in such numbers. They must be a cloud of mosquitoes, instead of eagles as they profess. And this becomes evident on further analysis. About one third aspire to the name of university; and I note one called by that name which has two professors and eighteen students, and another having three teachers and twelve students! And these instances are not unique, for the number of small institutions and schools which call themselves universities is very great. It is difficult to decide from the statistics alone the exact standing of these institutions. The extremes are easy to manage. Who can doubt that an institution with over eight hundred students, and a faculty of seventy, is of a higher grade than those above cited having ten or twenty students and two or three in the faculty? Yet this is not always true; for I note one institution with over five hundred students which is known to me personally as of the grade of a high-school. The statistics are more or less defective, and it would much weaken the force of my remarks if I went too much into detail. I append the

* Three hundred and sixty-four reported on, and twenty-five not reported.

following tables, however, of three hundred and thirty so-called colleges and universities :

218	had	from	0	to	100	students.
88	"	"	100	"	200	"
12	"	"	200	"	300	"
6	"	"	300	"	500	"
6	over		500			

Of three hundred and twenty-two so-called colleges and universities—

206	had	0 to	10	in the	faculty.
99	"	10 "	20	"	"
17	"	20 or over		"	"

If the statistics were forthcoming—and possibly they may exist—we might also get an idea of the standing of these institutions and their approach to the true university idea, by the average age of the scholars. Possibly also the ratio of number of scholars to teachers might be of some help. All these methods give an approximation to the present standing of the institutions. But there is another method of attacking the problem, which is very exact, but it only gives us the *possibilities* of which the institution is capable. I refer to the wealth of the institution. In estimating the wealth, I have not included the value of grounds and buildings, for this is of little importance, either to the present or future standing of the institution. As good work can be done in a hovel as in a palace. I have taken the productive funds of the institution as the basis of estimate. I find—

234	have	below $500,000.
8	"	between $500,000 and $1,000,000.
8	"	over $1,000,000.

There is no fact more firmly established, all over the world, than that the higher education can never be made to pay for itself. Usually the cost to a college, of educating a young man, very much exceeds what he pays for it, and is often three or four times as much. The higher the education, the greater this proportion will be ; and a university of the highest class should anticipate only a small accession to its income from the fees of students. Hence the test I have applied must give a true representation of the possibilities in every case. According to the figures, only sixteen colleges and universities have $500,000 or over of invested funds, and only one half of these have $1,000,000 and over. Now, even the latter sum is a very small endowment for a college ; and to call any institution a university which has less than $1,000,000 is to render it absurd in the face of the world. And yet more than one hundred of our institutions, many of them very respectable colleges, have abused the word "university" in this manner. It is to be hoped that the endowment of the more respectable of these institutions may be increased, as many of them deserve it; and their unfortunate appellation has probably been repented of long since.

But what shall we think of a community that gives the charter of a university to an institution with a total of $20,000 endownment, two so-called professors, and eighteen students; or another with three professors, twelve students, and a total of $27,000 endowment, mostly invested in buildings! And yet there are very many similar institutions; there being sixteen with three professors or less, and very many indeed with only four or five.

Such facts as these could only exist in a democratic country, where pride is taken in reducing everything to a level. And I may also say that it can only exist in the early days of such a democracy; for an intelligent public will soon perceive that calling a thing by a wrong name does not change its character, and that truth, above all things, should be taught to the youth of the nation.

It may be urged that all these institutions are doing good work in education; and that many young men are thus taught who could not afford to go to a true college or university. But I do not object to the education—though I have no doubt an investigation would disclose equal absurdities here—for it is aside from my object. But I do object to lowering the ideals of the youth of the country. Let them know that they are attending a school, and not a university; and let them know that above them comes the college, and above that the university. Let them be taught that they are only half-educated, and that there are persons in the world by whose side they are but atoms. In other words, let them be taught the truth.

It may be that some small institutions are of high grade, especially those which are new; but who can doubt that more than two thirds of our institutions calling themselves colleges and universities are unworthy of the name? Each one of these institutions has so-called professors, but it is evident that they can be only of the grade of teachers. Why should they not be so called? The position of teacher is an honored one, but is not made more honorable by the assumption of a false title. Furthermore, the multiplication of the title and the ease with which it can be obtained render it scarcely worth striving for. When the man of energy, ability, and perhaps genius, is rewarded by the same title and emoluments as the commonplace man with the modicum of knowledge, who takes to teaching, not because of any aptitude for his work, but possibly because he has not the energy to compete with his fellow-men in business, then I say one of the inducements for first-class men to become professors is gone.

When work and ability are required for the position, and when the professor is expected to keep up with the progress of his subject, and to do all in his power to advance it, and when he is selected for these reasons, then the position will be worth working for, and the successful competitor will be honored accordingly. The chivalric spirit which prompted Faraday to devote his life to the study of nature may actuate a few noble men to give their lives to scientific work; but, if we wish to cultivate this highest class of men in science, we must open a career for them worthy of their efforts.

Jenny Lind, with her beautiful voice, would have cultivated it to some extent in her native village; yet who would expect her to travel over the world, and give concerts for nothing? and how would she have been able to do so if she had wished? And so the scientific man, whatever his natural talents, must have instruments and a library, and a suitable and respectable salary to live upon, before he is able to exert himself to his full capacity. This is true of advance in all the higher departments of human learning, and yet something more is necessary. It is not those in this country who receive the largest salary, and have positions in the richest colleges, who have advanced their subject the most: men receiving the highest salaries, and occupying the professor's chair, are to-day doing absolutely nothing in pure science, but are striving by the commercial applications of their science to increase their already large salary. Such pursuits, as I have said before, are honorable in their proper place; but the duty of a professor is to advance his science, and to set an example of pure and true devotion to it which shall demonstrate to his students and the world that there is something high and noble worth living for. Money-changers are often respectable men, and yet they were once severely rebuked for carrying on their trade in the court of the temple.

Wealth does not constitute a university, buildings do not: it is the men who constitute its faculty, and the students who learn from them. It is the last and highest step which the mere student takes. He goes forth into the world, and the height to which he rises has been influenced by the ideals which he has consciously or unconsciously imbibed in his university. If the professors under whom he has studied have been high in their profession, and have themselves had high ideals; if they have considered the advance of their particular subject their highest work in life, and are themselves honored for their intellect throughout the world—the student is drawn toward that which is highest, and ever after in life has high ideals. But if the student is taught by what are sometimes called good teachers, and teachers only, who know little more than the student, and who are often surpassed and even despised by him, no one can doubt the lowered tone of his mind. He finds that by his feeble efforts he can surpass one to whom a university has given its highest honor; and he begins to think that he himself is a born genius, and the incentive to work is gone. He is great by the side of the mole-hill, and does not know any mountain to compare himself with.

A university should not only have great men in its faculty, but have numerous minor professors and assistants of all kinds, and should encourage the highest work, if for no other reason than to encourage the student to his highest efforts.

But, assuming that the professor has high ideals, wealth such as only a large and high university can command is necessary to allow him the fullest development.

And this is specially so in our science of physics. In the early days of physics and chemistry, many of the fundamental experiments could be performed with the simplest apparatus. And so we often find the names of Wollaston and Faraday mentioned as needing scarcely anything for their researches. Much can even now be done with the simplest apparatus; and nobody, except the utterly incompetent, need stop for want of it. But the fact remains, that one can only be free to investigate in all departments of chemistry and physics, when he not only has a complete laboratory at his command, but a friend to draw on for the expenses of each experiment. That simplest of the departments of physics, namely, astronomy, has now reached such perfection that nobody can expect to do much more in it without a perfectly equipped observatory; and even this would be useless without an income sufficient to employ a corps of assistants to make the observations and computations. But, even in this simplest of physical subjects, there is great misunderstanding. Our country has very many excellent observatories: and yet little work is done in comparison, because no provision has been made for maintaining the work of the observatory; and the wealth which, if concentrated, might have made one effective observatory which would prove a benefit to astronomical science, when scattered among a half-dozen, merely furnishes telescopes for the people in the surrounding region to view the moon with. And here I strike the key-note of at least one need of our country, if she would stand well in science. . . .

Americans have shown no lack of invention in small things; and the same spirit, when united to knowledge and love of science, becomes the spirit of research. The telegraph operator, with his limited knowledge of electricity and its laws, naturally turns his attention to the improvement of the only electrical instrument he knows anything about; and his researches would be confined to the limited sphere of his knowledge, and to the simple laws with which he is acquainted. But as his knowledge increases, and the field broadens before him, as he studies the mathematical theory of the subject, and the electromagnetic theory of light loses the dim haze due to distance and becomes his constant companion, the telegraph instrument becomes to him a toy, and his effort to discover something new becomes research in pure science.

It is useless to attempt to advance science until one has mastered the science: he must step to the front before his blows can tell in the strife. Furthermore, I do not believe anybody can be thorough in any department of science without wishing to advance it. In the study of what is known, in the reading of the scientific journals, and the discussions therein contained of the current scientific questions, one would obtain an impulse to work, even though it did not before exist. And the same spirit which prompted him to seek what was already known would make him wish to know the unknown. And I may say that I never met a case of thorough knowledge in my own science, except in the case of well-known investigators. I have met men who talked well, and I have sometimes asked myself why they did not do something; but further knowledge of their character has shown me the superficiality of their knowledge. I am no longer a believer in men who could do something if they would, or would do something if they had a chance. They are impostors. If the true spirit is there, it will show itself in spite of circumstances.

As I remarked before, the investigator in pure science is usually a professor. He must teach as well as investigate. It is a question which has been discussed in late years as to whether these two functions would better be combined in the same individual, or separated. It seems to be the opinion of most that a certain amount of teaching is conducive, rather than otherwise, to the spirit of research. I myself think that this is true, and I should myself not like to give up my daily lecture. But one must not be overburdened. I suppose that the true solution, in many cases, would be found in the multiplication of assistants, not only for the work of teaching, but of research. Some men are gifted with more ideas than they can work out with their own hands, and the world is losing much by not supplying them with extra hands. Life is short: old age comes quickly, and the amount one pair of hands can do is very limited. What sort of shop would that be, or what sort of factory, where one man had to do all the work with his own hands? It is a fact in nature, which no democracy can change, that men are *not* equal—that some have brains, and some hands. And no idle talk about equality can ever subvert the order of the universe.

I know of no institution in this country where assistants are supplied to aid directly in research. Yet why should it not be so? And even the absence of assistant professors and assistants of all kinds to aid in teaching is very noticeable, and must be remedied before we can expect much.

There are many physical problems, especially those requiring exact measurements, which can not be carried out by one man, and can only be successfully attacked by the most elaborate apparatus, and with a full corps of assistants. Such are Regnault's experiments on the fundamental laws of gases and vapors, made thirty or forty years ago by aid from the French Government, and which are the standards to this day. Although these experiments were made with a view to the practical calculation of the steam-engine, yet they were carried out in such a broad spirit that they have been of the greatest theoretical use.

Again, what would astronomy have done without the endowments of observatories? By their means, that science has become the most perfect of all branches of physics, as it should be from its simplicity. There is no doubt in my mind that similar institutions for other branches of physics, or, better, to include the whole of physics, would be equally successful. A large and perfectly equipped physical laboratory, with its large revenues, its corps of professors and assistants, and its machine-shop for the construction of new apparatus, would be able to advance our science quite as much as endowed observatories have astronomy. But such a laboratory should not be founded rashly. The value will depend entirely on the physicist at its head, who has to devise the plan, and to start it into practical working. Such a man will always be rare, and can not always be obtained. After one had been successfully started, others could follow; for imitation requires little brains.

One could not be certain of getting the proper man every time, but the means of appointment should be most carefully studied, so as to secure a good average. There can be no doubt that the appointment should rest with a scientific body capable of judging the highest work of each candidate.

Should any popular element enter, the person chosen would be either of the literary-scientific order, or the dabbler on the outskirts who presents his small discoveries in the most theatrical manner. What is required is a man of depth, who has such an insight into physical science that he can tell when blows will best tell for its advancement.

Such a grand laboratory as I describe does not exist in the world at present for the study of physics. But no trouble has ever been found in obtaining means to endow astronomical science. Everybody can appreciate to some extent the value of an observatory; as astronomy is the simplest of scientific subjects, and has very quickly reached a position where elaborate instruments and costly computations are necessary to further advance. The whole domain of physics is so wide that workers have hitherto found enough to do. But it can not always be so, and the time has even now arrived when such a grand laboratory should be founded. Shall our country take the lead in this matter, or shall we wait for foreign countries to go before? They will be built in the future, but when and how is the question.

Several institutions are now putting up laboratories for physics. They are mostly for teaching, and we can expect only a comparatively small amount of work from most of them. But they show progress; and, if the progress be as quick in this direction as in others, we should be able to see a great change before the end of our lives.

As stated before, men are influenced by the sympathy of those with whom they come in contact. It is impossible to immediately change public opinion in our favor; and, indeed, we must always seek to lead it, and not be guided by it. For pure science is the pioneer who must not hover about cities and civilized countries, but must strike into unknown forests, and climb the hitherto inaccessible mountains which lead to and command a view of the promised land—the land which science promises us in the future; which shall not only flow with milk and honey, but shall give us a better and more glorious idea of this wonderful universe. We must create a public opinion in our favor, but it need not at first be the general public. We must be contented to stand aside, and see the honors of the world for a time given to our inferiors; and must be better contented with the approval of our own consciences, and of the very few who are capable of judging our work, than of the whole world besides. Let us look to the other physicists, not in our own town, not in our own country, but in the whole world, for the words of praise which are to encourage us, or the words of blame which are to stimulate us to renewed effort. For what to us is the praise of the ignorant? Let us join together in the bonds of our scientific societies, and encourage each other, as we are now doing, in the pursuit of our favorite study; knowing that the world will some time recognize our services, and knowing, also, that we constitute the most important element in human progress.

But danger is also near, even in our societies. When the average tone of the society is low, when the highest honors are given to the mediocre, when third-class men are held up as examples, and when trifling inventions are magnified into scientific discoveries, then the influence of such societies is prejudicial. A young scientist attending the meetings of such a society soon gets perverted ideas. To his mind, a mole-hill is a mountain, and the mountain a mole-hill. The small inventor or the local celebrity rises to a greater height, in his mind, than the great leader of science in some foreign land. He gauges himself by the mole-hill, and is satisfied with his stature; not knowing that he is but an atom in comparison with the mountain, until, perhaps, in old age, when it is too late. But, if the size of the mountain had been seen at first, the young scientist would at least have been stimulated in his endeavor to grow.

We can not all be men of genius; but we can, at least, point them out to those around us. We may not be able to benefit science much ourselves; but we can have high ideals on the subject, and instill them into those with whom we come in contact. For the good of ourselves, for the good of our country, for the good to the world, it is incumbent on us to form a true estimate of the worth and standing of persons and things, and to set before our own minds all that is great and good and noble, all that is most important for scientific advance, above the mean and low and unimportant.

It is very often said that a man has a right to his opinion. This might be true for a man on a desert island, whose error would influence only himself. But when he opens his lips to instruct others, or even when he signifies his opinions by his daily life, then he is directly responsible for all his errors of judgment or fact. He has no right to think a mole-hill as big as a mountain, nor to teach it, any more than he has to think the world flat, and teach that it is so. The facts and laws of our science have *not* equal importance, neither have the men who cultivate the science achieved equal results. One thing is greater than another, and we have no right to neglect the order. Thus shall our minds be guided aright, and our efforts be toward that which is the highest.

Then shall we see that no physicist of the first class has ever existed in this country, that we must look to other countries for our leaders in that subject, and that the few excellent workers in our country must receive many accessions from without before they can constitute an American science, or do their share in the world's work. . . .

We call this a free country, and yet it is the only one where there is a direct tax upon the pursuit of science. The low state of pure science in our country may possibly be attributed to the youth of the country; but a direct tax, to prevent the growth of our country in that subject, can not be looked upon as other than a deep disgrace. I refer to the duty upon foreign books and periodicals. In our science, no books above elementary ones have ever been published, or are likely to be published, in this country; aud yet every teacher in physics must have them, not only in the college-library, but on his own shelves, and must pay the Government of this country to allow him to use a portion of his small salary to buy that which is to do good to the whole country. All freedom of intercourse which is necessary to foster our growing science is thus broken off; and that which might, in time, relieve our country of its mediocrity is nipped in the bud by our Government, which is most liberal when appealed to directly on scientific subjects. One would think that books in foreign languages might be admitted free; but, to please the half-dozen or so workmen who reprint German books, not scientific, our free intercourse with that country is cut off. Our scientific associations and societies must make themselves heard in this matter, and show those in authority how the matter stands. . . .

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

THE ALCOHOL-HABIT (*concluded*).

II.

BUT, in tracing the causes which led to the present development of the poison-vice, we should not overlook the working of another principle which I must call a reaction against the effect of a wrong remedy. We can not serve our cause by ignoring its weak points, for, if we persist in closing our eyes to the significance of our mistakes, our enemies will not fail to profit by our blindness. We can not work in the dark. In order to reach our goal, we must see our way clear; and I trust that no earnest fellow-laborer will misconstrue my motive if I dare to say the whole truth.

The matter is this: At a time when the civilization of antiquity had become extremely corrupt, a society of ethical reformers tried to find the panacea for vice, as we now seek the remedy for intemperance. But, instead of recognizing the local causes of the evil, they ascribed it to the general perversity of the human heart. They, too, failed to distinguish between natural appetites and morbid appetencies, and, misled by the glaring consequences of perverted passions, they conceived the unhappy idea that man's natural instincts are his natural enemies. In order to crush a few baneful nightshades and poppy-blossoms, they began a war of extermination against the flowers of this earth. But that attempt led to an unexpected result: the soil of the trampled fields engendered weeds that were far harder to destroy than the noxious herbs of the old flower-garden. The would-be reformers had overlooked the fact that it is easier to pervert than to suppress a natural instinct; but the history of the last twelve hundred years has illustrated that truth by many dreadful examples. The suppression of rational freedom led to anarchy. Celibacy became the mother of the ugliest vices. The attempt to suppress the pursuit of natural science led to the pursuit of pseudo-science—astrology, necromancy, and all sorts of dire chimeras. The suppression of harmless pleasures has always fostered the *penchant* for vicious pleasures. The austerity of the Stoics helped to propagate the doctrines of Epicurus; in Islam the era of the Hanbalite ascetics was followed by the riots of the Bagdad caliphate; and the open licentiousness of the English anti-Puritans, as well as the secret excesses of their northern neighbors, can be distinctly traced to the mistaken zeal of the party which had waged a long and unrelenting war against every form of physical pleasure, and hoped to find salvation in the suppression of all natural desires. That doctrine has never become the permanent faith of any Aryan nation, though now and then it has reached a local ascendency which made it a grievous addition to the evils it proposed to cure. More than fifteen hundred years ago the Emperor Julian, and even St. Clemens Alexandrinus, denounced the absurdities of the Marcionite Gnostics, who "abstained from marriage, the pursuit of worldly advantages, and all temporal pleasures." The original rigor of those dogmas could not maintain itself against the healthier instincts of mankind; but what they lost in consistency they made up in aggressiveness: an influential sect of the last century attempted to enforce upon others what the Marcionites practiced in private, and, while the Syrian ascetics preferred the desert to the world, the Scotch ascetics tried to turn the world into a desert.

"According to that code," says the author of the "History of Civilization," "all the natural affections, all social pleasures, all amusements, and all the joyous instincts of the human heart, were sinful. They looked on all comforts as wicked in themselves, merely because they were comforts. The great object in life was to be in a state of constant affliction; . . . whatever pleased the senses was to be suspected. It mattered not what a man liked; the mere fact of his liking it made it sinful. Whatever was natural was wrong. It was wrong to take pleasure in beautiful scenery, for a pious man had no concern with such matters. On Sunday it was sinful to walk in the fields, or in the meadows, or enjoy fair weather by sitting at the door of your own house."

"Whatever was natural was wrong"—though even the extremists of that school might have shrunk from the consistency of their Syrian exemplar, who forbade his anchorites to sleep twice under the same tree, lest their spiritual interests should be imperiled by an undue affection for any earthly object!

If it were possible that such dogmas could ever again overpower the common sense of mankind, we should welcome the poison-mania as the lesser evil, for it is better to seek happiness by a wrong road than to abandon the search altogether. It is better to taste a forbidden fruit than to destroy all pleasant trees. But it is impossible that such chimeras should have survived their native night. After the terrible experience of the middle ages, it is impossible that any sane person should fail to recognize the significance of the mistake, and we can not hope to maintain the field against the opponents of temperance till we have deprived them of their most effective weapon: we must furnish practical proofs that they, not we, are the enemies of human happiness; that we make war upon vice, and not upon harmless pleasures.

It is a significant fact that in every civilized country of this earth drunkenness is rarest among the classes who have other and better convivial resources. In the United States, where the "almighty dollar" confers unlimited privileges, the well-to-do people are the most temperate in the world, the poor the most intemperate. In Turkey, where the lower classes are indulged in many pastimes which are considered below the dignity of an *effendi*, the poison-vice is actually confined to the upper-ten: temperance reigns in the cottage, while opium-smoking and secret dram-drinking prevail in the palace. In Scotland, where all classes have to conform to the moral by-laws which discountenance holiday recreations, total abstinence is extremely rare. For—"Nature will have her revenge, and, when the most ordinary and harmless recreations are forbidden as sinful, is apt to seek compensation in indulgences which no moralist would be willing to condone. The charge brought against the Novatians in the early ages of the Church can, with equal plausibility, be brought against the Puritans in our own day. One vice, at all events, which Christians of every school, as well as non-Christian moralists, are agreed in condemning, is reputed to be a special opprobrium of Scotland; and the strictest observance of all those minute and oppressive Sabbatarian regulations to which we referred just now has been found compatible with consecrating the day of rest to a quiet but unlimited assimilation of the liquid which inebriates but does not cheer. And under the old *régime* to be drunk in private, though of course not sanctioned as allowable, would have been accounted a far less heinous outrage on the dignity of the Sabbath than to whistle in the public street."—(The "Saturday Review," July 19, 1879, p. 75.)

There is, indeed, no doubt that the "snuffling, whining saints, who groaned in spirit at the sight of Jack in the Green,"* have driven as many pleasure-seekers from the play-ground to the pot-house as despotism has turned freemen into outlaws and robbers. For the practical alternative is not between conventicles and rum-riots, but between healthful and baneful pastimes. Before we can begin to eradicate the poison-habit we must make reform more attractive than vice; and, as long as the champions of temperance shut their eyes to the significance of that truth, their legislative enactments will always remain dead-letter laws. Our worst defects we owe, in fact, less to the shrewdness of our beer-brewing opponents than to the blindness of our Sabbatarian allies. A free Sunday-garden, with zoölogical curiosities, foot-races, and good music, would do more to promote the cause of temperance than a whole army of Hudibras revivalists.†

* Macaulay's "History," vol. i, p. 371.

† "Every one who considers the world as it really exists, and not as it appears in the writings of ascetics and sentimentalists, must have convinced himself that, in great towns, where multitudes of men of all classes and all characters are massed together, and where there are innumerable strangers, separated from all domestic ties and occupations, public amusements of an exciting order are absolutely necessary, and that, while they are often the vehicle and the occasion of evil, to suppress them, as was done by the Puritans of the Commonwealth, is simply to plunge an immense portion of the population into the lowest depths of vice."—(Lecky, "History of Rationalism," vol. ii, p. 286 (*cf.* ibid., vol. ii, p. 350.)

"Sir," said Johnson, "I am a great friend to public amusements, for they keep people from vice."—("Boswell," p. 171.)

"Insani fugiunt mundum, immundumque sequuntur."—Giordano Bruno (Moriz Carrière, "Weltanschauung," p. 396).

Individuals, too, should be treated on that plan, and, next to absolute abstinence from stimulating poisons, the most essential condition of a permanent cure is *a liberal allowance of healthful stimulants*, in the form of diverting pastimes and out-door exercise. For the chief danger of a relapse is not the attractiveness of intoxication, but the misery of the after-effect, the depressing reaction that follows upon the abnormal excitement, and for several weeks seems daily to gain strength against the reformatory resolves of the penitent. This apathy of the unstimulated system can become more intolerable than positive pain, and embitter existence till, in spite of prayers and pledges, its victims either relapse into alcohol or resort to cognate stimulants—chloral, absinthe, or opium. In stress of such temptations the prophylactic influence of a *mind-stimulating occupation* is almost as effective as is the *deliquium* of disappointed love. *Ennui* is the chief coadjutor of the poison-fiend. On the *Militär-Grenze*, the "Military Frontier" of Eastern Austria, a soldier's life is a ceaseless guerrilla-war against smugglers, outlaws, and Bulgarian bed-bugs; yet hundreds of German officers solicit transfer to that region as to a refuge from the temptations of garrison tedium, deliberately choosing a concentration of all discomforts, as a *Schnapps-Kur*, a whisky-cure, as they express it with frank directness; and for similar purposes many of Fremont's contemporaries took the prairie-trail to the adventure-land of the far West. Frederick Gerstaecker found that the California rum-shops got their chief patronage from unsuccessful miners; the successful ones had better stimulants.

For the first month or two the convalescent should not content himself with negative safeguards, but make up his mind that temptations will come, and come in the most grievous form, and that active warfare is nearly always the safest plan. The alcohol-habit is a physical disease, and a Rocky Mountain excursion, a visit to the diggings, a month of sea-side rambles and surf-baths, will do more to help a convert across the slough of despond than a season-ticket to all the lecture-halls of the Christian Temperance Union.

But such excursions should be undertaken in company. Soldiers in the ranks will endure hardships that would melt the valor of any solitary hero; and in the presence of manly companions the spirit of emulation and "approbativeness" will sustain even an enervated fellow. The *esprit de corps* of a temperance society is more cogent than its vows.

An *appeal to the passions* is the next best thing. Everything is fair in the war against alcohol: love, ambition, pride, and even acquisitiveness, may be utilized to divert the mind from a more baneful propensity—for a time, at least. For, after the tempter has been kept at bay for a couple of months, its power will reach a turning-point; the nervous irritability will subside, the outraged digestive organs resume their normal functions, and the potency of the *poison-*

hunger will decrease from day to day. After that the main point is to gain time, and give Nature a fair chance to complete the work of redemption. As the *vis vitæ* recovers her functional vigor the employment of other tonics can be gradually dispensed with, except in the moments of unusual dejection that will now and then recur—especially on rainy days and after sultry nights. But in most such cases the demon can be exorcised with the price of an opera-ticket, and not rarely with *a liberal dinner*. "Good cheer" is a suggestive term; the mess, as well as music, has power to soothe the savage soul, and, before invoking the aid of medicinal tonics, Bibulus should try the dulcifying effect of digestible sweetmeats.

But, on the other hand, when luck and high spirits give a sufficient guarantee against present temptation, no opportunity should be missed to forego a meal. *Fasting* is a great system-renovator. Ten fast-days a year will purify the blood and eradicate the *poison-diathesis* more effectually than a hundred bottles of expurgative bitters.

And only then, after the paroxysmal phase of the baneful passion has been fairly mastered, moral suasion gets a chance to promote the work of reform. For, while the delirium or the crazing after-effects of the alcohol-fever distract the patient, exhortations are as powerless as they would be against chronic dysentery. Dr. Isaac Jennings illustrates the power of the poison-habit by the following examples: A clergyman of his acquaintance attempted to dissuade a young man of great promise from habits of intemperance. "Hear me first a few words," said the young man, "and then you may proceed. I am sensible that an indulgence in this habit will lead to loss of property, the loss of reputation and domestic happiness, to premature death, and to the irretrievable loss of my immortal soul; and now with all this conviction resting firmly on my mind and flashing over my conscience like lightning, if I still continue to drink, do you suppose anything you can say will deter me from the practice?"

Dr. Mussey, in an address before a medical society, mentioned a case that sets this subject in even a stronger light. A tippler was put into an almshouse in a populous town in Massachusetts. Within a few days he had devised various expedients to procure rum, but failed. At length he hit upon one that proved successful. He went into the wood-shed of the establishment, placed one hand upon a block, and, with an axe in the other, struck it off at a single blow. With the stump raised and streaming, he ran into the house, crying, "Get some rum—get some rum! my hand is off!" In the confusion and bustle of the occasion somebody did bring a bowl of rum, into which he plunged his bleeding arm, then raising the bowl to his mouth, drank freely, and exultingly exclaimed, "Now I am satisfied!"

More than the hunger after bread, more than the frenzy of love or hatred, the poison-hunger overpowers every other instinct, and even the fear of death. In Mexico, my colleague, Surgeon Kellermann, of the Second Zouaves, was one night awakened by the growling of his spaniel, and thought he saw something like the form of a man crawling out of his tent. The next day the captain informed the company that some fellow had entered the hospital-camp with burglarious intent, and that he had instructed the sentries to arrest or shoot all nocturnal trespassers. About a week after, the doctor was again awakened by his dog, and, lighting a match, he distinguished the figure of a large man crawling from under his table and carrying in his hand a box or a big book. He called upon him to stop, cocking his pistol at the same time, but the fellow made a rush for the door, and in the next moment was floored by a ball that penetrated his skull two inches above the neck. He lived long enough to confess the motive of his desperate enterprise. His regiment had been stationed in Northern Algiers, where he learned to smoke opium, and having exhausted his supply, and his financial resources, as well as the patience of the hospital steward, who had at various times furnished him small doses of the drug, he felt that life was no longer worth living, and resolved to risk it in the attempt at abducting the doctor's medicine chest. What can exhortation avail against a passion of that sort? We should learn to treat it as the advanced stage of a physical disorder, rather than as a controvertible moral aberration.

And, even after the delirium of that disease has subsided, homilies should be preceded by an appeal to reason. Ignorance is a chief cause of intemperance. The seductions of vice would not mislead so many of our young men if they could realize the significance of their mistake. All the efforts of the Temperance party have thus far failed to eradicate the popular fallacy that there is some good in alcohol; that somehow or other the magic of a stimulating drug could procure its votaries an advantage not attainable by normal means. Nor is this delusion confined to the besotted victims of the poison-vice. Even among the enlightened classes of our population, nay, among the champions of temperance, there is still a lingering belief that, with due precaution against excess, adulteration, etc., a dram-drinker might "get ahead" of Nature, and, as it were, *trick* her out of some extra enjoyment.

There is no hope of a radical reform till an influential majority of all intelligent people have realized the fact that this *trick* is in every instance a *losing game*, entailing penalties which far outweigh the pleasures that the novice may mistake for gratuitous enjoyments, and by which the old *habitué* can gain only a temporary and qualified restoration of the happiness which his stimulant has first deprived him of. For the depression of the vital energy increases with every repetition of the stimulation-process, and in a year after the first dose all the "grateful and exhilarating tonics" of our professional poison-venders can not restore the vigor, the courage, and the cheerfulness which the mere consciousness of perfect health imparts to the total abstainer.

A great plurality of all beginners underrate the difficulty of controlling the cravings of a morbid appetite. They remember that their natural inclinations at first opposed, rather than encouraged, the indulgence; they feel that at the present stage of its development they could abjure the passion and keep their promise without any difficulty. But they overlook the fact that the moral power of resistance decreases with each repetition of the dose, and that the time will come when only the practical impossibility of procuring their wonted tipple will enable them to keep their pledge of total abstinence. It is true that by the exercise of a constant self-restraint a person of great will-force may resist the progressive tendency of the poison-habit and confine himself for years to a single cigar or a single bottle of wine per day. But, if all waste is sinful, is not this constant pull against the stream a wicked misuse of moral energy—a wanton waste of an effort which in less treacherous waters would insure the happiest progress, and propel the boat of life to any desired goal?

But, while temperance people, as a class, are apt to underrate the difficulty of a total cure of a confirmed poison-habit, they generally overrate the difficulty of total prevention. The natural inclination of a young child is in the direction of absolute abstinence from all noxious stimulants. I do not speak only of the children of temperate people who strengthen that inclination by moral precepts, but of drunkards' boys, of the misbegotten cadets of our tenement barracks and slum-alleys. All who will make their disposition a special study may repeat the experiments which have convinced me that the supposed effects of hereditary propensities are in almost every case due to the seductions of a bad example, and that the influence of an innate predisposition has been immoderately exaggerated. Watch the young picnickers of an orphan-festival, and see what a great majority of them will prefer sweet cold milk to iced tea, and the lemonade-pail to the ginger-beer basket. Offer them a glass of liquor, and see how few out of a hundred will be able to sip it without a shudder. Or let us go a step further, and interview the inmates of a house of correction, or of a Catholic "protectory" for young vagrants. The superintendent of a penitentiary for adults (in Cologne, Germany) expressed a conviction that a plurality of his prisoners would stretch out their hands for a bottle of the vilest liquor rather than for a piece of gold. In the house of correction I would stake any odds that ninety per cent of all boy-prisoners under fourteen would prefer an excursion-ticket to a bottle of the best wine of Tokay or Johannisberg. At home, in a preparatory school of all vices, they of course imitate their teachers, but only by overcoming almost the same instinctive repugnance which is the best safeguard of the total abstainer's child. At the *first* attempt even the offspring of a long lineage of drunkards abhors the taste of alcohol as certainly as the child of the most inveterate smoker detests the smell of tobacco.

But it is true that the impaired vitality of the habitual drunkard transmits itself mentally in the form of a peculiar disposition which I have found to be equally characteristic of the children (and even grandchildren) of an opium-eater. They lack that spontaneous gayety which constitutes the almost misfortune-proof happiness of normal children, and, without being positively peevish or melancholy, their spirits seem to be clouded by an apathy which yields only to strong external excitants. But out-door work and healthy food rarely fail to restore the tone of the mind, and even before the age of puberty the manifestations of a more buoyant temper will prove that the patient has outgrown the hereditary hebetude, and with it the need of artificial stimulation. Temptation, of course, should always be guarded against, and also everything that could tend to aggravate the lingering despondency of the convalescent—harsh treatment, solitude, and a monotonous occupation.

With normal children such precautions are superfluous. They will resist temptation if we do not force it upon them. No need of threats and tearful exhortations ; you need not warn a boy to abstain from disgusting poisons—Nature attends to that ; but simply provide him with a sufficient quantity of palatable, non-stimulating food, till he reaches the age when habit becomes as second nature. It was Rousseau's opinion that a taste for stimulants could be acquired only during the years of immaturity, and that there would be little danger after the twentieth year, if in the mean while observation and confirmed habits had strengthened the protective instincts which Nature has erected as a bulwark between innocence and vice. We need not fortify that bulwark by artificial props, we need not guard it with anxious care ; all we have to do is to save ourselves the extraordinary trouble of breaking it down. After a boy becomes capable of inductive reasoning, it can, of course, do no harm to call his attention to the evils of intemperance, and give him an opportunity to observe the successive stages of the alcohol-habit, the gradual progress from beer to brandy, from a "state of diminished steadiness" to delirium tremens. In large cities, where the evils of drunkenness reveal themselves in all their naked ugliness, children can easily be taught to regard the poison-vice as a sort of disease which should be guarded against, like small-pox or leprosy.

But it should always be kept in mind that even the milder stimulant-habits have a progressive tendency, and that under certain circumstances the attempt to resist that bias will overtask the strength of most individuals. According to the allegory of the Grecian myth, the car of Bacchus was drawn by tigers ; and it is a significant circumstance that war, famine and pestilence have so often been the forerunners of veritable alcohol-epidemics. The last Lancashire strike was accompanied by whisky riots ; the starving Silesian weavers tried to drown their misery in *Schnapps*. In France almost every general decline of material prosperity has been followed by a sudden increase of intemperance, and after a prolonged war the vanquished party seems to be chiefly liable to that additional affliction. The explanation is that, after the stimulant-habit has once been initiated, every unusual depression of mental or physical vigor calls for an increased application of the wonted method of relief. Nations who have become addicted to the worship of a poison-god will use his temple as a place of refuge from every calamity ; and children whose petty ailments have been palliated with narcotics, wine, and cordials, will afterward be tempted to drown their deeper sorrow in deeper draughts of the same nepenthe.

And even those who manage to suppress that temptation have to suppress the revivals of a hard-dying hydra, and will soon find that only abstinence from *all* poisons is easier than temperance.

THE AGE OF TREES.

By J. A. FARRER.

SINCE De Candolle, the celebrated Swiss botanist, propagated the idea that a tree has no limits set by nature in its constitution to the term of its existence, the question of the age attainable by trees has never ceased to be debated with considerable interest. De Candolle's argument was to the effect that whereas animals have, by the physiological construction of their vessels, a set limit to the duration of their lives, trees have no such natural termination ; and that although their decay and death are so familiar to us that we commonly speak of this or that species as living for a given period like two hundred years, yet such decay is rather the result of accident or disease than of any law inherent in their nature such as in our own case we designate as death by old age. Whence, the same botanist inferred, there is no reason why trees under perfectly favorable conditions should ever perish ; and he proceeded to adduce in favor of that theory instances of trees which even then were in the enjoyment of no contemptible moment of eternity.

Until accurate observations have been made for hundreds or perhaps thousands of years, it would seem impossible to arrive at even an approximate solution of so wide a problem as this. Under the best conditions we could never eliminate those causes of tree mortality which De Candolle fairly enough calls accidental, but which are contained in the invariable laws of the elements. The largest, and therefore probably the oldest, trees are the special sport of the lightning ; and the storm which has so often felled trees of the most prodigious size will, even if it spare the trunk, break off boughs, thus admitting at the point of fracture that caries into the trunk which will ultimately reduce it to a mere shell, similar to one of those bull-oaks wherein the bull loves to hide himself. These causes of disease and decay can never be absent, since they evidently belong to the permanent order of nature.

Again, De Candolle accounts with great probability for the diminished rate of tree-growth after a certain period by such considerations as the greater distance of the roots from the air, their coming into contact with the roots of other trees, or with a rocky or otherwise unsuitable substratum, or the diminished elasticity of the bark; and though it is possible that trees might continue to grow in their fifth century at the same rate as in their first, if the conditions remained equally favorable, yet, since the proviso can never be insured, a further difficulty, amounting to insuperability, occurs, to prevent such an hypothesis from being brought to the test of either observation or experiment.

Whether, therefore, a tree might possibly continue living and growing forever is a question of less entertainment than the question of its possible duration in the common state of nature and under the irreversible conditions of climate, soil, and the elements. What age may we ascribe to some of our largest specimens, either still existing or recorded in trustworthy history? Is the period of one thousand years, the favorite figure of tradition, a common or probable period of arboreal longevity, or have our proudest forest giants attained their present size in half the time that is commonly claimed for them?

In the discussion of this question we have but few known data to guide us, since statistics of the rate of growth, as afforded by careful measurement, date only from about the beginning of the eighteenth century. Of such statistics we may dismiss at once measurement of height or of the spread of a tree's boughs, the measurement of girth being far easier and more conclusive. But it is unfortunate that no standard of distance from the ground has yet been adopted for measurement, so that the needless perplexity might be avoided which is derived from giving the circumference now at the ground and now at two, or three, or six feet above it.

The counting of the rings added by exogenous trees every year to their circumferences can only, without risk of great error, be applied to trees cut down in their prime, and hence is useless for the older trees which are hollow and decayed. Trees, moreover, often develop themselves so unequally from their center that, as in the case of a specimen in the museum at Kew, there may be about two hundred and fifty rings on one side to fifty on the other. Perhaps the largest number of rings that has ever been counted was in the case of an oak felled in 1812, where they amounted to seven hundred and ten; but De Candolle, who mentions this, adds that three hundred years were added to this number as probably covering the remaining rings which it was no longer possible to count. This instance may be taken to illustrate how unsatisfactory this mode of reckoning really is for all but trees of comparatively youthful age.

The external girth measurement is for these reasons the best we can have, being especially applicable where the date of a tree's introduction into a country or of its planting is definitely fixed, since it enables us to argue from the individual specimen or from a number of specimens, not with certainty, but within certain limits of variability, to the rate of growth of that tree as a species. In these measurements of trees of a century or more in age, such as are given abundantly in Loudon's "Arboretum," lies our best guide, though even then the growth in subsequent ages must remain matter of conjecture. The difficulty is to reduce this conjectural quantity to the limits of probability; for, given the ascertained growth of the first century, how shall we estimate the diminished growth of later centuries? The best way would seem to be to take the ascertained growth of the first century, and then to make, say, the third of it the average growth of every century. Thus, if we were to take twelve feet as the ascertained growth of an oak in its first century, four feet would be its constant average rate, and we might conjecture that an oak of forty feet was about a thousand years old. But clearly it might be much less; for the reason for taking the third is not so much that it is a more probable average than the half, as that it is obviously less likely to err on the side of excess of rapidity.

The cypress affords an instance where the approximate certainty of its introduction into England enables us to form some conclusions with regard to its attainable age. The fact of its being first mentioned in Turner's "Names of Herbs," published in 1548, makes it probable that it was not introduced into England before the beginning of that century. But, at all events, the cypress at Fulham, which in 1793 was two feet five inches at three feet from the ground, can not have been planted there before 1674, the year that Compton, the great introducer of foreign trees into England in the seventeenth century, became Bishop of London. That gives a growth of about two feet in the first century; but sometimes it attains a higher rate, as in the case of the cypress planted by Michael Angelo at Chartreux, which was thirteen feet round in 1817, giving the average rate of over four feet in the first three centuries. Now, the cypress at Somma, between Lake Maggiore and Milan, for whose sake Napoleon bent the road out of the straight line, is not more than twenty-three feet in girth, so that the tradition which makes its planting coeval with Christianity would seem doubtful; though if we take three feet as the first century's growth, and take the third as the average, it may evidently have been standing in the time of Cæsar, as an old chronicle of Milan is averred to attest.

The Lebanon cedar first planted at Lambeth in 1683 was only seven feet nine inches (girth measurements alone need be given) one hundred and ten years later. Dr. Uvedale's cedar, planted at Enfield not earlier than 1670, was fifteen feet eight inches when measured in 1835, i. e., one hundred and sixty-five years afterward. And the large cedar at Uxbridge, which was blown down in 1790, was one hundred and eighteen years old when Gilpin measured it in 1776, and found it to be fifteen feet and a half. We should therefore be justified in assuming twelve feet as the possible first century's growth of a cedar even in England ; whence we may test the probability of the oldest cedars now on Mount Lebanon having been growing there in the days of King Solomon. In the year 1696 the traveler Maundrell measured one of the largest of them and found it to be twelve yards six inches. Four feet a century being the average rate, the cedar measured by Maundrell would have required only nine centuries to have attained its dimensions of thirty-six feet ; so that it need have been no older than the time of Charlemagne, and, allowing for a more rapid growth on a site where it is indigenous, may probably have been considerably younger.

From the claims to antiquity of the cedars of Lebanon let us pass to those of the Tortworth Spanish chestnut in Gloucestershire, which sometimes boasts to be the oldest tree in England, and bears an inscription to the effect that King John held a Parliament beneath it.* Sir Robert Atkyns, whose history of that county was published in 1712, usually bears the responsibility of connecting the tree with King John ; but he only speaks of it as said by tradition "to have been growing there in the reign of King John. It is nineteen yards in compass, and seems to be several trees incorporated together, and young ones are still growing up which may in time be joined to the old body." It was also probably on hearsay evidence that Evelyn spoke of it as standing on record that a chestnut (at Tamworth) formed a boundary tree in the reign of Stephen. We may assume Evelyn to have meant the tree in question ; we may pass the hesitation of tradition between two kings not remote from one another in time ; and we may accept fifty-seven feet as the maximum measurement, though no subsequent measurement gives so high dimensions. Now, that a chestnut may attain seventeen feet in its first century is proved by the fact that a chestnut at Nettlecombe, planted within the recollection, and therefore within the life, of Sir John Trevelyan, who died in 1828, was over seventeen feet.† But we may be content with fifteen feet for the first century. Then, on the principle of the third as the average, we should require a period of eleven centuries for fifty-seven feet ; but that this average would be too low is evident from the fact that in seventy-one years—i. e., between 1766 and 1837—it was proved to have increased two feet in girth. Therefore we should have a diminishing series be-

* Jesse, "Gleanings in Natural History," i, 341.

† Selby, "Forest Trees," 334 (1842).

tween, say, fifteen feet a century at one end and a little over two feet a century at the other. This might be at the following rate, taking each figure for the growth of a century : 15+13+10+8+6+3+2 = 57. By which calculation seven centuries would have been the tree's age when Sir Robert Atkyns declared it to be fifty-seven feet in 1712, an antiquity that would amply satisfy tradition, but could not remove the probability that the tree is not a single trunk, but really a number of different trees that have become incorporated together.

A somewhat similar theory may be applied to the famous *Castagna di Cento Cavalli* on Mount Etna, so called because a Queen of Aragon and one hundred followers on horseback are said to have taken shelter beneath it from a shower of rain. Brydone, in 1790, measured the circumference to be two hundred and four feet, but it seemed to him that the tree in question, of which only separate trunks remain, was really five separate trees ; and though he professed to have found no bark on the insides of the stumps nor on the sides opposite to one another, yet a more recent traveler states, in Murray's guide-book, that this is only true of the southernmost stem, and that one of the masses still standing does show bark all round it, which would of course prove it to be a separate tree. Of the other large chestnuts on Etna the *Castagna del Nave* is rather larger than the Tortworth specimen, while the *Castagna della Galea* is seventy-six feet at two feet from the ground. The rich soil of pulverized volcanic ash combined with decomposed vegetable matter probably enabled them to attain their present size within a shorter period than would be implied by such dimensions elsewhere ; but whether they are five centuries or ten it is absolutely impossible to conjecture.

The great variability in the rate of growth in trees of the same species is perhaps the most remarkable thing afforded by statistics. We say, for instance, roughly, that the beech grows twice as fast as an oak ; but take four beeches mentioned by Loudon, placing their years in one column and their circumference in another :

One in King's County	at	60 years	was	17	feet.
One at Foster Hall	"	100	"	" 12	"
One at Courtachy Castle	"	102	"	" 18	"
One in Callendar Park	"	200	"	" 17	"

So that of three beeches nearly the same in size one was only sixty, another one hundred and two, and another as much as two hundred. And this variability of rate is still more conspicuous in the oak. De Candolle, who counted the rings of several oaks that had been felled, found one that at two hundred years had only the same circumference that another had attained at fifty. Some had grown slowly at first, and then rapidly ; others, like bad racers, had begun fast and ended slowly. And even the diminished rate of growth would not seem to be an invariable rule, for one oak of three hundred and thirty-three years was shown to have increased as much between three hundred and twenty and three hundred and thirty as it had between ninety and one hundred.

This reduces the computation of the age of an oak to little more than guess-work. The Cowthorpe oak, the largest existing in England, reached at one time seventy-eight feet in circumference. Damory's oak, in Dorsetshire, was only ten feet less when it was so decayed that it was cut up and sold for fire-wood in 1755; and the Boddington oak, in the vale of Gloucester, was fifty-four feet at the base when it was burned down in 1790. It is needless to mention other English oaks which are also claimants to a remote antiquity; but it is obvious, from the very variable rate of the growth of oaks, that size establishes no indisputable title, and that the Cowthorpe oak need not therefore be the oldest English oak because it is the largest recorded. From Loudon's statistics of oaks are extracted the following notices of trees, according to their age and girth:

Years.	Feet of circumference.	Years.	Feet of circumference.
40	8	200	7½
83	12	200	25
100	12	201	21
100	18	220	20
100	21	250	19½
120	14	300	33
180	15	330	27

This table not only shows the great variability of growth, but, if we take the three specimens of one hundred years old, gives us the high average of seventeen feet as that of only the first century. Taking, then, as usual, the third as the average growth, we should require rather more than eight centuries for an oak of fifty feet, which reduces to a very small number the oaks in England that can claim a thousand years.

When, therefore, Gilpin, in his "Forest Scenery," speaks of nine hundred years as of no great age for an oak, it must be said that very few oaks can be named which by measurement would sustain their title to that age. Tradition, which is always sentimental, leans naturally to the side of exaggerated longevity. William of Wainfleet gave directions for Magdalen College, Oxford, to be built near the great oak which fell suddenly in the year 1788, and out of which the president's chair was made, in memory of the tree. Gilpin assumes that for the tree to have been called great it must have been five hundred years old, and, therefore, perhaps standing in the time of King Alfred. But it is clear that it need not have been a century old to have fairly earned the title of great, and that, therefore, a period of six centuries may have covered its whole term of existence.

We are certainly apt to underrate the possible rate of growth where a tree meets with altogether favorable conditions. The silver fir was only introduced into England in the seventeenth century by

Sergeant Newdigate; and one tree of his planting was thirteen feet round when Evelyn measured it eighty-one years afterward. A comparison of the statistics of growth, as above collected with reference to the oak, indicates with respect to most trees a more rapid rate than is commonly supposed. Let us test the claims of some of the oldest limes. The Swiss used often to commemorate a victory by planting a lime-tree, so that it may be true that the lime still in the square of Fribourg was planted on the day of their victory over Charles the Bold at Morat in 1476. A youth, they say, bore it as a twig into the town, and arriving breathless and exhausted from the battle had only strength to utter the word "Victory!" before he fell down dead. But this tree was only thirteen feet nine inches in 1831, i. e., three hundred and fifty-five years afterward, and it would be extraordinary if a lime had not attained in that period greater bulk than even an oak might have reached in a century. The large lime at Neustadt, in Würtemberg, mentioned by Evelyn as having its boughs supported by columns of stone, was twenty-seven feet when he wrote (1664), and in 1837 it was fifty-four, so that within a period of one hundred and seventy-three years it had gained as much as twenty-seven feet. Consequently, making allowance for diminished growth, we may fairly assume that two hundred years would have been more than enough for the attainment of the circumference of the first twenty-seven feet which it had reached in the time of Evelyn. No English lime appears to have reached such dimensions as would imply a growth of more than three centuries, though the lime at Depeham, near Norwich, which was forty-six feet when Sir Thomas Browne sent his account of it to Evelyn, sufficiently dispels the legend that all limes in this country have come from two plants brought over by Sir John Spelman, who introduced the manufacture of paper into England from Germany, and to whom Queen Elizabeth granted the manor of Portbridge.

It would be natural to expect the greatest longevity in indigenous trees, and, though it has been much disputed what kinds are native to the English soil, etymology alone would indicate that the following trees were of Roman importation: the elm (*ulmus*), the plane (*platanus*), the poplar (*populus*), the box (*buxus*), the chestnut (*castanea*). The yew, on the contrary, is probably indigenous, though its opponents find some reason for their skepticism in the fact that its larger specimens are chiefly found in church-yards and artificial plantations. In favor of its claim is the fact that its pretensions to longevity seem to be better founded than those of any other English tree, not even excluding the oak. A yew that was dug up from a bog in Queen's County was proved by its rings to have been five hundred and forty-five years of age; yet for the last three hundred years of its life it had grown so slowly that near the circumference one hundred rings were traceable within an inch. Some great and sudden change for the worse in the external conditions may have accounted for so slow a rate; but it would hardly be safe, with such evidence before us, to allow more than three feet a century as the normal growth of a yew, in which case the Fortingal yew in Scotland, fifty-six feet round in 1769, may have lived more than eighteen centuries; and a longevity in proportion must be accorded to the yews at Fountain's Abbey, or to the Tisbury yew in Dorsetshire, which boasts of thirty-seven feet in circumference. Hence tradition in this case would seem to contain nothing incredible when it asserts that the yews on Kingley Bottom, near Chichester, were on their present site when the sea-kings from the North landed on the coast of Sussex.

It is, however, but seldom that any real aid can be derived from tradition in estimating the longevity of trees. We have even to be on our guard against it, especially when it associates the general claim to antiquity by a specific name or event. In the classical period the tendency was as strong as it is still; and we should look to our own legends when tempted to smile at the Delian palm mentioned by Pliny as coeval with Apollo, or at the two oaks at Heraclea as planted by Hercules himself. Pausanias, traveling in Greece in the second century of our era, saw a plane-tree which was said to have been planted by Menelaus when collecting forces for the Trojan war, whence Gilpin gravely inferred that the tree must have been thirteen centuries old when Pausanias saw it. Tacitus calculated that a fig-tree was eight hundred and forty years old because tradition accounted it the tree whereunder the wolf nursed Romulus and Remus. Nor was Pliny's inference more satisfactory, that three hollies still standing in his day on the site of Tibur must have been older than Rome itself, inasmuch as Tibur was older than Rome, and they were the very trees on which Tiburtus, the founder of the former, saw the flight of birds descend which decided him on the site of his city. There is of course no more reason to believe in the reality of Tiburtus than of Francion, the mythical forefather of France, or of Brute the Trojan, the reputed founder of the British Empire.

These things suffice to justify suspicion of trees associated with particular names, such as Wallace's Oak, or trees claiming to have been planted by St. Dominic or Thomas Aquinas. Our only safe guide is measurement, applied year by year to trees alike of known and of unknown age, of insignificant as of vast dimensions, and recorded in some central annual of botanical information, facilitating the work of comparison and the arrival at something like trustworthy averages. The experiment, moreover, has not been sufficiently tried whether our oldest trees are capable of an increased rate of growth by the application of fresh earth round their roots, favorable though the case of the Tortworth chestnut is to the probability of such a result. Until, therefore, such statistics are more numerous than at present, we must be content to rest in the uncertainty with regard to the ages of trees which the preceding attempt to estimate them makes sufficiently manifest, and to arrive at no more definite conclusion than was long ago arrived at by Pliny, that "vita arborum quarundam immensa credi potest" ("The life of some trees may be believed to be prodigious").—*Longman's Magazine.*

SOME UNSOLVED PROBLEMS IN GEOLOGY.*

By Dr. J. W. DAWSON.

II.

AGAIN: we are now prepared to say that the struggle for existence, however plausible as a theory, when put before us in connection with the productiveness of animals, and the few survivors of their multitudinous progeny, has not been the determining cause of the introduction of new species. The periods of rapid introduction of new forms of marine life were not periods of struggle, but of expansion—those periods in which the submergence of continents afforded new and large space for their extension and comfortable subsistence. In like manner it was continental emergence that afforded the opportunity for the introduction of land animals and plants. Further, in connection with this, it is now an established conclusion that the great aggressive faunas and floras of the continent have originated in the north, some of them within the Arctic Circle; and this in periods of exceptional warmth, when the perpetual summer sunshine of the Arctic regions co-existed with a warm temperature. The testimony of the rocks thus is, that not struggle, but expansion, furnished the requisite conditions for new forms of life, and that the periods of struggle were characterized by depauperation and extinction.

But we are sometimes told that organisms are merely mechanical, and that the discussions respecting their origin have no significance, any more than if they related to rocks or crystals, because they relate merely to the organism considered as a machine, and not to that which may be supposed to be more important, namely, the great determining power of mind and will. That this is a mere evasion, by which we really gain nothing, will appear from a characteristic extract of an article by an eminent biologist, in the new edition of the "Encyclopædia Britannica"—a publication which, I am sorry to say, instead of its proper *rôle* as a repertory of facts, has become a strong partisan, stating extreme and unproved speculations as if they were conclusions of science. The statement referred to is as follows: "A mass of living protoplasm is simply a molecular machine of great complexity, the total results of the working of which, or its vital phenomena,

* Address of the President of the American Association for the Advancement of Science, delivered at Minneapolis, August 15, 1883. Reprinted from "Science."

depend on the one hand on its construction, and, on the other, on the energy supplied to it; and to speak of vitality as anything but the name for a series of operations is as if one should talk of the horologity of a clock." It would, I think, scarcely be possible to put into the same number of words a greater amount of unscientific assumption and unproved statement than in this sentence. Is "living protoplasm" different in any way from dead protoplasm, and, if so, what causes the difference? What is a "machine"? Can we conceive of a self-produced or uncaused machine, or one not intended to work out some definite results? The results of the machine in question are said to be "vital phenomena"; certainly most wonderful results, and greater than those of any machine man has yet been able to construct! But why "vital"? If there is no such thing as life, surely they are merely physical results. Can mechanical causes produce other than physical effects? To Aristotle, life was "the cause of form in organisms." Is not this quite as likely to be true as the converse proposition? If the vital phenomena depend on the "construction" of the machine, and the "energy supplied to it," whence this construction, and whence this energy? The illustration of the clock does not help us to answer this question. The construction of the clock depends on its maker, and its energy is derived from the hand that winds it up. If we can think of a clock which no one has made and which no one winds—a clock constructed by chance, set in harmony with the universe by chance, wound up periodically by chance—we shall then have an idea parallel to that of an organism living, yet without any vital energy or creative law; but in such a case we should certainly have to assume some antecedent cause, whether we call it "horologity" or by some other name. Perhaps the term "evolution" would serve as well as any other, were it not that common sense teaches that nothing can be spontaneously evolved out of that in which it did not previously exist.

There is one other unsolved problem, in the study of life by the geologist, to which it is still necessary to advert. This is the inability of paleontology to fill up the gaps in the chain of being. In this respect, we are constantly taunted with the imperfection of the record; but facts show that this is much more complete than is generally supposed. Over long periods of time and many lines of being, we have a nearly continuous chain; and, if this does not show the tendency desired, the fault is as likely to be in the theory as in the record. On the other hand, the abrupt and simultaneous appearance of new types in many specific and generic forms, and over wide and separate areas at one and the same time, is too often repeated to be accidental. Hence paleontologists, in endeavoring to establish evolution, have been obliged to assume periods of exceptional activity in the introduction of species, alternating with others of stagnation—a doctrine differing very little from that of special creation as held by the older geologists.

The attempt has lately been made to account for these breaks by the assumption that the geological record relates only to periods of submergence, and gives no information as to those of elevation. This is manifestly untrue. In so far as marine life is concerned, the periods of submergence are those in which new forms abound for very obvious reasons already hinted. But the periods of new forms of land and fresh-water life are those of elevation, and these have their own records and monuments, often very rich and ample; as, for example, the swamps of the carboniferous, the transition from the cretaceous subsidence to the Laramie elevation, the tertiary lake-basins of the West, the terraces and raised beaches of the pleistocene. Had I time to refer in detail to the breaks in the continuity of life, which can not be explained by the imperfection of the record, I could show at least that nature, in this case, does advance *per saltum*—by leaps, rather than by a slow, continuous process. Many able reasoners, as Le Conte in this country, and Mivart and Collard in England, hold this view.

Here, as elsewhere, a vast amount of steady conscientious work is required to enable us to solve the problems of the history of life. But, if so, the more the hope for the patient student and investigator. I know nothing more chilling to research, or unfavorable to progress, than the promulgation of a dogmatic decision that there is nothing to be learned but a merely fortuitous and uncaused succession, amenable to no law, and only to be covered, in order to hide its shapeless and uncertain proportions, by the mantle of bold and gratuitous hypothesis.

So soon as we find evidence of continents and oceans, we raise the question, "Have these continents existed from the first in their present position and form, or have the land and water changed places in the course of geological time?" In reality both statements are true in a certain limited sense. On the one hand, any geological map whatever suffices to show that the general outline of the existing land began to be formed in the first and oldest crumplings of the crust. On the other hand, the greater part of the surface of the land consists of marine sediments which must have been derived from land that has perished in the process, while all the continental surfaces, except, perhaps, some high peaks and ridges, have been many times submerged. Both of these apparently contradictory statements are true; and, without assuming both, it is impossible to explain the existing contours and reliefs of the surface.

In the case of North America, the form of the old nucleus of Laurentian rock in the north already marks out that of the finished continent, and the successive later formations have been laid upon the edges of this, like the successive loads of earth dumped over an embankment. But, in order to give the great thickness of the palæozoic sediments, the land must have been again and again submerged, and for long periods of time. Thus, in one sense, the continents have been fixed;

in another, they have been constantly fluctuating. Hall and Dana have well illustrated these points in so far as Eastern North America is concerned. Professor Hull, of the Geological Survey of Ireland, has recently had the boldness to reduce the fluctuations of land and water, as evidenced in the British Islands, to the form of a series of maps intended to show the physical geography of each successive period. The attempt is probably premature, and has been met with much adverse criticism; but there can be no doubt that it has an element of truth. When we attempt to calculate what could have been supplied from the old eozoic nucleus by decay and aqueous erosion, and when we take into account the greater local thickness of sediments toward the present sea-basins, we can scarcely avoid the conclusion that extensive areas once occupied by high land are now under the sea. But to ascertain the precise areas and position of these perished lands may now be impossible.

In point of fact, we are obliged to believe in the contemporaneous existence in all geological periods, except perhaps the very oldest, of three sorts of areas on the surface of the earth: 1. Oceanic areas of deep sea, which must always have occupied the bed of the present ocean, or parts of it; 2. Continental plateaus, sometimes existing as low flats or as higher table-lands, and sometimes submerged; 3. Areas of plication or folding, more especially along the borders of the oceans, forming elevated lands rarely submerged, and constantly affording the material of sedimentary accumulations.

Every geologist knows the contention which has been occasioned by the attempts to correlate the earlier palæozoic deposits of the Atlantic margin of North America with those forming at the same time on the interior plateau, and with those of intervening lines of plication and igneous disturbance. Stratigraphy, lithology, and fossils are all more or less at fault in dealing with these questions; and, while the general nature of the problem is understood by many geologists, its solution in particular cases is still a source of apparently endless debate.

The causes and mode of operation of the great movements of the earth's crust which have produced mountains, plains, and table-lands, are still involved in some mystery. One patent cause is the unequal settling of the crust toward the center; but it is not so generally understood as it should be that the greater settlement of the ocean-bed has necessitated its pressure against the sides of the continents in the same manner that a huge ice-floe crushes a ship or a pier. The geological map of North America shows this at a glance, and impresses us with the fact that large portions of the earth's crust have not only been folded, but bodily pushed back for great distances. On looking at the extreme north, we see that the great Laurentian mass of central Newfoundland has acted as a protecting pier to the space immediately west of it, and has caused the Gulf of St. Lawrence to remain an undisturbed area since palæozoic times. Immediately to the south of this, Nova Scotia and New Brunswick are folded back. Still farther south, as Guyot has shown, the old sediments have been crushed in sharp folds against the Adirondack mass, which has sheltered the table-land of the Catskills and of the Great Lakes. South of this, again, the rocks of Pennsylvania and Maryland have been driven back in a great curve to the west. Nothing, I think, can more forcibly show the enormous pressure to which the edges of the continents have been exposed, and at the same time the great sinking of the ocean-beds. Complex and difficult to calculate though these movements of plication are, they are more intelligible than the apparently regular pulsations of the flat continental areas, whereby they have alternately been below and above the waters, and which must have depended on somewhat regularly recurring causes, connected either with the secular cooling of the earth, or with the gradual retardation of its rotation, or with both. Throughout these changes, each successive elevation exposed the rocks for long ages to the decomposing influence of the atmosphere. Each submergence swept away, and deposited as sediment, the material accumulated by decay. Every change of elevation was accompanied with changes of climate and with modifications of the habitats of animals and plants. Were it possible to restore accurately the physical geography of the earth in all these respects, for each geological period, the data for the solution of many difficult questions would be furnished.

It is an unfortunate circumstance that conclusions in geology, arrived at by the most careful observation and induction, do not remain undisturbed, but require constant vigilance to prevent them from being overthrown. Sometimes, of course, this arises from new discoveries throwing new light on old facts ; but when this occurs it rarely works the complete subversion of previously received views. The more usual case is, that some over-zealous specialist suddenly discovers what seems to him to overturn all previous beliefs, and rushes into print with a new and plausible theory, which at once carries with him a host of half-informed people, but the insufficiency of which is speedily made manifest.

Had I written this address a few years ago, I might have referred to the mode of formation of coal as one of the things most surely settled and understood. The labors of many eminent geologists, microscopists, and chemists in the Old and the New Worlds had shown that coal nearly always rests upon old-soil surfaces penetrated with roots, and that coal-beds have in their roofs erect trees, the remains of the last forests that grew upon them. Logan and I have illustrated this in the case of the series of more than sixty successive coal-beds exposed at the South Joggins, and have shown unequivocal evidence of land-surfaces at the time of the deposition of the coal. Microscopical examination has proved that these coals are composed of the materials of the same trees whose roots are found in the under-clays, and their stems and leaves in the roof-shales; that much of the material of the coal has been subjected to sub-aërial decay at the time of its accumulation; and that in this, ordinary coal differs from bituminous shale, earthy bitumen, and some kinds of cannel, which have been formed under water; that the matter remaining as coal consists almost entirely of epidermal tissues, which, being suberose in character, are highly carbonaceous, very durable, and impermeable by water,* and are hence the best fitted for the production of pure coal; and finally that the vegetation and the climatal and geographical features of the coal period were eminently fitted to produce in the vast swamps of that period precisely the effects observed. All these points and many others have been thoroughly worked out for both European and American coal-fields, and seemed to leave no doubt on the subject. But several years ago certain microscopists observed on slices of coal layers filled with spore-cases—a not unusual circumstance, since these were shed in vast abundance by the trees of the coal-forests, and because they contain suberose matter of the same character with epidermal tissues generally. Immediately we were informed that all coal consists of spores; and, this being at once accepted by the unthinking, the results of the labors of many years are thrown aside in favor of this crude and partial theory. A little later, a German microscopist has thought proper to describe coal as made up of minute algæ, and tries to reconcile this view with the appearances, devising at the same time a new and formidable nomenclature of generic and specific names, which would seem largely to represent mere fragments of tissues. Still later, some local facts in a French coal-field have induced an eminent botanist of that country to revive the drift theory of coal, in opposition to that of growth *in situ*. A year or two ago, when my friend Professor Williamson, of Manchester, informed me that he was preparing a large series of slices of coal with the view of revising the whole subject, I was inclined to say that, after what had been done by Lyell, Goeppert, Logan, Hunt, Newberry, and myself, this was scarcely necessary; but, in view of what I have just stated, it may be that all he can do will be required to rescue from total ruin the results of our labors.

An illustration of a different character is afforded by the controversy now raging with respect to the so-called fucoids of the ancient rocks. At one time the group of fucoids, or algæ, constituted a general place of refuge for all sorts of unintelligible forms and markings; graptolites, worm-trails, crustacean tracks, shrinkage-cracks, and, above all, rill-markings, forming a heterogeneous group of fucoidal remains distinguished by generic and specific names. To these were also added some true land-plants badly preserved, or exhibiting structures not well understood by botanists. Such a group was sure to be eventually

* "Acadian Geology," third edition, supplement, p. 68.

dismembered. The writer has himself done something toward this,* but Professor Nathorst has done still more; † and now some intelligible explanation can be given of many of these forms. Quite recently, however, the Count de Saporta, in an elaborate illustrated memoir,‡ has come to the defense of the fucoids, more especially against the destructive experiments of Nathorst, and would carry back into the vegetable kingdom many things which would seem to be mere trails of animals. While writing this address, I have received from Professor Crié, of Rennes, a paper in which he not only supports the algal nature of rusichnites, arthrichnites, and many other supposed fucoids, but claims for the vegetable kingdom even receptaculites and archæocyathus. It is not to be denied that some of the facts which he cites, respecting the structure of the siphoniæ and of certain modern incrusting algæ, are very suggestive, though I can not agree with his conclusions. My own experience has convinced me that, while non-botanical geologists are prone to mistake all kinds of markings for plants, even good botanists, when not familiar with the chemical and mechanical conditions of fossilization, and with the present phenomena of tidal shores, are quite as easily misled, though they are very prone, on the other hand, to regard land-plants of some complexity, when badly preserved, as mere algæ. In these circumstances it is very difficult to secure any consensus, and the truth is only to be found by careful observation of competent men. One trouble is, that these usually obscure markings have been despised by the greater number of paleontologists, and probably would not now be so much in controversy were it not for the use made of them in illustrating supposed phylogenies of plants.

It would be wrong to close this address without some reference to that which is the veritable *pons asinorum* of the science, the great and much-debated glacial period. I trust that you will not suppose that, in the end of an hour's address, I am about to discuss this vexed question. Time would fail me even to name the hosts of recent authors who have contended in this arena. I can hope only to point out a few landmarks which may aid the geological adventurer in traversing the slippery and treacherous surface of the hypothetical ice-sheet of pleistocene times, and in avoiding the yawning crevasses by which it is traversed.

No conclusions of geology seem more certain than that great changes of climate have occurred in the course of geological time; and the evidence of this in that comparatively modern period which immediately preceded the human age is so striking that it has come to be known as pre-eminently the ice age, while, in the preceding ter-

* "Footprints and Impressions on Carboniferous Rocks," "American Journal of Science," 1873.

† Royal Swedish Academy, Stockholm, 1881.

‡ "À propos des Algues Fossiles," Paris, 1883.

tiary periods, temperate conditions seem to have prevailed even to the pole. Of the many theories as to these changes which have been proposed, two seem at present to divide the suffrages of geologists, either alone, or combined with each other. These are—1. The theory of the precession of the equinoxes in connection with the varying eccentricity of the earth's orbit, advocated more especially by Croll; and, 2. The different distribution of land and water as affecting the reception and radiation of heat and the ocean-currents—a theory ably propounded by Lyell, and subsequently extensively adopted, either alone or with the previous one. One of these views may be called the astronomical; the other, the geographical. I confess that I am inclined to accept the second or Lyellian theory, for such reasons as the following: 1. Great elevations and depressions of land have occurred in and since the pleistocene, while the alleged astronomical changes are not certain, more especially in regard to their probable effect on the earth. 2. When the rival theories are tested by the present phenomena of the southern polar region and the North Atlantic, there seem to be geographical causes adequate to account for all except extreme and unproved glacial conditions. 3. The astronomical cause would suppose regularly recurring glacial periods of which there is no evidence, and it would give to the latest glacial age an antiquity which seems at variance with all other facts. 4. In those more northern regions where glacial phenomena are most pronounced, the theory of floating sheets of ice, with local glaciers descending to the sea, seems to meet all the conditions of the case; and these would be obtained, in the North Atlantic at least, by very moderate changes of level, causing, for example, the equatorial current to flow into the Pacific, instead of running northward as a gulf stream. 5. The geographical theory allows the supposition not merely of vicissitudes of climate quickly following each other in unison with the movements of the surface, but allows also of that near local approximation of regions wholly covered with ice and snow, and others comparatively temperate, which we see at present in the north.

If, however, we are to adopt the geographical theory, we must avoid extreme views; and this leads to the inquiry as to the evidence to be found for any such universal and extreme glaciation as is demanded by some geologists.

The only large continental area in the northern hemisphere supposed to be entirely ice- and snow-clad is Greenland; and this, so far as it goes, is certainly a local case, for the ice and snow of Greenland extend to the south as far as 60° north latitude, while both in Norway and in the interior of North America the climate in that latitude permits the growth of cereals. Further, Grinnell Land, which is separated from North Greenland only by a narrow sound, has a comparatively mild climate, and, as Nares has shown, is covered with verdure in summer. Still further, Nordenskiöld, one of the most experienced

Arctic explorers, holds that it is probable that the interior of Greenland is itself verdant in summer, and is at this moment preparing to attempt to reach this interior oasis. Nor is it difficult, with the aid of the facts cited by Woeickoff and Whitney,* to perceive the cause of the exceptional condition of Greenland. To give ice and snow in large quantities, two conditions are required—first, atmospheric humidity; and, secondly, cold precipitating regions. Both of these conditions meet in Greenland. Its high coast-ranges receive and condense the humidity from the sea on both sides of it and to the south. Hence the vast accumulation of its coast snow-fields, and the intense discharge of the glaciers emptying out of its valleys. When extreme glacialists point to Greenland, and ask us to believe that in the glacial age the whole continent of North America as far south as the latitude of 40° was covered with a continental glacier, in some places several thousands of feet thick, we may well ask, first, what evidence there is that Greenland, or even the Antarctic Continent, at present shows such a condition; and, secondly, whether there exists a possibility that the interior of a great continent could ever receive so large an amount of precipitation as that required. So far as present knowledge exists, it is certain that the meteorologist and the physicist must answer both questions in the negative. In short, perpetual snow and glaciers must be local, and can not be continental, because of the vast amount of evaporation and condensation required. These can only be possible where comparatively warm seas supply moisture to cold and elevated land; and this supply can not, in the nature of things, penetrate far inland. The actual condition of interior Asia and interior America in the higher northern latitudes affords positive proof of this. In a state of partial submergence of our northern continents, we can readily imagine glaciation by the combined action of local glaciers and great ice-floes; but, in whatever way the phenomena of the bowlder clay and of the so-called terminal moraines are to be accounted for, the theory of a continuous continental glacier must be given up.

I can not better indicate the general bearing of facts, as they present themselves to my mind in connection with this subject, than by referring to a paper by Dr. G. M. Dawson on the distribution of drift over the great Canadian plains east of the Rocky Mountains.† I am the more inclined to refer to this, because of its recency, and because I have so often repeated similar conclusions as to Eastern Canada and the region of the Great Lakes.

The great interior plain of Western Canada, between the Laurentian axis on the east and the Rocky Mountains on the west, is seven hundred miles in breadth, and is covered with glacial drift, presenting one of the greatest examples of this deposit in the world. Proceed-

* "Memoir on Glaciers," Geological Society of Berlin, 1881; "Climatic Changes," Boston, 1883.

† "Science," July 1, 1883.

ing eastward from the base of the Rocky Mountains, the surface, at first more than four thousand feet above the sea-level, descends by successive steps to twenty-five hundred feet, and is based on cretaceous and Laramie rocks, covered by bowlder clay and sand, in some places from one hundred to two hundred feet in depth, and filling up pre-existing hollows, though itself sometimes piled into ridges. Near the Rocky Mountains the bottom of the drift consists of gravel not glaciated. This extends to about one hundred miles east of the mountains, and must have been swept by water out of their valleys. The bowlder clay resting on this deposit is largely made up of local *débris* in so far as its paste is concerned. It contains many glaciated bowlders and stones from the Laurentian region to the east, and also smaller pebbles from the Rocky Mountains; so that at the time of its formation there must have been driftage of large stones for seven hundred miles or more from the east, and of smaller stones from a less distance on the west. The former kind of material extends to the base of the mountains, and to a height of more than four thousand feet. One bowlder is mentioned as being forty-two by forty by twenty feet in dimensions. The highest Laurentian bowlders seen were at an elevation of forty-six hundred and sixty feet, on the base of the Rocky Mountains. The bowlder clay, when thick, can be seen to be rudely stratified, and at one place includes beds of laminated clay with compressed peat, similar to the forest-beds described by Worthen and Andrews in Illinois, and the so-called interglacial beds described by Hinde on Lake Ontario. The leaf-beds on the Ottawa River and the drift-trunks found in the bowlder clay of Manitoba belong to the same category, and indicate that throughout the glacial period there were many forest oases far to the north. In the valleys of the Rocky Mountains opening on these plains there are evidences of large local glaciers now extinct, and similar evidences exist on the Laurentian highlands on the east.

Perhaps the most remarkable feature of the region is that immense series of ridges of drift piled against an escarpment of Laramie and cretaceous rocks, at an elevation of about twenty-five hundred feet, and known as the "Missouri Coteau." It is in some places thirty miles broad and a hundred and eighty feet in height above the plain at its foot, and extends north and south for a great distance; being, in fact, the northern extension of those great ridges of drift which have been traced south of the Great Lakes, and through Pennsylvania and New Jersey, and which figure on the geological maps as the edge of the continental glacier—an explanation obviously inapplicable in those Western regions where they attain their greatest development. It is plain that in the North it marks the western limit of the deep water of a glacial sea, which at some periods extended much farther west, perhaps with a greater proportionate depression in going westward, and on which heavy ice from the Laurentian districts on the east was wafted southwestward by the Arctic currents, while lighter ice from the Rocky Mountains was being borne eastward from these mountains by the prevailing westerly winds. We thus have in the West, on a very wide scale, the same phenomena of varying submergence, cold currents, great ice-floes, and local glaciers producing icebergs, to which I have attributed the bowlder clay and upper bowlder drift of Eastern Canada.

A few subsidiary points I may be pardoned for mentioning here. The rival theories of the glacial period are often characterized as those of land glaciation and sea-borne icebergs. But it must be remembered that those who reject the idea of a continental glacier hold to the existence of local glaciers on the highlands more or less extensive during different portions of the great pleistocene submergence. They also believe in the extension of these glaciers seaward and partly water-borne, in the manner so well explained by Mattieu Williams; in the existence of those vast floes and fields of current-and tide-borne ice whose powers of transport and erosion we now know to be so great; and in a great submergence and re-elevation of the land, bringing all parts of it and all elevations up to five thousand feet successively under the influence of these various agencies, along with those of the ocean-currents. They also hold that, at the beginning of the glacial submergence, the land was deeply covered by decomposed rock, similar to that which still exists on the hills of the Southern States, and which, as Dr. Hunt has shown, would afford not only earthy *débris*, but large quantities of bowlders ready for transportation by ice.

I would also remark that there has been the greatest possible exaggeration as to the erosive action of land-ice. In 1865, after a visit to the Alpine glaciers, I maintained that in these mountains glaciers are relatively protective rather than erosive agencies, and that the *détritus* which the glacier streams deliver is derived mostly from the atmospherically wasted peaks and cliffs that project above them. Since that time many other observers have maintained like views, and very recently Mr. Davis, of Cambridge, and Mr. A. Irving have ably treated this subject.* Smoothing and striation of rocks are undoubtedly important effects, both of land-glaciers and heavy sea-borne ice; but the leveling and filling agency of these is much greater than the erosive. As a matter of fact, as Newberry, Hunt, Belt, Spencer, and others have shown, the glacial age has dammed up vast numbers of old channels which it has been left for modern streams partially to excavate.

The till, or bowlder clay, has been called a "ground moraine," but there are really no Alpine moraines at all corresponding to it. On the other hand, it is more or less stratified, often rests on soft materi-

* "Proceedings of the Boston Society of Natural History," xxii; "Journal of the Geological Society of London," February, 1883.

als which glaciers would have swept away, sometimes contains marine shells, or passes into marine clays in its horizontal extension, and invariably in its imbedded bowlders and its paste shows an unoxidized condition, which could not have existed if it had been a sub-aërial deposit. When the Canadian till is excavated, and exposed to the air, it assumes a brown color, owing to oxidation of its iron; and many of its stones and bowlders break up and disintegrate under the action of air and frost. These are unequivocal signs of a sub-aqueous deposit. Here and there we find associated with it, and especially near the bottom and at the top, indications of powerful water-action, as if of land-torrents acting at particular elevations of the land, or heavy surf and ice action on coasts; and the attempts to explain these by glacial streams have been far from successful. A singular objection sometimes raised against the sub-aqueous origin of the till is its general want of marine remains, but this is by no means universal; and it is well known that coarse conglomerates of all ages are generally destitute of fossils, except in their pebbles; and it is further to be observed that the conditions of an ice-laden sea are not those most favorable for the extension of marine life, and that the period of time covered by the glacial age must have been short, compared with that represented by some of the older formations.

This last consideration suggests a question which might afford scope for another address of an hour's duration—the question how long time has elapsed since the close of the glacial period. Recently the opinion has been gaining ground that the close of the ice age is very recent. Such reasons as the following lead to this conclusion: The amount of atmospheric decay of rocks and of denudation in general, which have occurred since the close of the glacial period, are scarcely appreciable; little erosion of river-valleys or of coast-terraces has occurred. The calculated recession of water-falls and of production of lake-ridges lead to the same conclusion. So do the recent state of bones and shells in the pleistocene deposits and the perfectly modern facies of their fossils. On such evidence the cessation of the glacial cold and settlement of our continents at their present levels are events which may have occurred not more than six thousand or seven thousand years ago, though such time estimates are proverbially uncertain in geology. This subject also carries with it the greatest of all geological problems, next to that of the origin of life; namely, the origin and early history of man. Such questions can not be discussed in the closing sentences of an hour's address. I shall only draw from them one practical inference. Since the comparatively short post-glacial and recent periods apparently include the whole of human history, we are but new-comers on the earth, and therefore have had little opportunity to solve the great problems which it presents to us. But this is not all. Geology as a science scarcely dates from a century ago. We have reason for surprise, in these circumstances, that it has learned so much, but for equal surprise that so many persons appear to think it a complete and full-grown science, and that it is entitled to speak with confidence on all the great mysteries of the earth that have been hidden from the generations before us. Such being the newness of man and of his science of the earth, it is not too much to say that humility, hard work in collecting facts, and abstinence from hasty generalization, should characterize geologists, at least for a few generations to come.

In conclusion, science is light, and light is good; but it must be carried high, else it will fail to enlighten the world. Let us strive to raise it high enough to shine over every obstruction which casts any shadow on the true interests of humanity. Above all, let us hold up the light, and not stand in it ourselves.

INLETS FOR INFECTION.*

By R. THORNE THORNE, F. R. C. P.

IN selecting a subject to bring before you, I felt that I should not be trespassing beyond the lines indicated by the committee who have organized this series of lectures if I addressed my remarks to some points connected with those specific fevers the prevention of which must be regarded as coming within the scope of sanitary administration. I may, perhaps, indicate the importance of such a subject by quoting a few figures from the reports of the Registrar-General of England. Limiting myself to those diseases the spread of which is admittedly to be controlled by the adoption either of efficient sanitary works, or of such sanitary measures as isolation and disinfection, I find that during 1871–'80 the following deaths were registered in England and Wales: From typhus fever, 13,975; from enteric or typhoid fever, 78,421; from simple continued fever, which when fatal is probably nothing less than an ill-defined form of enteric fever, 25,643; from diphtheria, 29,425; and from scarlet fever, otherwise called scarlatina, 174,232. These deaths are essentially due to diseases which may be called preventable, and they amount in all to 321,696 in the ten years. But the influence of these diseases upon the population can not be judged of by the death-roll alone. For every fatal case there have probably occurred at least ten non-fatal attacks, and thus we come to be confronted with a total of 3,538,656 attacks from the preventable specific fevers. Mr. Simon, C. B., F. R. S., in dealing with such death returns, has said: "Of the incalculable amount of physical suffering and disablement which they occasion, and of the sorrows and

* Abridged from a lecture delivered at Cheltenham, March 15, 1883, and published in "The Practitioner."

anxieties, the often permanent darkening of life, the straitened means of subsistence, the very frequent destitution and pauperism, which attend or follow such suffering, death statistics, to which alone I can refer, testify only in sample or by suggestion."

The means by which infection is likely to be conveyed to households are far too numerous to be dealt with in a single lecture, and I have thought it best to select for consideration three or four of what I feel to be among the more important, and to deal with these in detail.

In a report on an epidemic of enteric fever at Croydon, in 1875, Dr. Buchanan, F. R. S., makes use of the following words: "The air of the sewers is, as it were, 'laid on' to houses." That significant expression "laid on" comes in aptly, as giving prominence to the special features of one of the channels for conveying infection to households, to which I propose drawing your attention. From the inside of every ordinary dwelling-house there pass certain waste-pipes intended to convey liquid refuse, first to the house-drains without, and thence to the public sewers. It is the custom to regard these conduits as passing from house to sewer, but this evening I would ask you to compare them with the pipes for the supply of coal-gas, and to view them rather as passing from the sewer as a center to the periphery within our dwelling-houses. In our comparison the public sewer may be regarded as corresponding with the gasometer; the house-drain and the waste-pipes as representing the service-pipes for gas; and the so-called "trap" indoors as taking the place of the metal tap found in connection with each gas-bracket. Sewer-air, even in its normal state, is a grave source of danger to health; but when the sewers receive in their course along the streets the infectious refuse discharged from houses where specific disease prevails, then the sewer-air — harmful hitherto—is changed into an intense poison.

How is it usually sought to debar this poisonous agent from dwellings? The sole means adopted, in nine cases out of ten, consists in placing at some point of the pipe which connects the interior of the house with the interior of the sewer a small body of water which is known as a "trap," and which is designed to act as a barrier to the passage of all sewer-air. The contrivance most commonly resorted to is the so-called bell-trap, an apparatus in which the rim of a bell-shaped cup is suspended in a small body of water contained within a circular depression. This form of trap is of all the least efficient; it is not only one in which the water-lock constituting the trapping may at any moment be entirely removed at the will of the individual, but at its best it provides between the house and the sewer a layer of water only about one half or three quarters of an inch in depth. Even the most efficient of all traps, the so-called "siphon-bend," is not much better. Dr. Andrew Fergus maintains that trapping has but little effect in keeping sewer-air out of houses, as the entrance of the contaminating air is not so much due to occasional and temporary failure in the efficacy of the trap as to an almost constant absorption of sewer-air by the water on the sewer-side of the trap, and its subsequent discharge from the house-side. Dr. Fergus has made a series of experiments in a glass tube so bent as to resemble the ordinary "siphon" trap, and charged with water. Certain gases were evolved on what we may call the sewer-side of the trap (*b*), and tests were applied to ascertain whether the gases succeeded in passing through the water. The results as tabulated by Dr. Fergus are as follows:

GAS.	Sp. gr.	Source.	Test.	Time for reaction to show.
Ammonia	·50	Solution.	Litmus.	15 minutes.
"	·50	"	Nessler.	30 minutes. Ate through a small wire in less than 24 hours.
Sulphurous acid	2·25	"	Litmus.	1 hour.
Sulphuretted hydrogen	1·25	"	Lead paper.	3 to 4 hours.
Chlorine	2·50	"	Iodide of starch paper.	4 hours.
"	2·50	"	Litmus-water in trap.	Began to show in a few minutes. In half an hour the whole was bleached.
Carbonic acid	1·50	Generated	Lime-water in trap.	1½ hour.
"	1·50	"	Litmus suspended over water in trap.	3 hours.

It was, however, urged that the results would probably be different if the trap were ventilated. A ventilating-shaft (*c*) was, therefore, inserted in the upper part of the bend on the sewer-side, and the experiments were repeated. "The results," says Dr. Fergus, "were much the same, except that the reaction was a little longer in showing itself."

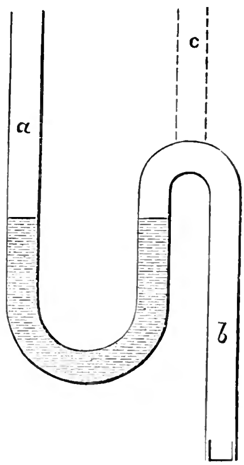

FIG. 1.

Ordinary sewer-air may be taken to contain in every hundred parts about seventy-nine parts of nitrogen, nearly twenty of oxygen, not quite half a part of carbonic acid, and traces of sulphuretted hydrogen, marsh-gas, and ammonia. These gases, however, when inhaled in the proportions indicated, can hardly be regarded as materially affecting health. Sewer-air also contains organic matter in the form of vapor, and of definite particles; but doubts have been expressed as to whether these organic particles succeed in making their way through water-traps, and some carefully executed experiments of Dr. Neil Carmichael, of Glasgow, have gone far to show that they do not do so.

There are other ways, however, in which danger comes about. The water in traps is apt to be sucked out by siphon-action, as the result, for example, of a rapid flow along the drain into which the waste-pipes discharge, and, under these circumstances, sewer-air and its organic ingredients pass unhindered into our houses. So, also, traps are liable to be forced by the pressure of the sewer-air upon them. Having regard to some of Dr. Carmichael's experiments, it might at first sight be supposed that organic particles contained in bubbles of air would be detained in their passage through a water-trap. This, however, is by no means the case. In certain experiments carried out at the Royal Institution by Professor Tyndall, F. R. S., it was found that air, passing through an experimental tube, carried with it "a considerable amount of mechanically suspended matter." Dr. Carmichael freely admits the inadequacy of water-traps as they exist, and points out many dangers attendant upon them. He enforces the caution he gives by a case related in a report of Dr. J. B. Russell, Medical Officer of Health for Glasgow. In certain tenements of one apartment, having no connection with the sewer, there had been a death-rate from diphtheria of 12, and from enteric fever of 24·9, per hundred thousand inhabitants. The introduction of a sink increased the diphtheria death-rate to 25·3—i. e., 110 per cent—and from enteric fever to 67·7—i. e., 171 per cent—the rate of mortality from certain allied diseases also undergoing a corresponding increase. Not knowing whether there were other circumstances that favored this special incidence of disease upon these tenements, I should find some difficulty in asserting that the drain-connection was the cause of the whole of the increase in the diseases specified; nevertheless, Dr. Russell's opinion that it was, carries great weight.

One striking instance, which further illustrates this point, came under my own cognizance. Some years ago I received instructions to inquire into the cause of an outbreak of enteric fever in a small township in Yorkshire. The main incidence of the disease was upon a group of houses, which formed an irregular square, containing twenty-three cottages, occupied by eighty-eight persons. Up to the first week in June the inhabitants of this locality had been free from fever, but at that date a series of attacks of well-marked enteric fever occurred almost simultaneously in a number of houses, fresh attacks taking place day by day until, in the space of a few weeks, one or more inmates in fifteen out of the twenty-three cottages had been attacked, the number of patients amounting to thirty-five. Now, when the contagium of enteric fever is conveyed by water, the persons attacked are generally attacked almost simultaneously. There is, however, in the case of enteric fever, a definite interval, generally of some ten to fourteen days, between the reception of the poison into the system and the occurrence of symptoms of the disease. The water-supply which these families generally used in common was a well in the neighboring field; but this had been disused for a period which more than covered the "period of incubation" above referred to.

In the course of my investigations I entered a wash-house belonging to one group of the houses in question. I was followed in by its owner, an old lady, who sought at once to satisfy my curiosity by assuring me that the building was rarely used; indeed, that the last time it was used was six weeks ago, at which date she had washed some linen there for a young man who had been very ill, and who lived some distance away. I had before this noticed that all the cottages were provided with sinks in their living-rooms, and that by means of these sink-pipes, which were in unbroken communication with a drain outside, offensive effluvia at times made their way into the dwellings, these having been especially noticed toward evening, when the houses were shut up and the fires were lighted. It at once occurred to me that if the sick man referred to had suffered from enteric fever, and if the drains for the several parts of the square all communicated

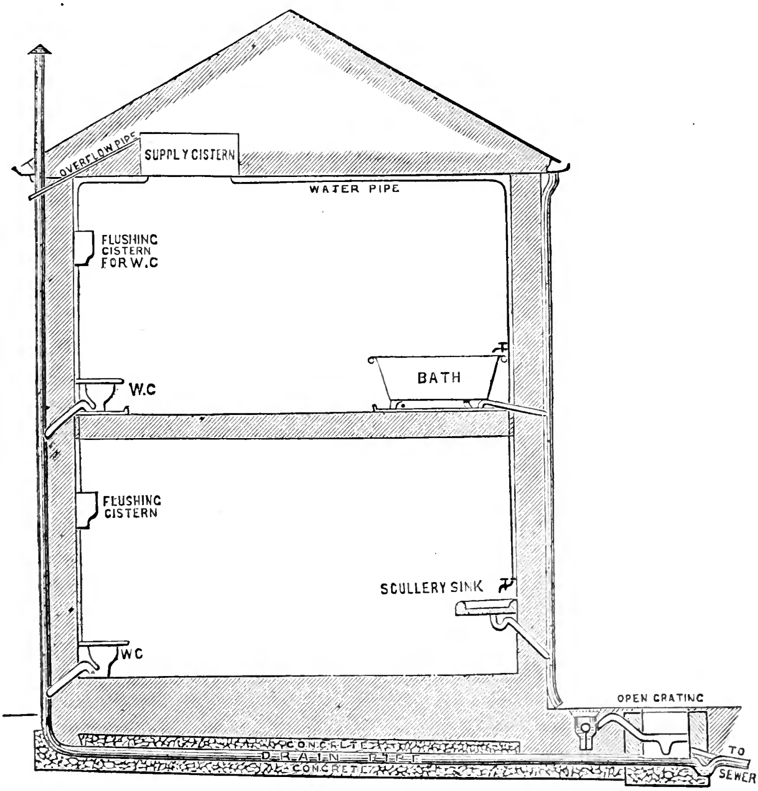

FIG. 2.

with the sewer by which the liquid refuse from the wash-house was conveyed away, then a specifically contaminated sewer-air had replaced the ordinary foul effluvia, and that in this way infection had been "laid on" to the several households. I found that the young man had indeed suffered from enteric fever, and, laborers having laid bare the drains, these were all seen to communicate with the sewer above mentioned, this being further of such faulty construction as to be little better than an elongated cesspool.

In view of the danger of direct communication between a sewer and our dwellings, "What," you may fairly ask, "is the remedy?" I answer that the remedy is simply breaking the direct connection which has been referred to. In the case of a waste-pipe from a sink, the pipe should be brought through the wall into the outer air, and there be cut off, its contents flowing to a trapped drain-inlet outside the dwelling. (This point was explained by means of diagrams.) This principle of disconnection is, however, of much wider application than I have as yet indicated. All waste-pipes coming from lavatories, baths, water-closets, etc., as also the overflow-pipes from cisterns, and the rain-pipes, especially such as have their heads anywhere near windows, or beneath overhanging eaves, should, like the sink-pipes, have an air-space intervening between them and the drain-inlets into which they empty.

There is exceptional danger in the direct connection which is often maintained between houses and the sewers by means of the overflow-pipes of cisterns. These pipes are very generally provided with a "siphon-bend," but the water constituting the trapping is often absent. The ball-cock of the cistern is intentionally so contrived as to prevent overflow, and hence, when once evaporation of the water in the trap has taken place, sewer-air passes through it without let or hindrance.

Adapting the principle of disconnection to the house-drain itself, I would further urge that an air-break should always be contrived between the end of the drain and a trapped inlet leading to the public sewer; the more so as when this is effected a further safeguard can be insured, namely, two ventilating apertures to the drain, and the maintenance of a constant current of air through its entire length.

(The conveying of infection by means of an "intermittent water-supply" was next described.)

I feel sure that many other methods by which water can act as a vehicle for conveying infection will occur to you. Milk, also, must be regarded as at least an equally important medium for the transmission of infection. I shall, however, ask your further consideration only of certain distributions of ice and cream as forming channels by which disease may be conveyed to households.

I believe that the first instance in which the consumption of ice was shown to have been followed by an outbreak of disease is that recorded in the "Seventh Annual Report of the State Board of Health of Massachusetts." The occurrence took place in one of the large hotels at Rye Beach, New Hampshire. At the beginning of the season of 1875 about a thousand visitors were assembled at Rye Beach, and a considerable number were attacked with a series of symptoms which led to the suspicion that they had consumed some noxious article. The incidence of the disease was entirely confined to three hundred persons occupying one of the large hotels. The sanitary state of this hotel is said to have been exceptionally good, and, although suspicion seemed at first to attach to the water-supply, yet the disease was found to have affected many who, "having apprehended trouble from the use of the water," which was strongly impregnated with salts of lime and magnesia, "had carefully limited themselves since their arrival to other beverages." Indeed, as the result of a careful process of elimination, suspicion came at last to be directed to the ice furnished to the house. The water obtained by melting the ice was discolored and charged with suspended matter, and gave off a decidedly disagreeable odor; the atmosphere of the ice-house was offensive, and some persons who had used the ice away from the hotel were found to have suffered in the same way from violent illness. The ice in question had been derived from a local pond, the water of which was found to have become foul from long-continued stagnation; one portion of the pond, measuring about five hundred feet in length and one hundred and fifty feet in width, was occupied by "a homogeneous mass of putrescent matter." A piece of ice, carefully cleansed from all surface impurities, was then melted, and the water thus obtained was submitted to chemical analysis, the result being the detection in it of a quantity of "decaying organic matter." The use of the ice had also in the mean time been discontinued, and coincident with its disuse "there was observed an abrupt amelioration in the symptoms of nearly all who had hitherto been ill." So, also, no fresh attacks occurred during the remainder of the season.

Even among the more educated classes there prevails an impression that even if water is contaminated it is purified by freezing. Many experiments have, however, shown the fallacy of this view. In some of these made recently by Mr. C. P. Pengra, an American chemist, various organic matters (urea, albumen, etc.) were mixed with water, and the specimens were gradually frozen. A certain amount of purification did take place—the ice containing thirty and even forty per cent less organic matter than the unfrozen liquid. But a large amount of the added pollution remained, and the investigator, though expressing surprise that the purification had been as great as it was, says that the experiments afford abundant proof that we ought not to tolerate the indiscriminate collection of ice.

These experiments do not, however, prove that the contagium of an infectious fever can withstand the process of freezing, but as to this we are not left in doubt. Dr. E. Klein, F. R. S., thus reports the results of some of his experiments in freezing *bacillus anthracis:* "I have exposed in a capillary pipette fluid full of spores to the influence of ether spray, and, having thus kept the liquid frozen for several minutes, have injected it into the Guinea-pig and rabbit with fatal result. . . . I then placed a capillary tube filled with spores in a mixture of ice and salt, and kept it there for one hour exposed to a temperature of 12° to 15° Cent. below freezing-point; after thawing, the material was injected into the subcutaneous tissue of a Guinea-pig. This animal died of typical anthrax on the third day."

We are thus bound to accept the position that the morbific organisms, the introduction of which into the human system produces specific infectious diseases, are not destroyed by freezing, but, on the contrary, that ice collected from an infected water and supplied to households would act as a vehicle for the introduction of the poison of those diseases. In short, a wholesome ice can be derived only from a wholesome water.

I now pass to my last point. On the 9th of June, 1875, a party of sixteen persons sat down to dinner at a house in South Kensington, and later on in the evening about one hundred and fifty additional guests assembled with the family of the host and hostess in the drawing-room; the service of the house was also re-enforced for the evening by seven extra servants. Within five days eighteen of the assembled guests suffered from more or less well-marked attacks of scarlet fever; two others had "sore throats"; one of the waiters had scarlet fever; and a few days later a lady, not at the house on the 9th, but who lunched there the next day, was found to be suffering from a distinct attack of the disease. In all, twenty-two persons were attacked.

The circumstances of the outbreak were investigated by Dr. Buchanan, F. R. S., and his report on it is specially instructive as indicating the method in which such an inquiry should be conducted. It was ascertained that the scarlet fever could not have been communicated by any of the guests, by any member of the host's family, nor by any of the servants, nor indeed did the circumstances of the outbreak suggest infection from such a source. On the other hand, strong circumstantial evidence was forthcoming in favor of the infection having been communicated by means of some article of food or drink.

The dinner guests were the principal ones affected; several of the household who could not have touched any of the articles of food served up escaped altogether, and there was a marked incidence of the disease on those who had several opportunities of eating certain exceptional articles supplied on that day. Up to this point, however, no one article of food had come under suspicion.

Two special supplies of cream were delivered at the house on the day of the entertainment; one, which arrived at 4 P. M., was "double cream" from a London dairy, and was used for ice-puddings, custards, and "creams"; the other, arriving at 5 P. M., was from a Hampshire dairy, and was mainly used as cream. The latter supply was generally used by all the evening guests, among whom there was but little scarlet fever; the former, or four-o'clock, cream was distributed essentially to the family and to the dinner guests. It was again used at luncheon the next day, and thirteen persons who were known to have had opportunity of partaking of it suffered from scarlet fever within five days. The bulk of this four-o'clock cream was used in the preparation of articles which had to be boiled previous to their being used in a cool or frozen form, and those persons who partook of such articles alone were not specially attacked. But of this cream some that was in excess of the cook's requirements was put into at least one jug along with the five-o'clock cream.

This mingling of the two creams added materially to the difficulty of the investigation, because it was that remnant of the four-o'clock cream which had not been boiled previous to use to which interest was now found specially to attach. For "no less than seven ladies who were at the dinner, and who took cream in their coffee in the drawing-room, afterward became ill, none of them who took that cream having escaped." There was, however, no such incidence of disease on the gentlemen who took coffee down-stairs. And further, whereas all who partook of cream on the day following the dinner were ill, none of those who did not partake of it suffered. Now, it was known that it was the four-o'clock cream that was used at the luncheon on the 10th, and if it so happened that the cream which was sent up into the drawing-room with coffee for the ladies who had left the dinner-table was the jug of mingled cream, then that four-o'clock supply from the London dairy comes strongly under suspicion.

The complicated nature of the conditions which had to be contended with in pursuing such an investigation in the metropolis forbade any conclusive demonstration as to the exact method by which this special cream-supply may have become infected. It was, however, ascertained that upon one section of the London dairyman's customers there had been a large incidence of scarlet fever, and a suspicious history as to scarlet fever in the person of one of the dairy-staff who was engaged in milking and carrying out the milk was also elicited. In short, there is little doubt that the cream supplied from this dairy was the vehicle by which the infection of scarlet fever was conveyed to that household in South Kensington.

Some years ago I conducted a somewhat similar inquiry. The same disease had attacked a large proportion of persons who had met at a London dinner-table, and the source of infection must have been some article of food. In this case, fruit as well as cream came under suspicion, and the employment as strawberry-gatherers of persons in the desquamative stage of scarlet fever seemed as likely a source of infection as that which might have operated through the agency of a dairy. The circumstances were, however, too complex to be unraveled, and further inquiry was abandoned.

In considering each of the previous channels of infection I have pointed to some remedy. That which promises most in dealing with infection conveyed in the manner just indicated is the early isolation of persons suffering from the several infectious fevers.

REMARKS ON THE INFLUENCE OF SCIENCE.*

By LESLIE STEPHEN.

"IF it were a qualification for his office," Mr. Stephen remarked, "to be impartial in the sense of not having an opinion on the matter, it would have been hardly possible to select a less qualified chairman in all London than himself. He believed that the spread of scientific influence had not only not been bad, but that the thing of which we stand most in need is a great deal more scientific thought and method in every direction. He felt, however, that his case was so strong that he could afford to give points to the opposite side; and for this reason, and because to a certain extent he was prepared to go with the opener in his remarks, he hoped to be able to point out fairly where the various arguments which had been used found their proper place. The only definition, or rather description, of science which ever appeared satisfactory to him was, that Science is that body of truths which may be held to be definitely established, so that no reasonable person doubts them. To speak of mischievous science is, therefore, to assert that truth is mischievous, an assertion to which no one would be likely to seriously agree, especially in such a place as University College. If it is to be supposed that science is mischievous, it must either be meant that certain false theories which call themselves science are wrongful, which may well be the case, or that the scientific progress at the present time happens to be exercising a mischievous influence.

"No one denies that science may accidentally lead to a large number of our particular mischiefs, as in the case of the invention of dynamite; but it can not in any way be admitted on that account that science is mischievous. For the question arises, If science is bad, what can be substituted for it? and in what way will these mischiefs be remedied if we are not scientific? It is impossible to say that erroneous impressions will make us better off than correct ones. For instance, the old belief in medicine subjected people to years of tor-

* Remarks by Mr. Leslie Stephen in summing up a debate at University College, London, on the motion by Mr. B. Paul Newman: "That the spread of scientific thought and method has, on the whole, exercised an injurious influence on English society." The motion was supported by Mr. N. Mickleman, and opposed by the Rev. A. Capes Tarbolton and Mr. J. G. Pease.

ture because of supposed witchcraft. In India it is still believed in some parts that small-pox is a demon, and efforts are made to propitiate it, so that, if unnecessary torture and small-pox are evils, we are better for the light which the scientific man has thrown on these subjects. Still, it must be admitted that in particular ways the development of science has produced new evils as well as new benefits, and for that matter no sort of progress is made without collateral evils. But the question then remained as to the remedy, and in his opinion that remedy could be very shortly described as more science and not less. There is no sort of conflict between a scientific and a literary education. Everybody ought to have some literary knowledge, and everybody ought to be taught the first principles of science; even a smattering of chemistry might be useful in a literary pursuit. He himself had found what little smattering of science he had acquired at Cambridge and elsewhere of the greatest use in every other kind of study. The habits of thought and feeling acquired by the study even of mathematics, which he took to be the most uninteresting science there is to most individuals, are very useful when one comes to need accurate thinking anywhere, even in matters purely literary.

"It had been urged that science prevents a man from taking the same sort of pleasure in nature as he would do without it. Wordsworth was very fond of saying this, and of denouncing generally the scientific position. But the reason of that was, that Wordsworth knew nothing about science. The result was, that there is no other instance of so great a poet leaving off writing great poems so early in his career. All his finest poems were written in his early life; and the reason is, that he went mooning about the mountains by himself, and did not get any new thoughts. In contrast to him Goethe stands out as a man great in both science and poetry, and is a typical example of the way in which they react on one another. Whenever it was suggested that science is opposed to a love of nature, the speaker always thought of the greatest man of science of modern times, Mr. Darwin, whose books are, apart from their scientific value, quite delightful in their literary style. No one, for instance, could read his 'Voyage in the Beagle' without seeing that Darwin's love of science was only a part of his love of nature. There is, indeed, no conflict between the two, and a man can not strengthen the one side of his nature without at the same time contributing to strengthen the other. Indeed, the reason why so many of our living poets are inferior to those who wrote at the beginning of this century, or to those of an earlier generation still, is just that they have not had the pluck to look science in the face, but have only taken a passing and sideway glance at it.

"An important point in the argument—namely, the relation of science to morality—was suggested by the remarks that had been made on the subject of vivisection. The vivisection question, in the first place, did not seem to him to be quite fairly stated. People speak as though vivisection were a recent practice, just introduced by a hard-hearted scientific generation. But, in point of fact, vivisection had been going on for many centuries. The thing which was new was the objection to it. The stock argument in favor of vivisection—that by it the discovery of the circulation of the blood was made—is only one of many instances.

"It had been remarked by a previous speaker, with whom he was inclined to agree, that there had been a great increase in humanity in modern times, and that this increase is to be attributed to the growth of science. It is not true, for instance, to say that the abolition of excessive and cruel punishments has been due to the action of a few energetic but unscientific individuals. They were, on the contrary, put down by the growth of the scientific spirit of the age—a spirit closely allied to humanity, and which showed itself in the philosophy of the eighteenth century, especially in the writings of Hume and Bentham. They gave up the idea of punishment as simply a revenge to gratify the feelings of the punishers, and took the utilitarian ground that it must only be administered in so far as it is beneficial to society. They were thus inevitably drawn into denouncing excessive punishments. Romilly, who had been cited by the other side, was probably a pupil of that school; and certainly Bentham and Mill were, who really spread the principles which led to the abolition of excessive punishment. And those principles were only the principles of science applied to morality.

"Though he admired our ancestors of the sixteenth century, he felt bound to admit that they were a brutal lot. An instance of how far we have improved in point of humanity is to be seen in 'Roderick Random.' After having reduced his young, amiable, and beloved hero to very great straits through 'dissipation,' Smollett makes him go to India to purchase a lot of slaves, whom he sells in America at a large profit. This we should consider brutal and degrading conduct, and the fact that we do so consider it marks the great improvement which has taken place in our morality. It is quite true that it is not merely the growth of science, but the general intellectual development of the country, which has put a stop to cruelty; but it is equally true that the growth of science is an integral part of that development, and one that can not be separated from it. None of these things would have been possible unless the intellect had widened; and science has helped to do this. We may hope for similar good results from the application of science to other things; for example, to politics, where there is little enough of scientific principles at present.

"On the religious question I can only say this," Mr. Stephen remarked in conclusion, "that you have got this plain dilemma to face, which can not be avoided. In the first place, if any religion, or religious belief, is true, what can the holders of it have to fear from the growth of truth, which you call scientific truth? If these beliefs are destroyed, is it not a conclusive proof that they may be false, or at least contain an element of untruth? The religion may, indeed, have been very useful, although not true, and not qualified to satisfy all the aspirations of a cultivated mind. You may see, when a civilized race comes in contact with a lower race, that the effect of the sudden contact may be to destroy the religion and the rule of life of the inferior race, without putting anything in its place. Evils of that kind have been caused by modern science. It is destroying inevitably many beliefs which people have lived under well and happily. It is undeniable that this causes pain, and that it may be injurious to their morality I shall not attempt to deny. But when I am asked to say that therefore science is injurious, I have to come back to my original proposition—the remedy is more science. The only way out of the difficulty is this: we are here, and we have got to go—forward. And the only way is, to apply the test of truth to all our beliefs. This effects a certain amount of pain, as every other kind of progress does; but the only other way is to go on believing what you know to be lies. And, without saying which are true and which are false, I can not see who any person can wish to do anything else but increase the amount of truth, the only satisfactory cure."—*Knowledge.*

A HOME-MADE TELESCOPE.

By Dr. GEORGE PYBURN.

TO render easier of attainment instruments which assist in the investigation or contemplation of natural phenomena, and which supplement man's sense-organs, is to forward by so much the diffusion of real knowledge, and to aid the work of human enlightenment and progress. Indeed, it is not to be doubted that the popularizing of instrumental aids for experimentally verifying the teachings of scientific discoverers will form a notable part of the work of the future schoolmaster.

A few years ago I derived great pleasure from successfully constructing a home-made microscope, guided by directions contained in "The Popular Science Monthly," at a time when my means did not enable me to purchase a good instrument from the optician. I now lay before my fellow-readers the following directions which, step by step, I myself have put in practice, in making a really serviceable achromatic telescope, which will exhibit the moon's surface magnificently, and show very satisfactorily the spots on the sun's disk, the satellites of Jupiter, and other celestial phenomena.

Some people conclude that, if they can not possess a first-class instrument of this or that kind, they are better off without any; but a moment's consideration will show the fallacy of this conclusion, and that, on the contrary, even a very poor instrument of observation or precision, or generally of research, in aid of the senses—be it telescope, microscope, spectroscope, balance, thermometer, chronometer, or chemical reagent—is vastly better than none. We have but to remember the great strides made in the acquisition of knowledge by the aid of the very imperfect first-forms of every instrument which has been invented, to be assured of this. Moreover, reflect!—so far as vision is concerned, men, on an average, without instrumental assistance, are inexorably kept at a distance from "things" of ten inches, and must view them under the angle thence subtended. But the use of a simple lens of two and a half inches focus annihilates three fourths of this distance, quadruples the angle of vision, and enables us to see objects only one sixteenth as large as the least we can see with the naked eye. And for some purposes a poor instrument is as good as the best: an egg or a potato gives the housewife all the advantages, in measuring the density of her brine, which she would derive from the most skillfully-constructed hydrometer, or the most accurate balance and specific-gravity bottle. Galileo, with his simple-lens telescope, saw what, perhaps, never man before saw—viz., the moons of Jupiter; and by exhibiting the partial illumination of Venus, with the same imperfect instrument, he removed one of the strongest objections raised against the heliocentric theory of Copernicus. A word to the wise is enough. To my fellow-students I say: Whatever may be your several lines of study, get real knowledge, where possible, by seeing and handling things for yourselves; and, if you can not possess or have the use of a good instrument, do not therefore refuse the assistance of a poor one; but in all cases get and use the best you can. Rembrandt made pictures with a burned stick before ever he possessed pigment or pencil.

The lenses requisite for such a telescope as I have constructed, and shall describe, can be purchased of an optician by those who live in large cities; those who reside at a distance may have them sent by mail at a trifling additional cost. They are: 1. An achromatic object-glass, one and a half inch diameter, with a focus of thirty inches. 2. Two plano-convex lenses of the respective foci of two inches and three fourths of an inch. The object-glass will cost about two dollars, and the other two lenses about seventy-five cents each.

Now procure a *straight* cylindrical roller of pine, two and five eighths inches in diameter, and thirty inches long; procure also a roller seven eighths of an inch in diameter, and fifteen or sixteen inches long. These are for forming the tubes on. Take stout brown wrapping-paper, and, with book-binder's paste, form a tube, twenty-nine inches long, on the large roller. Spread the paste on evenly, and rub the several layers of paper down smoothly with a cloth. Nine or ten thicknesses of paper will form a tube sufficiently thick and firm for our purpose; but only three or four layers should be laid at one time, and, when these are dry, three or four more may be added, and so on, until the requisite thickness is attained. When thoroughly dry, which will be in three or four days, you will have a stiff, straight, and light tube, the ends of which must be neatly and *squarely* cut off with a sharp knife, so as to leave it, when finished, exactly twenty-eight inches long. With a bit of sponge tied on the end of a stick, and some common or India ink, black the whole inside of the tube, and set it aside, on end, until the other parts are ready.

Next form a tube on the smaller roller, with only four or five thicknesses of paper, fifteen inches in length. *When this is dry,* proceed to form a third tube, over this second one as a roller, using six or seven thicknesses of paper in its formation. This last is to be used as a draw-tube for focusing with, and must be cut neatly and squarely off at the ends to a length of fifteen inches. A portion of the inner tube on which this was formed will be required for the eye-piece, directions for making which I shall give further on. Blacken the insides of both tubes, and set them aside, on end.

One more tube is required, viz., that in which the draw-tube shall slide. It needs to be only six inches long, but, in order to smooth working, should be lined inside with fine cloth or cotton-velvet. Procure, therefore, a piece of black broadcloth, six inches long, and of sufficient width to fit easily and accurately around the draw-tube. Then, using the latter as a roller, first neatly fit the cloth thereon as a first layer; next paste or gum the back of the cloth, and, with this for the innermost layer, form a short tube, six inches long, with paper and paste, as before directed, using here not more than six thicknesses. The draw-tube will now be found to move easily and smoothly back and forth in this cloth-lined sheath; but, for fear that the gum or paste should have penetrated the cloth lining, and should stick the tube and its sheath together, it will be safer to draw them apart before drying, and thus save needless trouble and annoyance.

On comparing the external diameter of this sheath with the interior diameter of the large tube first made, it will be found that some packing is required, to hold the former steadily and concentrically within the latter. Take, therefore, some three-quarters inch strips of brown paper, and, having pasted them, wind around the sheath at each end, to form rings or collars of equal thickness, and large enough to fit snugly within the main tube. The appearance of the sheath when completed will be as shown in Fig. 1, where *a a'* are the collars just described.

Now take the compound object-glass, consisting of a double-convex crown-glass lens, A (Fig. 2), and a plano-convex flint-glass lens, B. They will come from the optician's shop separate, but loosely fitted into each other. Be careful to see that their several surfaces are bright and free from specks, and, in handling them, touch only their edges. Remember, also, that the double-convex lens must be *outside* when the telescope is fitted up. Have ready a strip of tissue-paper, just the width of the thickness of the lenses at the edges: gum this on one side, and, holding the two lenses together with the fingers of the left

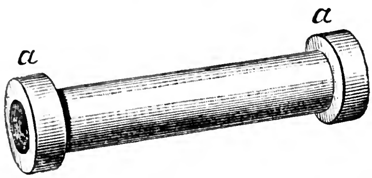

Fig. 1.

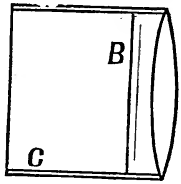

Fig. 2.

hand, wind the strip around the edges, so as to fix them together, and thus make a single piece which can be easily handled. When this is dry, take a strip of brown paper one and a quarter inch wide, and with paste form a short tube or cell, C, around the object-glass, using (say) five thicknesses. Fig. 2 shows the object-glass and cell in section.

To form the eye-piece: cut off a portion of the smallest tube—that on which the draw-tube was rolled—one and three-eighths inch in length, and make the ends even and *square*. Make, now, two disks of blackened cardboard, of the diameters respectively of seven-eighths inch and one inch. Punch or cut out exactly in the center of each disk an aperture one quarter inch in diameter. Gum the edges of the smaller disk, and fit it *into* the tube, exactly three quarters of an inch from one end, and, of course, five eighths of an inch from the other end. Then take the two-inch plano-convex lens, and, having made it perfectly clean, cement it on to the end of the tube nearest the perforated disk, with the plane surface inward. Use shellac varnish, or gold-size, for cementing the lens on to the edge of the tube. Cement the three-quarters inch plano-convex on to the one-inch perforated disk, centrally over the aperture, and with the plane surface next the card. When the cement on both lenses is dry, which will be in a day or two, fasten this one-inch disk to the open end of the tube, *keeping the lens inside*. A single layer of tissue-paper, gummed on to the outside of the tube, and turned down about one sixteenth of an inch all around the edge of the two-inch lens, and around the disk at the other end, will now serve as a sort of fastener to both, and will complete the eye-piece, which is shown in full size in section, Fig. 3. The smaller lens *a* must be next the eye when the telescope is fitted up; the larger lens *b*, called the field-glass, will be inside and facing the object-glass.

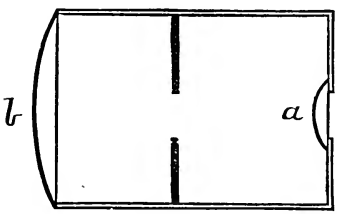

Fig. 3.

For fitting together the various parts now completed few directions are needed. The cell containing the object-glass must first be slid into one end of the large tube, and made to fit neatly, by *even-wrapping* with tissue-paper or other soft material. The sheath (Fig. 1) must now be slid into the other end of the large tube, and fitted in a similar manner. Now push the draw-tube into the sheath, and slide the eye-piece about half-way into the end of the draw-tube, and the telescope is completed. Those who are æsthetically inclined may give an extra finish to the main tube, and also to the draw-tube and eye-piece, by using for the outermost layers gilt-paper, or other smooth and colored

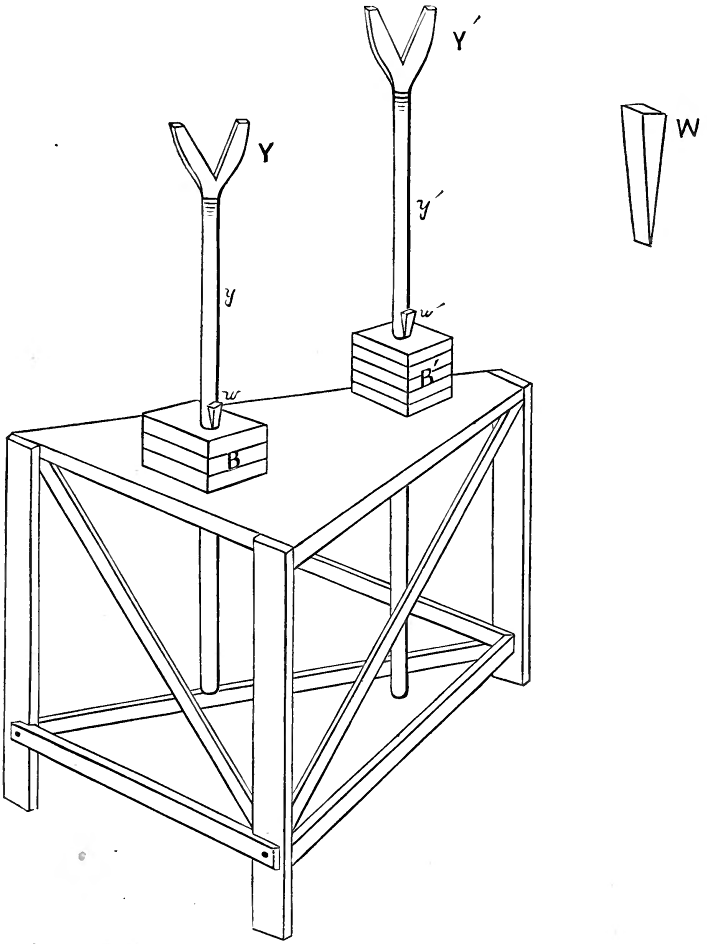

Fig 4.

material. A sun-shade, consisting of a wide tube, three inches long, may also be made to slide over the object-end of the telescope ; and a cap may be added to this to keep out dust. A kind of cap, perforated with an aperture one quarter of an inch in diameter, may also be constructed for slipping over the eye-piece, so as to preserve the proper distance between the eye and the eye-lens when making observations; and a second similar cap should be made, and furnished with a disk of black or red glass, for protecting the eye when viewing the sun. For myself, I use a disk of thin microscopic glass, smoked and fastened in a cap which slips over the eye-piece.

But a telescope, even such as I have described, and which has a power of only twenty-five or twenty-six diameters, needs a stand, and this can be constructed easily and cheaply of one-inch pine and a few nails and screws, something after the pattern shown in Fig. 4. By laying the telescope on the two end-supports, Y Y′, greater steadiness is secured than by using a single support in the center; and the rods *y y′* are easily raised or lowered, and may be fixed in their positions by the little wedges *w w′*. The stand is thirty inches high, sixteen inches broad, and twenty-five inches long. The rods *y y′* are forty inches and sixty inches long respectively. The blocks B B′ are built up of pieces of one-inch board, nailed together; then an auger-hole is bored through the whole, so as to form a sheath or tube in which the rods may slide easily, but without so much lateral motion, or "wiggle," as they would have if they only passed through one thickness of board.

By following these directions you will have a really useful achromatic telescope; small, indeed, and insignificant when compared with the six-foot reflector of Lord Rosse, or with one of Clark's twenty-six-inch refractors; but, nevertheless, a veritable Jacob's ladder, by which you can ascend—if not *into*—at least twenty-five twenty-sixths of the way *toward* heaven; a perpetual source of pleasure, to a family of intelligent children, on moonlight nights and on occasions of eclipses; worth a whole year's "schooling" as an incentive and help to the study of the universe, and a practical realization of an answer to the oft-mouthed prayer—

"Nearer, my God, to thee!"

THE UTILITY OF SCHOOL-RECESSES.

By JOSEPH CARTER.

THERE is a growing tendency to abandon the school-recess. The editor of the Boston "Journal of Education" says of the no-recess experiment, adopted in Rochester, New York, that it has given "perfect satisfaction." Among the advantages gained, he mentions, "a continuous school-session without interruptions in school-work"; "better health of pupils, on account of freedom from exposure to cold and wet weather in the midst of each session"; "discipline easier, on account of freedom from recess-troubles"; "more time for teachers," etc.; "less tardiness and absenteeism"; and less frequent opportunities for vicious pupils to come in contact with and corrupt other pupils." Believing that these reasons are unsatisfactory, and that the tendency is a bad one, I propose to offer some general considerations that weigh strongly against it.

The schools are utilitarian in their aim; to fit the child for living successfully is the object of their existence. As animal strength is the foundation of all moral and physical welfare, and is the chief condition of success in all the pursuits of life, the future welfare of the child in every way depends upon the normal development of his body.

An effeminate man is half sick; and when it comes to any of the severer trials of life, either physical or moral, where great endurance or courage is required, the weakest must inevitably be the first to succumb. This is as true of moral trials as of physical, for moral cowardice often results from physical feebleness. It is to be doubted if anything that is taught in the schools is of so much value to a child that it would not better be foregone than to be obtained by the loss of any physical vigor whatever. Taken in the truest sense, that city has the best schools where the school restraints have least effect upon the physical growth and normal development of the pupils, and not the one where the pupils show the greatest proficiency in acquiring in a *memoriter* way a few fragments of conventional facts which happen irrationally to pass current for an education. But because in so many schools the test to be applied at the end of the term, or at the end of the course, is the *memoriter* one, and because no teacher expects her pupils to be examined as to their health, or as to whether they are forming habits of life that will be conducive to healthfulness, it is not to be wondered at that all the plans of the teacher look more to the development of conventional proficiency than to the infinitely more important matter of health.

Under our present standard for successful teaching, it is a necessity that the teacher bend all her energies to the attainment of those things which are to be measured by a technical school examination, and that the matter of health be entirely ignored; in fact, it is a thing rather to be shunned, for, as a rule, the nervous, sallow-cheeked, flat-chested boy or girl, with the attenuated skeleton, will vanquish his more robust and healthful brother in one of these examination-jousts; and that teacher whose school contains the largest per cent of the former class may reasonably expect to obtain the greatest per cent from the examination by the superintendent. Hence it is that the "no-recess" plan will frequently meet with great favor among teachers who are most zealous and honest in doing their duty as they understand it.

There is already too strong a tendency, under our mode of civilization, to form troglodytic habits. This is shown by the number of people who flock to the cities, by the number of boys who seek in-door employment, and by the prevalent sentiment that any person who is properly educated will secure something to do where he may stay in the shade and away from the weather. That the abandonment of the out-door recess in our schools will strengthen this tendency to an in-door life, and weaken the disposition, born with every child having a normal development, to get out-of-doors, can not be doubted. That this "no-recess" plan is in direct opposition to all the instincts of the child's nature, ought to insure its immediate condemnation.

Muscular action for the health of a growing child is a necessity, and the amount of exercise that a child will take, when permitted to roam out-of-doors with congenial company at his own sweet will, is a quantity of vast magnitude. Muscular action is and should be a thing for which the child has an appetite, a craving, as intense as any he ever feels for food or fruit, and no school discipline should be allowed to interfere with its necessary gratification. The play-ground is more of a necessity to a school of young children than any of the other school appliances.

Recognizing the violence that the no-recess plan is doing to the future well-being of their pupils, some superintendents have invented a series of in-door games, which are played for a few minutes, at short intervals, in the school-room, under the charge of the teacher, such as tossing little bags of beans, marching, exercises with the arms and legs, and the like. The best of such exercises fall very far short of the real, soul-stirring, cheek-glowing, muscle and brain making exercise of the play-ground; while the poorest of them—and all are poor when they take the place of the open-air recess—are the severest trial of the day, both to the nerves and the amiability of teacher and pupils. As a rule, there is no other school exercise in which there is so much friction between teacher and pupils, none other where so frequent appeals are made to higher authority, and none other from which the pupil so often tries to escape, as this gymnastics. The law of physics, that all bodies move in the direction of least resistance, ought to show teachers that this plan, in its present form, should be abandoned. Children do not like to be marched around under the direction of a teacher who needs the exercise more than they, and who sits or stands still while they are marching. During a five years' military service, the hardest campaign I went through was a three months' drill, and I never saw a regiment but would sooner undertake a week of severest marching than a week of camp-drilling. That gymnastics can be, and sometimes is, made of great benefit to the pupils, is true, but the teachers who have the skill, ability, and enthusiasm requisite for the work are very rare. Children have a desire to manage for themselves. How often do we observe their impatience at our opening some box or package of theirs that they wish to open for themselves! And, if the teacher were competent to enter thoroughly into the spirit of the in-door game, the children would still prefer to manage it in their own way.

But if the exercise in the house, so far as muscular action is concerned, answered every purpose, it would still be unwise, because it begets the habit of in-door life, and this is destructive of all educational development except in a few very narrow lines, and it is questionable if these lines are educational in any true sense. A child with the in-door habit may be an adept at parsing, he may be skillful in translating Latin and Greek, and be able to follow in the beaten track of mathematics; but when it comes to any of the sciences, when he attempts any of the studies which relate to the phenomena of the living world, or of the objective world about him, because he has never observed these phenomena himself, he will fail. He will fail because in what he has seen and experienced there is nothing by which he will be able to translate to himself the words or the pictures of the text-book. In all the branches of natural history he can learn nothing but the words of the book. What the science of chromatics would be to a blind child, or acoustics to a deaf one, is the greater part of our science-teaching, in cities especially, to the boys and girls—Kaspar Hausers—whose life is spent in the house. Knowing so little of the phenomena of the world, they are, of course, unable to comprehend any of the grand generalizations which follow a knowledge of their causes and sequences; and, being deprived of this, they are without both the powers of observation and of the deeper reasoning which can come only as a result of facts obtained by observations of their own and kindred ones of others. To teach such children text-book science is not only a waste of the time of the child, but it is a very great damage to him, both because it will have a stultifying effect upon his mental powers, and because it will make him believe—if he learns the words and secures a fair per cent from his teacher—that he has an understanding of the subject, when, as a matter of fact, he knows nothing of it but the words in which the thoughts are expressed, while the very existence of the true thoughts is all unknown to him.

To speak of the advantages of an out-of-door life seems almost like stating truisms universally accepted; and yet the great mortality among the dwellers in-doors, their precarious tenure of life, the prevalence of nervous diseases among them, and the tendency to crime, all show that it is still necessary to refer to the ruddy health of the farmer, to his greatly prolonged life, to his freedom from insomnia, to his immunity from pulmonary complaints, and to his absence both from the prison and the almshouse, as a proof that out-door life is necessary to health and to happiness. The tendency of book-learning, under the most favorable conditions, is to too much in-door life, and, when this tendency receives the additional influence of the no-recess plan, it certainly has a powerful hold upon the young person just emerging from the school-room. Is Solomon's injunction, to "train up a child in the way he should go," sufficiently heeded? Dr. Oswald says: "Early impressions are very enduring, and can make evil habits as well as useful ones a sort of second nature. In order to forestall the chief danger of an in-door life, make your children love-sick for fresh air; make them associate the idea of fusty rooms with prison-life, punishment, and sickness." So at school, the deprivation of the regular recess ought to be as severe a punishment as the criminal code of the school permits, and to be sent to the school-room from the play-ground should be a sufficient penalty for the worst offense, and is a punishment that should be administered to the juvenile offender only for offenses of a nature similar to those which in the adult offender are punished by incarceration in the jail or bridewell.

Our physical constitution was never intended for the sluggish inactivity of our sedentary and bookish school-life, and we sin against the laws of our being when we forego necessary physical exercise. Sloth is not one of our original sins, but an acquired one, and perhaps in no other place is its acquisition so rapid as in a modern school-room, where pencils and paper are passed to the pupils, and every movement must be quiet, subdued, and noiseless, and where the temperature is kept at a uniform degree, so that not even the involuntary muscles get any exercise. When along with this condition come the multitude of studies pursued, and the pressure of emulation, and upon all the abolition of the regular play-spell, what is there to prevent the boys and girls from forming the most fatal habits of muscular indolence? A recent writer in the "Monthly" says: "Where the chief danger seems to lie, in most schools, is in the encroachment made on the play-hours. In some schools the lessons set to be learned at home are absurdly long and tedious. I find that in other schools, public and private, a great deal of work is done during the period nominally allotted to recreation only. This is a very important part of the actual school system, and one which requires great care on the part of the masters" ("Science Monthly," March, 1880). In a school of eighty pupils, with ages ranging from twelve to fifteen years, each pupil counted his pulsations for one minute immediately before and after a fifteen minutes' recess, and recorded each result upon a card; the recess was varied, sometimes an out-door, sometimes an in-door, with light gymnastics, and sometimes the pupils were advised to follow their own inclination in the matter, but always to record upon the card how the recess was passed. These are some of the general averages:

1. Those pupils who go out and engage in play increase the number of pulsations per minute by 13·4. 2. Those who engage in in-door gymnastics increase the number by 3. 3. Those who stay in the school-room at their seats, or visiting their neighbors, decrease their number by 3·8. This increase of number of pulsations from the recess-play is by no means the full measure of the benefit derived, for that increase

implies a more rapid flow of the fluid through the hemal channels, and, when we know that the carrying power of fluid currents increases as the sixth power of their velocities, we can appreciate with how much greater force these currents sweep through their courses, washing away the ashes, which have been made by previous combustion, from the brain-hearth and the muscle-hearth. To the child who has been busily engaged upon his lessons, it frequently happens that the further ability to accomplish mental work successfully, and without nervous debility, depends upon the thorough removal of the *débris* caused by cerebral exercise. When this removal has been accomplished by recreation, the child's power has been recreated. That pupils generally do their best school-work just after recess, and that they are less "nervous" at that time, is because the exercise has increased their nerve-power, and given them a better control of their intellectual faculties, and a greater willingness to do hard thinking. Muscular exercise, then, becomes a motive power for driving forward the machinery of thought.

Were there no other objection to this plan, the one that it keeps children away from the sunlight would still be enough to condemn it. When we see the boys and girls of this country gathering at the call of the school-bell at 9 A. M. and remaining till 4 P. M., away from the sunlight—except a few minutes' walk to and from dinner—and this continued from six to sixteen years of age, for five days in a week and ten months in a year, how can we help fearing that this school-life, however good it may be in other respects, can not fail to leave its pupils with emaciated bodies, attenuated limbs, and with a general strength much below the average of what it should be, and much below the average of what it must be, in order to give them that start in the struggle for existence which they must have if they would win ; it is not possible to save them from this competition ; all must meet it, and the power of physical endurance is an absolute necessity for success.

Neither Latin, Greek, grammar, nor geography, can give this power ; but an hour's play in the sunshine daily, for this ten years of school-life, might do so.

Not only do the out-door recesses have the advantage of air and sunshine in good weather, but in bad weather they have the advantage of exposure also ; and, contrary to the commonly accepted theories, exposure to inclement weather, in a reasonable degree and with proper care, is of very great advantage. For nine years past it has been my invariable practice, at four different periods daily, for a time aggregating ninety minutes, to supervise a play-ground where several hundred children of a public school assemble. I have observed that there are certain ones, some of each sex, who are seldom absent. No cold, except, perhaps, half a dozen days of the severest, and no storm except a most drenching rain, ever drives them into their school-rooms. Through all ordinary rains and snows they seem to feel no discomfort.

With lists of the names of these I have examined the registers of daily attendance kept by the teachers, and, upon making out lists of their absences from school on account of sickness, find their per cent is not one fifth as great as that of the whole school, and not one twelfth as great as that of an equal number of pupils of the same grade who are never seen upon the play-ground in either good or bad weather.

At first sight these figures seem inexplicable; but when any one looks about his own town and sees families of laboring-men with half a dozen children to each house, and sees their houses are poorly built, that they admit the wind and sometimes the rain, he sees the children running about in quite frosty weather barefoot, he sees them playing in the rain and storm with perfect freedom from colds, and he knows they are seldom sick—then if he looks up the avenue to some residence with its double windows, its base-burner, which keeps the house at a uniform temperature, and observes when the children come out how carefully they are protected from the weather, and how very delicate they are, he will, if he is thoughtful, soon conclude that the good health of the children of the laboring-man is because they encounter exposure, and not that they encounter exposure because of their good health.

Where school-rooms are warmed by an abundance of pure, warm air, and where pupils have perfect liberty to go at any time to the registers to warm and dry shoes and clothing, they will not suffer by any voluntary out-door exposure, however inclement the weather. There seem to be no other gymnastics for the involuntary muscles, those controlling the vital functions of respiration and circulation, but exposure and vigorous exercise. Who has ever heard a hale old man, who had long since passed his allotted halting-place of threescore-and-ten, tell of his youth, but could tell of exposure, constant and severe, in his youth? Hunters, wood-choppers, ranchers, and soldiers, are not afraid of the weather, nor are they subject to coughs and colds. During five years of army life as a trooper, our regiment was never in barracks, and much of the time was without tents. Often we were wet to the skin, and sat our horses till our clothes dried upon us by the heat from our bodies without feeling any other effect than an increased appetite. By exposure we were made water-proof; and I believe children can be made largely cold-proof, and sickness-proof, by allowing them their own free-wills as to exposure.

Children need the rough-and-tumble of an out-door recess to toughen the sinews of the body. Many at home are so tenderly cared for that, what with cushioned chairs, stuffed sofas, and spring-seats to the very carriages in which they ride to school, they are in danger of becoming too tender for even this usage; and, if they are ever to accomplish anything in this world, they must somewhere acquire the physical power to endure many hard knocks in the various ways and stations of life. They can not always be held in their nurses' arms. They will meet with accidents which, if they are accustomed to the games of the play-ground, will not affect them at all, but which, if they are not, will lay them up with a lame side, a sprained ankle, or a dislocated joint. Falls and tumbles occur daily upon the play-ground, with no injurious effects whatever, which would put some of the tenderly nurtured in bed for a week. The play-ground is the only place connected with the schools where children can become hardy: and this element of hardiness has been very strongly marked in all successful men. It is not the carpet-knights who to-day rule in politics or in business—no, nor in science or religion—but the men who have grit and toughness, men who fear neither ridicule nor a crowd of rowdies.

Take the boy who has a few companions to play with him upon his own lawn, and who, like himself, are carefully kept from the society of the rougher and more world-wise boys of the street, and how is he to get any knowledge of the methods or the power by which these others are to be controlled in after-life? Yet this boy and his class are those who in many respects ought to have a controlling influence on the destiny of his neighborhood, but, because he has no acquaintance with the other class, because he does not know what are their ruling motives, he is powerless for good among them. By means of this knowledge those agitators among the people, like Moody and Dennis Kearny, the leading politician in each town and ward, and the organizers of strikes, have such power among the masses; and their lack of this knowledge is the main cause of failure of our citizens' social-reform societies and kindred organizations which attempt some very laudable reforms. As the boy is father to the man, so the play-ground is the antecedent of the future society of the town or ward, and upon the play-ground, more than in the school-room, the leaders of the future are made; there the boy must learn, if he ever learn it, how to lead, control, and master the others—boys to-day, but men to-morrow. The school-room is an autocracy, with the teacher for autocrat and the pupils for subjects, but the play-ground is a pure democracy: there each, in proportion to his strength, dexterity, and skill, is equal to any other; there the egotist learns his insignificance, the rude boy gets his first lessons in common courtesy, and there the bully learns that his ways are not approved.

But the ruling sentiment of the play-ground must not be allowed to form itself by accident: children must not be left to themselves at these times.

An out-door recess needs the controlling presence of the teacher quite as much as an in-door one, and more than the ordinary exercise of the school-room, and because this has been neglected is the reason why some people have objected to it. Several hundred children, after experiencing the restraint of the school-room, should not be released upon the play-ground without supervision competent to suppress whatever may appear that is pernicious. There is no other time in all the day when competent guidance can do so much to make boys manly and girls womanly as when they are at their games. It is not enough to leave the play-ground to the janitor or to some inferior authority; it is the place where the principal teacher and nearly all the others are most needed—not to direct the games, or to meddle in any way with the sports, but to be ready with a cheery voice and an easy grace to suggest to any one about to engage in anything improper that he has forgotten himself. Ruffianism will soon disappear, timid children will learn to assert themselves, and an *esprit de corps* of the play-ground can soon be formed which will have a wonderful influence on the characters as well as the actions of the pupils. Nor is the benefit to the pupils all that is derived from this plan; the teacher needs such a recess quite as much as, and in many cases more than, her pupils. Fifteen minutes of each ninety in the open air, away from the sights and thoughts of the lessons, will remove the nervous, tired, irritable, and almost despondent feeling experienced by many teachers, and give them renewed strength and cheerfulness and mental elasticity for the remainder of the session. By being upon the play-ground among her pupils, many a teacher learns their character, their ambitions, the bent of their minds, as she can not learn them in the peculiar position in the school-room; and yet there are many children who, unless understood in these particulars, can not be successfully taught. To the teacher who sees her pupils only in their relation of pupils, the school-work is very likely to become a grind, a machine at which she is to perform a regular and a constant part, and the children are little else than so much raw material which is to pass through the mill over which she presides. She sees no individuality in them, and of course her work is arranged for the aggregate, and individuals receive no consideration as such. To overcome this error there is nothing better than for her to see them daily at their sports, for there their distinctive characteristics are manifested as in no other place. If the schools are to build character, certainly an out-door recess is an absolute essential for both teacher and pupils.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XVI.

A CORRESPONDENT of Manchester asks me which is the most nutritious, a slice of English beef in its own gravy, or the browned morsel as served in an Italian restaurant with the burnt-sugar addition to the gravy?

This is a very fair question, and not difficult to answer. If both are equally cooked, neither over-done nor under-done, they must contain, weight for weight, exactly the same constituents in equally digestible form, so far as chemical composition is concerned. Whether they will actually be digested with equal facility and assimilated with equal completeness depends upon something else not measurable by chemical analysis, viz., the relish with which they are respectively eaten. To some persons the undisguised fleshiness of the English slice, especially if under-done, is very repugnant. To these the corresponding morsel, cooked according to Francatelli rather than Mrs. Beeton, would be more nutritious. To the carnivorous John Bull, who regards such dishes as "nasty French messes" of questionable composition, the slice of unmistakable ox-flesh from a visible joint would obtain all the advantages of appreciative mastication and that sympathy between the brain and the stomach which is so powerful that, when discordantly exerted, may produce the effects that are recorded in the case of the sporting traveler who was invited by a Red Indian chief to a "dog-fight," and ate with relish the savory dishes at what he supposed to be a preliminary banquet. Digestion was tranquilly and healthfully proceeding, under the soothing influence of the calumet, when he asked the chief when the fight would commence. On being told that it was over, and that in the final *ragoût* he had praised so highly the last puppy-dog possessed by the tribe had been cooked in his honor, the normal course of digestion of the honored guest was completely reversed.

Reverting to the fat used in frying, and the necessity of its purification, I may illustrate the principle on which it should be conducted by describing the method adopted in the refining of mineral oils, such as petroleum or the paraffin distillates of bituminous shales. These are dark, tarry liquids of treacle-like consistency, with a strong and offensive odor. Nevertheless, they are, at but little cost, converted into the "crystal-oil" used for lamps, and that beautiful pearly substance, the solid, translucent paraffin now so largely used in the manufacture of candles. Besides these, we obtain from the same dirty source an intermediate substance, the well-known "*vaseline*," now becoming the basis of most of the ointments of the pharmacopœia. This purification is effected by agitation with sulphuric acid, which partly carbonizes and partly combines with the impurities, and separates them in the form of a foul and acrid black mess, known technically as "acid tar." When I was engaged in the distillation of cannel and shale in Flintshire, this acid tar was a terrible bugbear. It found its way mysteriously into the Alyn River, and poisoned the trout; but now, if I am correctly informed, the Scotch manufacturers have turned it to profitable account.

Animal fat and vegetable oils are similarly purified. Very objectionable refuse fat of various kinds is thus made into tallow, or material for the soap-maker, and grease for lubricating machinery. Unsavory stories have been told about the manufacture of butter from Thames mud or the nodules of fat that are gathered therefrom by the mud-larks, but they are all false. It may be possible to purify fatty matter from the foulest of admixtures, and do this so completely as to produce a soft, tasteless fat, i. e., a butter substitute, but such a curiosity would cost more than half a crown per pound, and therefore the market is safe, especially as the degree of purification required for soap-making and machinery-grease costs but little, and the demand for such fat is very great.

These methods of purification are not available in the kitchen, as oil of vitriol is a vicious compound. During the siege of Paris some of the Academicians devoted themselves very earnestly to the subject of the purification of fat in order to produce what they termed "siege-butter" from the refuse of slaughter-houses, etc., and edible salad oils from crude colza oil, the rancid fish oils used by the leather-dresser, etc. Those who are specially interested in the subject may find some curious papers in the "Comptes Rendus" of that period. In vol. lxxi, page 36, M. Boillot describes his method of mixing kitchen-stuff and other refuse fat with lime-water, agitating the mixture when heated, and then neutralizing with an acid. The product thus obtained is described as admirably adapted for culinary operations, and the method is applicable to the purpose here under consideration.

Further on in the same volume is a "Note on Suets and Alimentary Fats" by M. Dubrunfaut, who tells us that the most tainted of alimentary fats and rancid oils may be deprived of their bad odors by "appropriate frying." His method is to raise the temperature of the fat to 140° to 150° Centigrade (284° to 302° Fahr.) in a frying-pan; then cautiously sprinkle upon it small quantities of water. The steam carries off the volatile fatty acids producing the rancidity in such as fish-oils, and also the neutral offensive fatty matters that are decomposed by the heat. In another paper by M. Fua this method is applied to the removal of cellular tissue of crude fats from slaughter-houses. It is really nothing more than the old farm-house proceeding of "rendering" lard, by frying the membranous fat until the membranous matter is browned and aggregated into small nodules, which constitute the "scratchings"—a delicacy greatly relished by our British plowboys at pig-killing time, but rather too rich in pork-fat to supply a suitable meal for people of sedentary vocations.

The action of heat thus applied and long continued is similar to that of the strong sulphuric acid. The impurities of the fat are organic matters more easily decomposable than the fat itself, or, otherwise stated, they are dissociated into carbon and water at about 300° Fahr., which is a lower temperature than that required for the dissociation of the pure oil or fat (see No. 13 of this series). By maintaining this temperature, these compounds become first caramelized, then carbonized nearly to blackness, and all their powers of offensiveness vanish, as such offense is due to slow decomposition of the original organic compounds, which now exist no longer, and the remaining caramel or carbon cinders being quite inoffensive or no further decomposable by atmospheric agency.

In the more violent factory process of purification by sulphuric acid the similar action which occurs is due to the powerful affinity of this acid for water; this may be strikingly shown by adding to thick sirup or pounded sugar about its own bulk of oil of vitriol, when a marvelous commotion occurs, and a magnified black cinder is produced by the separation of the water from the sugar.

The following simple practical formula may be reduced from these data. When a considerable quantity of much-used frying fat is accumulated, heat it to about 300° Fahr., as indicated by the crackling of water when sprinkled on it, or, better still, by a properly constructed kitchen thermometer graduated to about 400° Fahr. Then pour the melted fat on hot water. This must be done carefully, as a large quantity of fat at 400° poured upon a small quantity of boiling water will illustrate the fact that water when suddenly heated is an explosive compound. The quantity of water should exceed that of the fat, and the pouring be done gradually. Then agitate the fat and water together, and, if the operator is sufficiently skillful and intelligent, the purification may be carried further by carefully boiling the water under the fat, and allowing its steam to pass through; but this is a little dangerous, on account of the possibility of what the practical chemist calls "bumping," or the sudden formation of a big bubble of steam that would kick a good deal of the superabundant fat into the fire.

Whether this supplementary boiling is carried out or not, the fat and the water should be left together to cool gradually, when a dark layer of carbonized impurities will be found resting on the surface of the water, and adhering to the bottom of the cake of fat. This may be peeled off and put into the waste grease-pot, to be further refined with the next operation. Ultimately the worst of it will sink to the bottom of the water. Then it is of no further value, and will be found to be a mere cinder.

XVII.

Regarding the fat used in frying as a medium for conveying heat, freedom from any special flavor of its own is a primary desideratum. Olive-oil of the best quality is almost absolutely tasteless, and, having as high a boiling-point as animal fats, it is the best of all frying media. In this country there is a prejudice against the use of such oil. I have noticed at some of those humble but most useful establishments where poor people are supplied with penny or twopenny portions of good fish, better cooked than in the majority of "eligible villa residences," that in the front is an inscription stating that "only the best beef-dripping is used in this establishment." This means a repudiation of oil. Such oil as has been supplied for fish-frying may well be repudiated.

On my first visit to arctic Norway I arrived before the garnering and exportation of the spring cod harvest was completed. The packet stopped at a score or so of stations on the Lofodens and the mainland. Foggy weather was no impediment, as an experienced pilot free from catarrh could steer direct to the harbor by "following his nose." Huge caldrons stood by the shore in which were stewing the last batches of the livers of cod-fish caught a month before and exposed in the mean time to the continuous arctic sunshine. Their condition must be imagined, as I abstain from description of details. The business then proceeding was the extraction of the oil from these livers. It is, of course, "cod-liver oil," but is known commercially as "fish-oil," or "cod-oil." That which is sold by our druggists as cod-liver oil is described in Norway as "medicine-oil," and though prepared from the same raw material, is extracted in a different manner. Only fresh livers are used for this, and the best quality, the "cold-drawn" oil, is obtained by pressing the livers without stewing. Those who are unfortunately familiar with this carefully prepared, highly refined product, know that the fishy flavor clings to it so pertinaciously that all attempts to completely remove it without decomposing the oil have failed. This being the case, it is easily understood that the fish-oil stewed so crudely out of the putrid or semi-putrid livers must be nauseous indeed. I am told that it has nevertheless been used by some of the fish-fryers, and I know that refuse "Gallipoli" (olive-oil of the worst quality) is sold for this purpose. The oil obtained in the course of salting sardines, herrings, etc., has also been used.

Such being the case, it is not surprising that the use of oil for frying should, like the oil itself, be in bad odor.

I dwell upon this because we are probably on what, if a fine writer, I should call the "eve of a great revolution" in respect to frying media.

Two new materials, pure, tasteless, and so cheap as to be capable of pushing pig-fat (lard) out of the market, have recently been introduced. These are cotton-seed oil and poppy-seed oil. The first has been for some time in the market offered for sale under various fictitious names, which I will not reveal, as I refuse to become a medium for the advertisement of anything—however good in itself—that is sold under false pretenses. If the lamp of Knowledge, more fortunate than that of Diogenes, should light upon some honest men who will retail cotton-seed oil as cotton-seed oil, I shall gladly (with the editor's permission) do a little straightforward touting for them, as they will be public benefactors, greatly aiding the present movement for the extension of the use of fish-food.

As every bale of cotton yields half a ton of seed, and every ton of seed may be made to yield twenty-eight to thirty-two pounds of crude oil, the available quantity is very great. At present only a small quantity is made, the surplus seed being used as manure. Its fertilizing value would not be diminished by removing the oil, which is only a hydro-carbon, i. e., material supplied by air and water. All the fertilizing constituents of the seed are left behind in the oil-cake from which the oil has been pressed.

Hitherto cotton-seed oil has fallen among thieves. It is used as an adulterant of olive-oil; sardines and pilchards are packed in it. The sardine trade has declined lately, some say from deficient supplies of the fish. I suspect that there has been a decline in the demand, due to the substitution of this oil for that of the olive. Many people who formerly enjoyed sardines no longer care for them, and they do not know why. The substitution of cotton-seed oil explains this in most cases. It is not rancid, has no decided flavor, but still is unpleasant when eaten raw, as with salads or sardines. It has a flat, cold character, and an after-taste that is faintly suggestive of castor-oil; but faint as it is, it interferes with the demand for a purely luxurious article of food. This delicate defect is quite inappreciable in the results of its use as a frying medium. The very best lard or ordinary kitchen butter, eaten cold, has more of objectionable flavor than refined cotton-seed oil.

I have not tasted poppy-seed oil, but am told that it is similar to that from the cotton-seed. As regards the quantities available, some idea may be formed by plucking a ripe head from a garden poppy and shaking out the little round seeds through the windows on the top. Those who have not tried this will be astonished at the numbers produced by each flower. As poppies are largely cultivated for the production of opium, and the yield of the drug itself by each plant is very small, the supplies of oil may be considerable; 571,542 cwt. of seeds were exported from India last year, of which 346,031 cwt. went to France.

Palm-oil, though at present practically unknown in the kitchen, may easily become an esteemed material for the frying-kettle (I say "kettle," as the ordinary English frying-pan is only fit for the cooking of such things as barley bannocks, pancakes, fladbrod, or oat-cakes). At present, the familiar uses of palm-oil in candle-making and for railway grease will cause my suggestion to shock the nerves of many delicate people, but these should remember that before palm-oil was imported at all, the material from which candles and soap were made, and by which cart-wheels and heavy machinery were greased, was tallow—i. e., the fat of mutton and beef. The reason why our grandmothers did not use candles when short of dripping or suet was that the mutton-fat constituting the candle was impure; so are the yellow candles and yellow grease in the axle-boxes of the railway carriages. This vegetable fat is quite as inoffensive in itself, quite as wholesome, and—sentimentally regarded—less objectionable, than the fat obtained from the carcass of a slaughtered animal.

When common sense and true sentiment supplant mere unreasoning prejudice, vegetable oils and vegetable fats will largely supplant those of animal origin in every element of our dietary. We are but just beginning to understand them. Chevreul, who was the first to teach us the chemistry of fats, is still living, and we are only learning how to make butter (not "inferior Dorset," but "choice Normandy") without the aid of dairy produce. There is, therefore, good reason for anticipating that the inexhaustible supplies of oil obtainable from the vegetable world—especially from tropical vegetation—will ere long be freely available for kitchen uses, and the now popular product of the Chicago hog factories will be altogether banished therefrom, and used only for greasing cart-wheels and other machinery.

As a practical conclusion of this part of my subject, I will quote from this month's number of "The Oil Trade Review" the current wholesale prices of some of the oils possibly available for frying purposes. *Olive-oil*, from £43 to £90 per ton of 252 gallons; *Cod-oil*, £36 per ton; *Sardine or train* (i. e., the oil that drains from pilchards, herrings, sardines, etc., when salted), £27 10*s*. to £28 per ton. *Cocoa-nut*, from £35 to £38 per ton of 20 cwt. (This, in the case of oil, is nearly the same as the measured ton.) *Palm*, from £38 to £40 10*s*. per ton; *Palm-nut or copra*, £31 10*s*. per ton; *Refined cotton-seed*, £30 10*s*. to £31 per ton; *Lard*, £53 to £55 per ton. The above are the extreme ranges of each class. I have not copied the technical names and prices of the intermediate varieties. One penny per pound is = £9 6*s*. 8*d*. per ton, or, in round numbers, £1 per ton may be reckoned as one ninth of a penny per pound. Thus the present price of best refined cotton-seed oil is 3½*d*. per pound; of cocoanut-oil, 3¾*d*.; palm-oil, from 3½*d*. to 4½*d*., while lard costs 6*d*. per pound wholesale—usually 7*d*.

I should add, in reference to the seed-oils, that there is a possible objection to their use as frying media. Oils extracted from seeds contain more or less of *linoleine* (so named from its abundance in linseed-oil), which, when exposed to the air, combines with oxygen, swells and dries. If the oil from cotton-seed or poppy-seed contains too much of this, it will thicken inconveniently when kept for a length of time exposed to the air. Palm-oil is practically free from it, but I am doubtful respecting palm-nut-oil, as most of the nut-oils are "driers."—*Knowledge*.

SKETCH OF LAMARCK.

THERE are two classes of scholars. Those of the one class, who travel in the footsteps of their predecessors, increase the domain of knowledge, and add new discoveries to those that were made before them; their labors are immediately appreciated, and they enjoy their well-earned fame in full measure. Others, who leave the trodden ways, emancipate themselves from traditions, and expose to the light of the sun the germs of future discovery which lie buried in the teachings of the present. Sometimes they are appreciated at their full value during their lifetime, but more frequently they pass away, misunderstood by the scientific public of their time, which is incapable of comprehending and following them. Indolence, routine, and ignorance oppose an invincible resistance against them during their career, and they die isolated and forsaken. In the mean time, science advances, facts increase, methods are perfected, and their contemporaries who survive them gradually come up to the mark they had left. Then all their forgotten services are brought into the light, justice is partly done to their labors, their genius is admired, it is recognized that they foresaw the future, and a tardy posthumous fame comforts their pupils for the neglect which the masters had to endure during the years of vain struggle for the triumph of the truth.

Lamarck belonged to both of these classes. By his descriptive labors in botany and zoölogy, and by the improvements which he introduced in the classification of animals, and which were accepted by his contemporaries, he gained a first place among the naturalists of his time; but his philosophical views on organic beings in general were rejected, and did not even enjoy the honor of a sincere testing. They were only accorded a polite silence, or treated with scornful irony.

Jean Baptist Pierre Antoine de Monet, known as the Chevalier de Lamarck, was born on the 1st of August, 1744, at Bazentin, a little town between Albert and Bapaume, in Picardy. He was the eleventh child of Pierre de Monet, lord of the manor, who was descended from an old family in the county Béarn, and called only a small hereditary estate his own. His father had designed him for the church, then the common destination for the younger sons of noble families, and took him to the Jesuit college at Amiens. This, however, was not the natural vocation of our young nobleman. Everything in his family associations inclined his mind toward military fame. His eldest brother had fallen in the breach at the siege of Berg-op-Zoom; the other two brothers were still in the service, while France was exhausting its forces in an unequal contest. His father opposed his wishes on this point; but, when the father died, Lamarck, following his own inclination, betook himself on a poor horse to the army, which was encamped near Lippstadt, in Westphalia. He was furnished with a letter of introduction from Frau von Lameth, proprietor of a neighboring estate, to Colonel de Lastic, of the Beaujolais regiment. This officer, when he saw the seventeen-year-old youth, who looked much younger, sent him to his quarters. A battle took place on the next day. M. de Lastic drew up his regiment, and noticed his *protégé* in the front rank of a company of grenadiers. The French army was under the command of Marshal Broglie and Prince Soubise while the allied troops were commanded by Prince Ferdinand of Brunswick. The two French officers, who did not agree together, were killed. The company Lamarck had joined was broken up by the enemy's fire, and was forgotten in the confusion of the retreat. The officers and under-officers were killed, and only fourteen were left standing. The oldest of these counseled retreat; Lamarck, who had, on the spur of the moment, improvised himself to the command, answered: "We have been assigned to this position, and we must not forsake it till we are relieved." The colonel, who now remarked that the company was not with his regiment, recalled it by an order which he managed to get back to it by a secret way. On the next day Lamarck was appointed an officer, and soon afterward a lieutenant. Fortunately for science, this brilliant beginning of a military career was not decisive of the future of the youth. After the conclusion of peace he performed garrison duty in Toulon and Monaco, till an inflammation of the lymphatic glands of the neck made it necessary for him to go to Paris to undergo an operation by Tenon, the scar of which he carried all his life.

The aspect of the vegetation in the neighborhood of Toulon and Monaco had attracted the attention of the young officer, who had already acquired some knowledge of botany from the "Traité des plantes usuelles" of Chomel. After he withdrew from the military service and had been awarded a modest pension of four hundred francs, he became engaged with a banker in Paris. Moved by an irresistible impulse to the study of Nature, he observed from his attic-room the forms and movements of the clouds, and made himself acquainted with plants in the royal gardens, and by means of botanical excursions. He felt that he was on the right way, and recalled Voltaire's judgment on Condorcet, that discoveries to come would secure him more fame with posterity than a company of soldiers. Dissatisfied with the botanical systems in use, he wrote in a half-year his "Flore française," and published his "Clé dichotomique," by the aid of which it is easy for a beginner to ascertain the name of the plants he is accustomed to see. This was in 1778. Through Rousseau botany became a fashionable study; the lords and ladies of the world of society busied themselves with plants; Buffon had the three volumes of the "Flore française" published at the Royal Printing-House; and in the next year

Lamarck entered the Academy of Sciences. Buffon, who wished his son to travel, gave him Lamarck as a conductor, with a commission from the government. They journeyed through Holland, Germany, and Hungary, and Lamarck became acquainted with Gleditsch in Berlin, Jaquin in Vienna, and Murray in Göttingen.

The "Encyclopédie methodique," begun by d'Alembert and Diderot, was not yet finished. Lamarck composed four volumes of this work, and in them described all the then known plants the names of which begin with the letters from A to P—a huge work, which was completed by Poiret, and included twelve volumes, appearing between 1783 and 1817. A still more important work, which also forms a part of the "Encyclopædia," and is continually quoted by botanists, is entitled "Illustration des genres" ("Illustration of Genera"), in which Lamarck described the characteristics of two thousand species. The work, says the title-page, is illustrated with nine hundred copper-plate engravings. Only a botanist can form a conception of the researches in herbaria, gardens, and books, which such an undertaking demanded. Lamarck accomplished it all by means of the most restless industry. If a traveler came to Paris, he was the first one to announce himself to him. Sonnerat returned from India with immense collections. Nobody but Lamarck took the trouble to look at them, and Sonnerat was so pleased with him for this that he presented the splendid herbarium to him. In spite of his indefatigable labors, Lamarck's situation was miserable enough. He lived by his pen, and in the service of the book-sellers. Even the petty position of overseer of the Royal Herbarium was refused him. Like the majority of naturalists, he contended for many years with the difficulties of life. A fortunate circumstance, which gave his activity another direction, brought improvement in his condition. The convent ruled over France. Carnot organized victory. Lamarck undertook to organize the sciences. The Museum of Natural History was founded upon his motion. They had been able to name professors for all the branches except zoölogy; but, in those times of ardent enthusiasm, France found warriors and men of science wherever it needed them. Étienne Geoffroy Saint-Hilaire was twenty-one years old, and was engaged with Haity in mineralogy. Daubenton said to him: "I take the responsibility for your inexperience upon myself; I have the authority of a father over you. Be so bold as to assume the chair of zoölogy, and it may be said some day that you have made a French science of it." Geoffroy acceded, and undertook the higher animals. Lakanal had well comprehended that a single professor would not be adequate to the task of working out the whole animal kingdom. Since the classification of the vertebrates only was taken care of by Saint-Hilaire, the whole list of invertebrates, including the insects, mollusks, worms, zoöphytes, etc., still remained in chaos—in the unknown. Lamarck, says Michelet, undertook the unknown. He had busied himself a little, under Bruguières's direction, with the mollusks, but he still had nearly all to learn, or, to speak more accurately, nearly all to create, in that uninvestigated world in which Linnæus had failed to introduce the methodical arrangement which he had been so successful in introducing among the higher animals. After devoting a year to preliminary studies, Lamarck began his lectures in the Museum in the spring of 1794; he immediately instituted the great division of animals into vertebrates and invertebrates, which has become fixed in science. Adhering to the Linnæan division of the vertebrates into mammalia, birds, reptiles, and fishes, he divided the invertebrates into mollusks, insects, worms, echinoderms, and polyps. In 1799 he separated the order of crustaceans from the insects with which it had been confounded; in 1800 he separated the arachnids from the insects; in 1802 he set off the annelids as a subdivision of the worms, and the radiates as separable from the polyps. Time has confirmed the justice of his division, which depends in every respect upon the organization of the animals. This is the rational method, incorporated in science by Cuvier, Lamarck, and Geoffroy Saint-Hilaire.

As our sketch has so far dealt only with Lamarck's achievements in natural history, we pass with a simple mention a few works in which he treated of physics and chemistry; mistakes of a good intention, which attempted to establish truths that rest exclusively on experiment, by reasoning alone, or to resuscitate old theories like that of phlogiston. These efforts did not even receive the honor of a contradiction; they did not deserve it; and they should serve as a warning to all those who would write upon any science without being acquainted with it, and without having had practical experience in it.

The generalizations of Lamarck in geology and meteorology, sciences which at the time he wrote had hardly come into existence, were mistaken in another sense. They were premature. Every science must begin with the knowledge of facts and phenomena. When these are numerous enough, a partial generalization is possible; as they increase, the basis grows broader; but systems which can justly claim to be absolute and definitive can never be, for they presuppose that all the phenomena and facts are known, a condition which will be impossible as long as man lives. In the beginning of this century geology did not exist, and little was known of the matters of which it treats; but systems were created that included the whole earth. Lamarck elaborated his system in 1802; and twenty-three years afterward the clear mind of Cuvier succumbed to the prevailing tendency, and he published his treatise on the revolutions of the globe. It was Lamarck's merit that he perceived that there were no revolutions in geology, and that the slow manifestations of force through hundreds of thousands of years far better explained the wonderful changes of which our planet has been the scene than violent disturbance could do. "To nature," he said, "time is nothing: it is no obstacle. Nature always has time enough at its disposal; time is a means of unlimited capacity, through which it produces the greatest as well as the smallest effects."

He was the first who distinguished the littoral fossils from the deep-sea fossils. Yet no one will to-day accept his idea that the sea, by force of its ebb and flow, could have hollowed out its bed and changed its local position on the surface of the earth without altering the relative level of the different points on the surface. In view of recognized facts, it is impossible to ascribe the origin of all the valleys to the wear of the waters. Just as Lamarck's conclusions in the science of organic beings, which he knew so well, were sharp-sighted and prophetic, so were they, in the sciences which were strange to him, careless, hazardous, and destined to be contradicted in the future. Like the metaphysicians, he built in the air, and his structure, like theirs, fell for want of a firm foundation. Limited by his lectures in the Museum, and by the duty of classifying the collections to a definite scientific work, he devoted himself entirely to this double object. In 1802 he published his "Considérations sur l'organisation des corps vivants" (Considerations on the Organization of Living Bodies); in 1809, his "Philosophie Zoologique" ("Zoölogical Philosophy"), an expansion of the "Considérations," and from 1816 to 1822 the "Histoire naturelle des animaux sans vertèbres" ("Natural History of the Invertebrate Animals"), in seven volumes. This was his principal work, and, as it was exclusively descriptive and systematic, it was received by the learned world with great favor. His paper on the fossil mollusks of the neighborhood of Paris, in which his profound knowledge of living mollusks permitted him to make an accurate classification of those remains of animals that had laid for thousands of years in the bosom of the earth, was likewise well received.

Lamarck had begun his zoölogical work when fifty years old. The painstaking study of minute animals, visible only through the lens and the microscope, wore upon his eyesight, which grew feebler and feebler till he became totally blind. Four times married, the father of seven children, he saw his little inheritance, and also his earlier savings, disappear in one of those high-sounding speculations with which a credulous public is often deluded. His modest salary as a professor only kept him from want. The friends of science, whom his fame as a zoölogist attracted to him, were shocked when they observed in what neglect he lived. He spent the last years of his life in total darkness, but comforted by the loving care of his two daughters. The elder daughter wrote at his dictation a part of the sixth, and some of the seventh, volume of his "History of the Invertebrates." After the father could not leave his room, the daughter would not go out of the house; and, when she did at last go out, she could not endure the open air from which she had been excluded so long. Lamarck died on the 18th of December, 1829, at the age of eighty-five years.

It has been more the fashion to condemn Lamarck for his speculations than to give him the credit that is his due for his great work in classification. Recently, however, two naturalists have endeavored to present these speculations in a more favorable light, and, without denying that they embodied much that was not well enough established, to show that much in them was only anticipatory of what science has since accepted: Herr Haeckel, in Germany, who declares that in Darwin, Goethe, and Lamarck, "each of the three great civilized nations of middle Europe has presented mankind in the course of a hundred years with an intellectual hero of the first rank, who comprehended in its full significance the fundamental idea of the concordant development of the world from natural causes"; and M. Barthélemy, in France, who considers that Lamarck was a forerunner of Darwin, and a greater than he.

M. Barthélemy, while admitting that Lamarck's theories on physics, chemistry, and meteorology were frequently rash and lacking the precision that experiment gives, says: "He believed in natural laws, in the unity and transformation of physical and physiological forces, because he attributed a special signification to *nature*. To him nature was a power subordinate to God, its sublime author, who must not be confounded with it, and whose function it is to put to work forces and laws which it has not made, and can not modify. His cosmical system is summarized in the three elements: God, nature, and the universe. Transformism, with Lamarck, is not born of abstract meditations and *a priori* conceptions, as has sometimes been said. It is connected with the whole of the theories that precede. He rose from the careful study of the immense multitude of beings he had to examine to carry order and light into the chaos of invertebrate animals. In his first lectures he began with the most rudimentary beings, the origin of which he attributed to physico-chemical forces, and then saw the organization and the circulation of the fluids become more complicated and more perfect as the scale of being rose with new faculties resulting from the acquisition of new organs derived from the cellular tissue, and owing their origin to new wants or new circumstances in which the being found itself placed. He conceived very clearly the influence of external conditions, and attributed the modifications of organisms to two factors, one interior and constant and regular in its operation; the other exterior and irregular, and including modifications of media, temperature, nutrition, etc. He concluded from this that a continuous chain of beings is not possible, for, if such a chain existed, it would quickly be broken by the accidental or irregular circumstances to which beings are obliged to adapt themselves."

Herr Haeckel pronounces Lamarck's "Philosophie Zoologique," in respect to its uniform and complete deduction of the development theory, as well as to its many-sided empirical basis, far more important than the similar efforts of all his contemporaries, even than the similar work of Geoffroy Saint-Hilaire, and styles it "the greatest production of the great literary epoch of the beginning of our century." According to this naturalist's review of Lamarck's system, it supposes that "all the forms of animals and plants which we distinguish as species have only a relatively temporary stability, and the varieties are incipient species. Therefore the form-group or type of the species is just as much an artificial product of our analyzing reason as are the genus, order, class, and other categories of the system. Changes in the conditions of life on one side, the use and non-use of the organs on the other side, constantly exert a formative influence on the organism; through adaptation they bring about a gradual metamorphosis of forms, the principal features of which are transmitted by inheritance from generation to generation. The whole system of animals and plants is thus peculiarly their genealogical tree, and reveals to us the relations of their natural blood-kinship. The course of development on the globe has therefore been continuous and unbroken, like that of the earth itself. . . . Lamarck regarded life as only a very complicated physical phenomenon; for all the phenomena of life depend on mechanical antecedents, which are themselves dependent on the adaptedness of the organic matter. Even the phenomena of the mental life are not different in this respect from the others. For the conceptions and acts of the mind depend upon motor-organs in the central nerve-system." He did not shrink from the solution of the difficult question of the origin of life on the globe, and assumed "that the common primitive forms of all organisms were absolutely simple beings which originated by spontaneous generation, under the combined operation of different physical causes, out of the inorganic matter in water." "Undoubtedly," adds Herr Haeckel, "the greatest defect in Lamarck's work was the insufficient number of observations and experiments which he adduced in proof of his far-reaching theories." A great part of Darwin's immense success was owing to the fact that he was backed by a host of clear and convincing observations and experiments, while "poor Lamarck, trusting too much to the logical acumen of the naturalist, in great part neglected them."

CORRESPONDENCE.

DR. OSWALD AGAIN REPLIES TO DR. BLACK.

Messrs. Editors:

DR. J. R. BLACK'S second epistle, published in the October issue of the "Monthly," can hardly have surprised your intelligent readers, and may even have excited their pity. When people like Dr. Black see a way to achieve publicity, they must be pardoned for trying to make the best of their chance, even on the terms accepted by that Paris quack who volunteered to be pilloried, if they would permit him to exhibit himself in a pair of canvas breeches, displaying a printed advertisement of his pills. Besides, the doctor has somewhat modified his original plan. Having undertaken to pose as a martyr of medical orthodoxy, but finding his nasal organ out of plumb to a degree he had not quite bargained for, he now attempts to effect his retreat under a dust-cloud of irrelevant obscurities.

After admitting that dyspepsia in children *can* be explained by the agency of causes distinct from hereditary transmission (which he had denied in his first letter), he now defies me to prove that, by moderate eating and abstinence from virulent drugs, children can escape the disease. Has the plan ever failed where it had a chance of a fair trial, as in hygienic homes, or in Schrodt's "Boarding Kindergartens"? Or does Dr. Black know what his thesis implies? He can not deny—1. That the digestive organs of children are governed by the same pathological laws as those of adults, the difference, if any, being in favor of the children, since every birth is a hygienic regenesis, and since diseases, as he himself admitted in his first letter, do not exist *per se* from the moment of birth. 2. That a correct regimen and abstinence from noxious drugs will prevent dyspepsia in adults, and cure even far-gone dyspeptics. Yet he holds that a correct regimen and abstinence from noxious drugs will not prevent dyspepsia in children. In other words, the laws of health hold good in the ordinary affairs of life, but may be set aside when it comes to account for the mortality in the infant-wards of an Ohio drug-hospital. Dr. Black informs us that the public is deeply interested in the issue of our controversy. Feverishly. But your readers can make their minds easy. Nature is not so inconsistent as Dr. Black; and I will undertake to insure any child against dyspepsia, nay, any cured dyspeptic against a relapse of the disease, on the sole condition that they shall avoid dietetic abuses and Dr. Black's prescriptions. In his distress to evade the logical inference of his admissions, Dr. Black suggests that some of my arguments might be used to disprove the hereditary tendency of insanity and consumption. Before the doctor's friends permit him to undertake another pathological controversy, I would advise them to enlighten his mind on the difference between functional and organic disorders, and thus enable him to understand the reason why consumption or cancer, but not dyspepsia, can be called an hereditary disease, and why hereditary diseases and not dyspepsia reappear in successive generations at the same period of life when they were first contracted. If I had ever doubted the chronic persistence of mental derangements, I confess that Dr. Black's arguments would have convinced me of my error. The manner of his attempt to defend the drivel of his first letter is a sufficient proof that the taint of idiocy is ineradicable.

In trying to explain away the silliness of his soap-water argument, Dr. Black volunteers the confession that Nature protests against the use of soap when the sensitiveness of the cutaneous tissue has been morbidly increased by the influence of a skin-disease. In other words, he admits that a morbid condition increases the danger of using even the mildest chemical depurative. Yet to the morbidly sensitive membrane of the diseased digestive organs he proposes to apply the virulent "intestinal soaps," as he calls his cathartic drugs. The "striking benefit" resulting from the use of patent laxatives is too exclusively confined to the experience of the patentee.

Dr. Black's assertion that I propose to cure syphilis on the let-alone plan is a fiction which can be pardoned only to a nonplused sophist at the brink of a *reductio ad absurdum*. Not only have I never propounded such a theory, but I have repeatedly named syphilis as the representative disorder of the exceptional class of diseases which (for reasons stated on page 729 of "The Popular Science Monthly" for October, 1881, and on page 199 of my work on "Physical Education") have to be cured by an artificial removal of the cause.

As a last attempt to retrieve the reverses of his game, Dr. Black tries to score a point on a lexicographical quibble. In defending my plea for longer pauses between meals, he says, I have spoken of digestion and assimilation as being one and the same thing. The truth is, that I mentioned them as synergistic operations. But within the scope of my argument I would have been justified in treating them as identical functions. Does Dr. Black wish to deny that intestinal digestion, in its normal phases, includes an assimilative process? But, as in the case of *dyspepsia infantum*, the doctor's experience is perhaps limited to the action of a drug-convulsed system, in which case the activity of the digestive organs does, indeed, but rarely lead to assimilation.

Dr. Black's exception-plea in favor of the stimulant superstition illustrates only the radical confusion of his pathological theories. For that energy of action which he mistakes for a sign of restored functional vigor demonstrates nothing but the urgency of an expulsive process. The functional activity excited by the influence of a drastic tonic proves only the virulence of the drug, and the system's eagerness to rid itself of a deadly foe. In my treatises on "Dyspepsia and Climatic Fevers" I have exposed the two most specious fallacies of the stimulant-delusion; and there is an end to all inductive reasoning if the analogies of the stimulant-vice and the medicine-habit do not establish my tenet that the *poison-hunger* in all its forms, whether as *mania a potu*, or a hankering after a digestive excitant, is wholly abnormal and mischievous; that its repeated gratification rarely fails to inoculate the system with the seeds of a progressive stimulant-habit; that the dyspeptic's dependence upon Dr. Black's calomel pills is an aggravation of the original disease; and that even the temporary results, effected at such risk, by the use of virulent drugs, can, in nine cases out of ten, be more safely and as directly attained by other means, as by refrigeration in the treatment of malarial fevers, or indirectly by reform of the predisposing habits, as in consumption and various enteric disorders.

In one of his tirades against heretical theories, Dr. Black carries his bravado to the degree of appealing to the testimony of "stubborn facts"—in other words, to the lessons of experience. I would advise my colleague to avoid that arena. Hospital statistics might prove that the homœopathists can challenge our best record and demonstrate by proofs, which should satisfy a depreciator of their sugar-pellets, that they can beat it by total abstinence from the so-called remedies of the drug-shops.

In his first letter Dr. Black proposed to let dyspeptics trust themselves to the guidance of their morbid appetite, and, after I proved that the absurdity of that plan could be demonstrated by the analogies of the alcohol-habit, our entrapped medicine-man tries to slip out by the following hole: The chronic hunger of the dyspeptic, he informs us, is a craving after food, while the unquenchable thirst of the alcohol-drinker is a craving after poison. Does that subvert my tenet that, in regard to the persistency of the appetite, both cravings are wholly abnormal? For, let us remember that the original point at issue was the question about the proper number of daily meals. Now, in pursuance of Dr. Black's plan, his patients would have to eat about forty meals a day; for, in his first letter, he advised dyspeptics to follow the promptings of an appetite which he now admits to be morbid and unappeasable, as caused by a chronic state of semi-starvation. Thus Dr. Black continually shifts his ground, to dodge the inferences of his own premises. But the fact is, that he never expected to maintain his positions. He merely wrestles against time, and accepts his successive overthrows in the secret hope that the shrieks of his afflictions might attract the aid of some brother-sophist. Hence, also, his repeated allusions to a "numerous class of physicians" whose wrath he warns me to deprecate. Like other champions of orthodoxy who find that their logic leaves them in the lurch, he tries to retreat behind the shelter of a numerical majority.

By my outspoken denunciation of the stimulant-superstition, Dr. Black holds that I have offered an insult to that large body of medical men to whom is due the credit of the most important discoveries in hygiene, physiology, surgery, etc. My orthodox contemporary will try in vain to identify the interests of his cause with the progress of those sciences. All their promoters have contributed their share to undermine the foundations of the position which he tries to defend. For the last hundred years the history of medical science has been the history of a continued and increasingly rapid collapse of the *drug-delusion*—a delusion whose defenders have always tarried in the rear of progress, and, after doing their utmost to obstruct the path of reform, have recognized its triumphs only by sharing the fruits of its victories. My invectives were not directed against the thousand earnest seekers after truth, not against its great discoverers, the pioneers of the true healing art, not against men like Bichat,* Schrodt,†

* "To what errors have not mankind been led in the employment and denomination of medicines! They created *deobstruents* when the theory of obstruction was in fashion; and *incisives* when that of the thickening of the humors prevailed. Those who saw in diseases only a relaxation or tension of the fibers employed *astringents* and *relaxants*. The same identical remedies have been employed with all these opposite views. . . . Hence the vagueness and uncertainty our science presents at this day. An incoherent assemblage of incoherent opinions, it is, perhaps, of all the physiological sciences, that which best shows the caprices of the human mind. What do I say? For a methodical mind it is not a science at all. It is a shapeless collection of inaccurate ideas; of observations often puerile; of deceptive remedies, and of formulas as fantastically conceived as they are tediously arranged."

† "If we reflect upon the obstinate health of

Magendie,* Bock,† Jules Virey,‡ Jennings,§ Rush,‖ but against bigots like Dr. Black; against medical obscurantists who dread the enlightenment of their victims as vampires dread the dawn of the morning; who oppose independent thinkers with that rancorous hatred which Jesuits feel toward the divulgers of their trade-secrets; who, by holding on to the last planks of their wrecked dogmas, by illogical compromises and temporizing sophisms, are trying to perpetuate the curse of a life-blighting delusion; who subordinate the interests of mankind to the interests of their clique, and disparage reformers till they find it convenient to appropriate the credit of their discoveries.

"Some acute philosophers," our obliging correspondent informs us, "think that all the phenomena of the universe can be explained on the laws of mechanics, from the motions of a molecule up to those of the celestial masses." Just so. And Dr. Black might as well confess the secret of his predilection for that system. Its application to therapeutics has so simplified the practice of medicine; and its recognition as the law of the universe would confirm the prestige of the orthodox cause. Instead of troubling himself with a life-long study of the laws and revelations of Nature, the lessons of instinct, the interaction of the vital functions, their modifications under abnormal circumstances, the secrets of the reproductive and self-regulating principle of the human organism, our mechanical philosopher would prefer to re-establish the system of the good old times, when he could consult a pocket-index of drugs, set against an alphabetical list of diseases, point to his diploma as a presumptive proof that he had learned to repeat the Latin synonyms and construct the pharmaceutic symbols of the various "remedial agents," etc., and magisterially reprimand hygienic "idealists," as a village schoolmaster, well read in Genesis, would reprove an exponent of the evolution doctrine.

"Dr. Oswald," says our astute correspondent, "is apparently unable to discern that all the customs and habits of savages are intimately correlated to their vital organism, and that for us to adopt only one of them might prove murderous to civilized beings." Because we can not imitate *all* the customs of a primitive nation, is that a reason why we should not adopt *some* of them? With such arguments our medical censor dares to insult the intelligence of your readers! Must we avoid the unleavened bread of the ancient Hebrews because we dislike circumcision? Must we disparage Japanese temperance, because we do not want to commit *hari-kari?* Would the Samian water-cure prove more murderous to civilized beings than Dr. Black's blue-pills? If I should recommend the system of the medical philosopher Asclepiades, who used to prescribe a special course of gymnastics for every form of human disease, Dr. Black would try to retreat behind his correlation-dodge. "Such systems," he would probably remark, "were intimately correlated to the physical and social organism of the pagan savages and their uncivilized doctors; but nowadays every intelligent druggist would agree with me that it would never do to let people cure their diseases with such reme-

animals and savages, upon the rapidity of their recovery from injuries that defy all the mixtures of materia medica; also upon the fact that the homœopathists cure their patients with milk-sugar and mummery, the prayer-Christians with mummery without milk-sugar, and my followers with a milk-diet without sugar or mummery—the conclusion forces itself upon us that the entire system of therapeutics is founded upon an erroneous view of disease."

* "I hesitate not to declare, no matter how sorely I shall wound our vanity, that so gross is our ignorance of the real nature of the physiological disorders called diseases, that it would perhaps be better to do nothing, and resign the complaint we are called upon to treat to the resources of Nature, than to act, as we are so often compelled to do, without knowing the why and the wherefore of our conduct, and at the obvious risk of hastening the end of the patient."

† "By special methods of diet nearly all known diseases can be cured as well as caused. . . . Twenty-five years' experience at the sick-bed and the dissecting-table, in the nursery and on the battle-field, have convinced me that, with rare exceptions, the disorders of the human body, which have been treated after such an infinite variety of drug-systems, can be as well cured without any drugs at all."

‡ "Our system of therapeutics is so shaky" (*vacillant*) "that the soundness of the basis itself must be suspected."

§ "It is unnecessary for my present purpose to give a particular account of the results of homœopathy; . . . what I now claim with respect to it is, that a wise and beneficent Providence is using it to expose and break up a deep delusion. In the results of homœopathic practice we have evidence, in amount and of a character sufficient, most incontestably to establish the fact that disease is a restorative operation, or renovating process, and that medicine has deceived us. The evidence is full and complete. It does not merely consist of a few isolated cases, whose recovery might be attributed to fortuitous circumstances, but it is a chain of testimony fortified by every possible circumstance. . . . All kinds and grades of disease have passed under the ordeal and all classes and characters of persons have been concerned in the experiment as patients or witnesses; . . . *while the process of infinitesimally attenuating the drugs used was carried to such a ridiculous extent that no one will, on sober reflection, attribute any portion of the cure to the medicine.* I claim, then, that homœopathy may be regarded as a providential sealing of the fate of old medical views and practices."

‖ "I am here incessantly led to make an apology for the instability of the theories and practice of physic; and those physicians generally become the most eminent who have the soonest emancipated themselves from the tyranny of the schools of physic. Dissections daily convince us of our ignorance of disease, and cause us to blush at our prescriptions. What mischief have we done under the belief of false facts and false theories! We have assisted in multiplying diseases; we have done more, we have increased their mortality. I will not pause to beg pardon of the faculty for acknowledging, in this public manner, the weakness of our profession. I am pursuing Truth, and am indifferent whither I am led, if she only is my leader."

dies. In a country like ours," he would add in a whisper, "the introduction of such a system might prove murderous to some civilized beings."

Dr. Black complains of my superciliousness in preferring a charge of ignorance against a contemporary who has for a long series of years anxiously sought the solution of "the problem how the sick can be made well." Sad enough; but that is no reason why I should withdraw my charge. Dr. Black may have sought that solution for a most venerable series of years, but, unless he holds his own time as cheap as that of your readers, he ought to seek it more anxiously than ever, for it is very evident that he has not yet found it.

Felix L. Oswald.

THE GEOLOGICAL DISTRIBUTION OF FORESTS.

Messrs. Editors:

In discussing "The Geological Distribution of North American Forests," in your August number (pp. 521, 522), Mr. Thomas J. Howell makes the general statement that the loess (or lacustral deposits) of the campestrian province "is devoid of trees," except where cut through by erosion; from which he infers that "the loess is not capable of sustaining forest-growths for any length of time." By way of explanation, he adds that the loess "evidently was timbered during the time that part of it was covered by lakes and marshes," but, "when the great rivers cut their beds down to nearly their present level, the timber gradually died out." To generalization, inference, and explanation, exception must alike be taken.

In much of Eastern Iowa, and in Southeastern Minnesota, the loess is confined to an irregular zone, five to fifty miles wide, flanking the deeply eroded valley of the Mississippi on the west, and overlapping the glacial drift which forms the greater part of the surface of both States. The western limit of this zone is exceedingly sinuous; lobes of drift extend for miles within its general area, and narrow, finger-like belts of loess, sometimes separating into isolated outliers, extend still farther upon the drift-plain. Now, this drift-plain is quite timberless; but the loess is naturally wooded to its extreme margin, and its outliers are also generally wooded. The coincidence of forest-growth with loess is indeed so perfect in this region that maps showing the wooded area indicate with almost equal accuracy the loess area. This is a region, too, in which not only the "great rivers," but many of their minor tributaries, have cut their channels through the loess, and far into the subjacent rocks, thus developing the picturesque river bluffs which lure so many tourists to the upper Mississippi region. A parallel relation between loess and forests obtains in Central and Southern Illinois. Here the loess first appears, in passing from north to south, as isolated mounds rising from the almost dead-level drift-plain; which mounds, however far from other forests, are well wooded. The Missouri River loess-belt is, it is true, generally treeless, except along water-ways, which may or may not, however, cut through its deposits; but natural timber is far more abundant than over contiguous drift-areas, while its capability of supporting arborescent vegetation is emphatically attested by the unprecedented growth of artificially-planted fruit and forest trees, which is at once the marvel of Eastern and the boast of Western horticulturists. The potent influence of geological structure in determining the flora of any region is demonstrated by these relations of loess and forests, especially in Northeastern Iowa; but the connection is directly opposite from that which Mr. Howell seeks to establish.

But other and equally significant relations exist. Thus, it has been repeatedly pointed out by the director of the Iowa Weather Service, Dr. Gustavus Hinrichs, that the lines of equal timber in Eastern Iowa correspond remarkably, though in a general way, with the lines of equal rainfall.

Again, the origin of the loess is yet a mooted point in geology, and the declaration that its surface was once marshy is scarcely warranted; while no unequivocal evidence that it was ever more heavily or continuously wooded than now has ever been adduced.

The question as to the distribution of forests, particularly in the campestrian province, is inextricably involved with that of the treelessness of the prairies, concerning which so much has been written, but concerning which it is evident (since neither of the relations pointed out in this note have ever been adequately considered by those who have addressed themselves to the problem) that the last word has not yet been spoken. Mr. Howell would sever the Gordian knot at a stroke; but certainly some of its strands have escaped his blade.

Yours, W. J. McGee.

Washington, D. C., *July* 24, 1883.

INFANTILE DYSPEPSIA.

Messrs. Editors:

Referring to the very interesting passage at arms between Dr. Oswald, representing the natural, and Dr. Black, the anti-natural school of medicine, while not desiring to provoke further controversy, I beg leave to offer a few remarks upon one point at issue, viz., that pertaining to the alimentation of infants. Dr. Black (see October

"Popular Science"), while granting the soundness of Dr. Oswald's position as to the "millions of infants who from the moment of birth are overfed and drug-poisoned," viz., that we have here a sufficient cause of dyspepsia, asks: "Well, what of the millions that are not? Are they the ones who do not show any such tendency, despite the fact that some of their progenitors do?" Would Dr. Black have us believe that, outside of "baby-farms," a single babe, of all the millions who live to be born, escapes being constantly overfed and (in consequence) occasionally medicated? I assert that, as to the first count in the indictment, an infant is about as sure to be excessively fed as he is to be born. The only exception in general practice is where the babe is nourished at the breast, and the supply happens to be short of an excess, and even in these cases all haste is made to supplement his natural aliment with the bottle; for mothers are unhappy unless their babies are growing obese at the rate of a pound or more a week. Infants usually measure more round the body, arms, and legs, and weigh more, at some period during their first year—often at six months—than at the age of two and a half or three years. No growing thing, in either the animal or vegetable kingdom, can, under natural conditions, exhibit anything of this sort. Parents, no more than the average "druggist," are aware of the fact that the normal or true growth of an infant is never more than three to five ounces per week, and that all the gain above this is from fat, representing excess, though seldom all of the excess—more or less being daily purged away by the bowels, or excreted through other outlets. All this produces or constitutes disease, leads on to sickness, and probably dosing. While we have to admit that only about forty or fifty per cent are, before the age of five years, stamped out by this combination—a method of getting rid of the weakling* far more cruel than the Spartan plan, of freezing them, or the African, of feeding to the crocodiles—ninety-nine in every hundred are made sick by overfeeding, and few of these escape being more or less drugged. Having made the question of infant dietetics a specialty for the past ten years, I find that to hold to cow's milk as the exclusive diet of bottle-babes (a portion of the cream to be removed in case the milk is very rich in this constituent), limiting the number of meals to three, and somewhat restricting the amount at each meal, and allowing nurslings three to five meals (according as the breast may or may not require the "stimulation" of frequent drawing), is an almost absolute guarantee against the gastro-intestinal disorders which are popularly supposed to be unavoidable at this period of life.

Considerable restriction is essential with bottle-babies; for a greedy infant will at any age swallow at two "sittings" a full physiological ration for twenty-four hours, and, if there is to be no restriction as to the quantity taken at each meal, no more than two should be offered. Furthermore, every infant who is not fed *ad nauseam* will be "greedy." In case of infants nourished at the breast, the flow, if excessive, must be diminished by regulating the mother's diet; for in such cases the excess is due to an over-stimulating or slop diet, which affects the nursing-woman as a "driving" diet does our dairy cows, causing a large yield of unnaturally constituted, though perhaps "rich" milk. In order to show the wide contrast between the universal cramming and a truly wholesome diet, I will cite the case of my own infant, now a "stout, strapping boy" of twelve months, who is one of a number known to me as having enjoyed a really fair chance for proving their fitness to survive. His allowance at this time is a coffee-cupful, or about eighteen tablespoonfuls, at each meal. It is usual for infants to swallow as much, often more than three such cupfuls, every day, at the age of three or four months, except when nausea or lack of appetite prevents. They are either "constantly" fed, or at least have a meal every two or three hours. This is the practice with the "million," by which I presume Dr. Oswald meant all "civilized" infants, including Dr. Black's, if he has been blessed with such "troublesome comforts," as they are universally called—a term, by-the-way, in itself very significant in this connection; for, again referring to the few infants who have been exceptinoally fed, "breathed," clad, and exercised, i. e.—1. Fed in the manner I have described as constituting a physiological diet; 2. Given the breath of life, viz., out-door air twenty-four hours a day, whether the babe is in-doors or out; 3. Saved from sweltering clothing—allowing the skin to "breathe"; 4. Rationally "neglected," or, in other words, instead of being constantly held, tended, or wheeled, early allowed the opportunity, on the floor or lawn, of rolling, tumbling, stretching out, and learning to creep at an early age, thus earning a good digestion, and avoiding one of the principal causes of infantile dyspepsia, by being, like kittens, puppies, and young monkeys, largely "self-supporting," and like them developing naturally in all parts of the frame—by these means, I would say, it has been shown to be entirely practicable to insure for the "infant race" a condition as comfortable,

* Quoth Dr. Black, "Now, we nurse them (the weaklings) to adult life!" In fact, only about fifty to sixty per cent of all infants arrive at adult age, and these have been fitly described as "too tough to kill." Even these, to the last one, would make healthier men and women, if saved the abuses we have named.

happy, and thrifty, as that enjoyed by the most fortunate of the nurslings of our domestic animals or household pets.

If in order, I would also venture to cite a case of gastric cramps similar to that mentioned by Dr. Black, but more "naturally" cured. I was called one day during the past summer to the bedside of an old lady friend, who is sixty-six years of age, and very frail. She was suffering intensely from acute dyspepsia. "Well, doctor," she moaned, between the spasms, "you—will have—to—give—me—some—medicinethis-time!" "Very good," I replied, "here it is." (Having obtained a hint from the nurse as to the state of affairs, I had ordered up a pitcher each of hot and cold water.) "Just drink this cupful of warm water. Take it right down, please, as if it were a delicious draught, and you were feeling very thirsty." This she did, and then another and another, and so on until she had, within twenty minutes, taken eight full cups. Then I asked her to make a slight exploration to see if she could touch that warm water with her forefinger! She made the attempt and succeeded—the water meeting her more than half-way. Along with the water came the cause of the cramps, in the shape of undigested food. Directly after this she swallowed, though under protest, seven cupfuls more of the same safe remedy, which had just the effect I anticipated. She soon became entirely at ease, rested quietly for the balance of the afternoon, slept soundly that night, and awoke next morning to laugh over the experience of the day before. There was no poison taken to tax the organism. The water did its perfect work—washing the stomach, diluting the blood, and aiding in the elimination of impurities, instead of adding to them in the least degree. C. E. PAGE.

NEW YORK, *September* 17, 1883.

EDITOR'S TABLE.

THE CURRENT STUDY OF CLASSICS A FAILURE.

PRESIDENT PORTER has replied to Mr. Adams on the Greek question. The President of Yale College, we need not say, is a very strong man—an eminent scholar, an experienced educator, a keen controversialist, and thoroughly familiar with this subject; and so in the "Princeton Review" for September, in the opening article, entitled "A College Fetich," he has given what must be virtually accepted as the official answer to Mr. Adams's argument. Assuming, then, that President Porter has made out the best case possible, let us see whether Mr. Adams's main position has been successfully assailed or remains undisturbed.

It will be remembered that in his Phi Beta Kappa address Mr. Adams arraigned the system of classical study in Harvard College, and more emphatically that of Greek, as a failure; and he appealed to his own experience, and to that of three generations of his ancestors, in proof of the charge. He alleged that the time spent upon classical languages was wasted, first, because he did not master them, and, second, because the time spent upon them ought to have been given to more valuable acquisitions in preparation for the duties and responsibilities of modern life.

President Porter takes issue with Mr. Adams on the main points of his argument. He holds to "the perfection of the Greek language as an instrument for the perpetual training of the mind of the later generations"; and maintains that "the ancient languages, in their structure, their thoughts, also in the imagery which their literature embodies, are better fitted than any modern languages can be for the single office of training the intellect, and the feelings, and the taste; and in every one of these advantages the Greek is pre-eminently superior to the Latin." As a consequence, he maintains that "the old classical training" is the best preparation for the intellectual work of modern life, the best corrective of its injurious influences, and therefore not an educational failure.

But Mr. Adams had condemned the system after trial of it. He had diligently pursued the classics as prescribed and taught in the preparatory schools and at Harvard College, and found that they had yielded to him none of the great and salutary results that are claimed for them. President Porter replies that we are not bound to accept the cause assigned for the alleged failure. He says: "Mr. Adams seems to forget that at least *three* solutions may be given for the apparent failure of his own college life, of which he has recognized but one: 1. The failure was only apparent, but not real, or not to the extent which he imagines. He derived more advantage than he is now aware of, even from the Greek. . . . 2. The curriculum may have been wisely selected, and the teaching may have been imperfect. . . . 3. The student may neglect and render futile the most wisely-selected curriculum, even when enforced by the most skillful and zealous teaching."

It is upon the first of these considerations that President Porter lays the greatest stress in his article. He does not urge the other alternatives—either that the Harvard teaching was bad, or that Mr. Adams was idle or negligent, but he argues that Mr. Adams is mistaken in his assertion that he derived no important benefits from his classical studies. He says: "In judging of the effects of a course of studies, the sharp distinction should be made between the impressions which are actually received, and the reflective recognition of these impressions by the recipient and his own consequent estimate of them." And again: "It is certainly no new thing for children, even those of an older growth, to fail to appreciate the value of the training to which they owe all their success in life, and to esteem those features of it the least to which they owe the most."

We have here the old stock defense of the classical superstition. It is not a failure, because it exerts certain wonderful and mysterious influences of which the student may not be aware, but which are abundantly vindicated by time. That is, the student is not the proper judge of the effects upon his own mind of the leading studies to which he gives the best years of his life. But it is proper to ask, If those who have had experience of it "fail to appreciate the value of the training to which they owe all their success in life," who else has authority to speak in the matter? The argument cuts both ways. If Mr. Adams did not know when he declared that the study of Greek had in his case proved a failure, does President Porter know when he denies it? If the evidence of experience is not to be trusted, what evidence is to be taken? The case looks like one of dogmatic assumption against positive self-knowledge. If a college graduate, after long trial of his education in the arena of practical life, is incompetent to decide upon its adaptability and adequacy to his needs, then there are no valid grounds of judgment in the matter. But the idea is an outrage upon common sense, and we might be well surprised that it should be put forth by a distinguished college president if we did not know to what ridiculous shifts the classicists are driven in defense of their anomalous traditions. Sydney Smith long ago declared, in relation to the classical superstition, that it has been the practice of the universities "to take credit for all the mind they did not succeed in extinguishing." The practice lives on in the equally preposterous assumption that all the success a university man achieves in life is due to the Greek and Latin he learned or did not learn—whether he knows it or not. That this nonsensical notion should be so all-prevalent, and still so influential with multitudes, only shows how completely even our higher education is still in the fetichistic stage.

What President Porter had before him to do was to break the force of Mr. Adams's testimony that his classical education had proved a failure. He first tried to discredit him as not knowing the difference between failure and success, intimating that Mr. Adams has been after all a very successful man; that he studied Greek; therefore, by a well-known classical formula, his success was due to his Greek. But President Porter is not entirely satisfied with the sufficiency of this logic, and so he proceeds to strengthen his case by resorting to counter-testimony. Suddenly converted to the faith that the evidence of men of experience *is* worth something—at least when it comes on his side—he cites repeated cases of men who, in opposition to Mr. Adams, set a high value on their classical education. The question, then, is, to what extent is Mr. Adams's view substantiated by the testimony of others, and of those who must be regarded as the highest authorities? Let us rule out the enemies of the classics—those ignorant of them or prejudiced against them—and appeal to men whose sympathies and predilections are on the other side, but who have had large opportunities of observing the results of classical study—eminent educators, college presidents, experienced teachers, and professors of Latin and Greek, and those who have systematically and under responsibility inquired into the general working of this kind of education.

A conspicuous example of such testimony is obtained without going very far. The eminent President of Columbia College, Dr. F. A. P. Barnard, is a man of enlarged experience in the field of collegiate education, and he has anticipated Mr. Adams in the emphatic reprobation of dead-language studies, on the ground of their incontestable failure. In an address before the University Convocation a few years ago President Barnard said: "What are in fact the results which we do actually reach in the teaching of the classics at this time? Are they in truth anything like what we claim for them? We hear, for instance, a great deal said of the intellectual treasures locked up in the languages of Greece and Rome, which it is asserted that our system of education throws open to the student freely to enjoy. And yet we know that practically this claim is without foundation. It will not, I presume, be affirmed of the graduates of American colleges generally that they become familiar with any portions of the literature of Rome and Greece which do not form part of their compulsory reading. It will hardly be affirmed that one in ten of them does so. And why not? The reason is twofold: First, there is hardly one in ten in whose mind the classics ever cease to be associated with notions of painful labor. Reading is not therefore pursued beyond the limit of what is required, because it is not agreeable. But, secondly and chiefly, there is hardly one in ten whose knowledge of the Latin or the Greek is ever sufficiently familiar to give him the command of the ancient literature which it is asserted for him that he enjoys. I suppose that, to read with any satisfaction any work in any language, we should be able to give our attention to the *ideas* that it conveys, without being embarrassed or confused by want of familiarity with the machinery by which they are imparted. It will not be for mere pleasure that we shall pursue our task, if every sentence brings us a new necessity to turn over our lexicons, or to reason out a probable meaning by the application of the laws of syntax. And yet, if there be any of our graduates who are able, without such embarrassments, to read a classical author, never attempted before, the number must be very few. If there are any who can read even such books of Latin and Greek as they have read before, with anything like the fluency with which they read their mother-tongue, the number can not be large; and if there are any who can read, with similar facility, classic works which they take up for the first time, it is so small that I have never seen one. . . .

"Can a person be said to know a language which he can not read? And is it a result worth the time and labor expended upon it to attain such a doubtful acquaintance with a language or anything else, as that which the majority of our graduates carry away with them of these, at the close of their educational career? Might not the same amount of time and labor differently employed have produced at last something having a value at least appreciable? And is not the immense disproportion between labor expended and results obtained itself the best evidence that this labor has not been expended most wisely for the accomplishment of its own avowed end? For surely there can not be any language, dead or living, in the known world, which any intelligent person ought not to be able to acquire, so as at least to read it, in a course of ten years' study."

But it may be said that the American standard of classical attainment is low, and that we must go where the system has been more faithfully tried, for the highest evidence of its advantages. Very well, and it happens that this evidence is abundant. Classical studies have been tested upon the most extensive scale, and under all the most favorable conditions. For hundreds of years they have been the staple elements of English culture. The English universities and the great public schools of England form a consolidated system devoted for centuries almost exclusively to classical teaching. The system has had the authority of tradition, it has been backed by abounding wealth, it has had the patronage of church and state, and has been cherished by institutions of every grade, which have been independent of all disturbance from the caprice of public opinion. If "the perfection of the Greek language," as President Porter assumes, fits it as "an instrument for the perpetual training of the mind of the later generations," then the circumstances of English education have been most favorable for proving it. But what is the result? A thousand authorities may be summed up in the following sentence of a letter from Professor Blackie, of Edinburgh, to the late Dr. Hodgson. He says, "I entirely agree with you that the present system of classical education, as a general method of training English gentlemen, is a superstition, a blunder, and a failure." The evidence is overwhelming that the great mass of students, in the best English institutions, so far from gaining access to the sphere of classical thought, do not even get a decent knowledge of the bare forms of the dead languages themselves. To such an extent had classical study become itself an utter failure, and to such an extent did it stand in the way of all other studies, that it came to be widely denounced as a scandal to the nation, and the Government was called upon to interfere and put an end to it. They are very cautious in England about meddling with old and venerated things by the intervention of law, but they have a salutary habit of inquiring into them with great thoroughness upon suitable occasions. Parliamentary commissions were therefore appointed to investigate the condition of education, both in the universities and in the great public schools which prepare young men for the universities. The reports that resulted were monuments alike of searching inquiry and the total failure of the cherished classical education. The London "Times" thus summed up the report of the commissioners upon the teaching of the public schools: "In one word, we may say that they find it to be a failure—a failure, even if tested by those better specimens, not exceeding one third of the whole, who go up to the universities. Though a very large number of these have literally nothing to show for the results of their school-hours, from childhood to manhood, but a knowledge of Latin and Greek, with a little English and arithmetic, we have here the strongest testimony that their knowledge of the former is most inaccurate, and their knowledge of the latter contemptible."

And now let us observe how this thorough-going system is characterized by one who has had the best possible opportunities for observing and knowing its results. In a lecture delivered before the Royal Institution of Great Britain, by the Rev. F. W. Farrar, a distinguished author and philologist, and who was one of the masters of Harrow School, and for thirteen years a classical teacher, we have the following estimate of the present value of the system. Canon Farrar says: "I must, then, avow my own deliberate opinion, arrived at in the teeth of the strongest possible bias and prejudice in the opposite direction—arrived at with the fullest possible knowledge of every single argument which may be urged on the other side—I must avow my distinct conviction that our present system of exclusively classical education, as a whole, and carried out as we do carry it out, is a deplorable failure. I say it, knowing that the words are strong words, but not without having considered them well; and I say it because that system has been 'weighed in the balance and found wanting.' It is no epigram, but a simple fact, to say that classical education neglects all the powers of some minds, and some of the powers of all minds. In the case of the few it has a value which, being partial, is unsatisfactory; in the case of the vast multitude it ends in utter and irremediable waste."

In speaking of the defects in teaching the dead languages, President Porter refers to the superiority in some points of English over American methods. He says: "The culture and elevation which might come were the power of rapid and facile reading cultivated, and the use of it, or the expression of thought and feeling appreciated, fail in great measure to be attained. These mistakes and failures are probably more conspicuous in the American colleges than in those of England or Germany, for the reason that in England composition in prose and verse compels to a certain mastery of the vocabulary, and a sense of the use of words which mere grammatical analysis can never impart."

Certainly, if anywhere, we should expect to find in these critical constructive exercises in "composition in prose and verse," which President Porter recognizes as a special excellence of the English teaching, the most successful exemplification of the benefits of classical culture. But Canon Farrar refers to this very practice in the following scathing terms as the worst failure of the system: "To myself, trained in the system for years, and training others in it for years—being one of those who succeeded in it, if that amount of progress which has been thought worthy of high classical honors in two universities may be called success—influenced, therefore, by every conceivable prejudice of authority, experience, and personal vanity in its favor, I can only give my emphatic conclusion that every year the practice of it appears to me increasingly deplorable, and the theory of it every year increasingly absurd."

After giving some examples, this disgusted but but unusually candid classical teacher thus proceeds: "This is the sort of 'kelp and brick-dust' used to polish the cogs of their mental machinery! And when, for a good decade of human life, and those its most invaluable years, a boy has stumbled on this dreadful mill-round, without progressing a single step, and is plucked at his matriculation for Latin prose, we flatter ourselves, forsooth, that we have been giving him the best means for learning Latin quotations, for improving taste (or what passes for such), for acquiring the niceties of Greek and Latin scholarship! We resent the nickname of the 'Chinese of Europe,' yet our education offers the closest possible analogue to that which reigns in the Celestial Empire, and for centuries we have continued, and are continuing, a system to which (so far as I know) no other civilized nation attaches any importance, yet which leaves us to borrow our scholarship second-hand from them; which is now necessary for the very highest classical honors at the University of Cambridge alone; in which only one has a partial glimmering of success, for hundreds and hundreds who inevitably fail; and in which the few exceptional successes are so flagrantly useless that they can only be regarded at the best as a somewhat trivial and fantastic accomplishment—an accomplishment so singularly barren of all results that it has scarcely produced a dozen original poems on which the world sets the most trifling value; while we waste years in thus perniciously fostering idle verbal imitations, and in neglecting the rich fruit of ancient learning for its bitter, useless, and unwholesome husk—while we thus dwarf many a vigorous intellect, and disgust many a manly mind—while a great university, neglecting in large measure the literature and the philosophy of two leading nations, contents itself with being, in the words of one of its greatest sons, 'a bestower of rewards for school-boy merit'—while thousands of despairing boys thus waste their precious hours in 'contracting their own views and deadening their own sensibilities' by a failure in the acquisition of the useless—while we apply this inconceivably irrational process to Greek and Latin, and to no other language ever yet taught under the sun—while we thus accumulate instruction without education, and feel no shame or compunction if at the end of many years we thrust our youth, in all their unwarned ignorance, through the open gate of life—while, I say, such a system as this continues and flourishes, which most practical men have long scorned with an immeasurable contempt, do not let us consider that we have advanced a single step in reforming education, to reform which, in the words of Leibnitz, is to reform society and to reform mankind."

This is sufficiently explicit and emphatic as to the worth of current classical study, but the ever-ready objection is, that all this condemnation is only true of the bad methods by which the dead languages are taught, and that, if they were taught as they should be and can be, there would be no basis for the charge of failure. But Mr. Adams's arraignment was of the existing practice, and he did not deny that there may possibly be a better practice in which classical studies shall be successful. President Porter does not hesitate to fall back upon the bad methods of teaching as giving some excuse for the charge of failure. We suspect, however, that a good deal more is made of this bad-method pretext than it will bear, and that the study of dead languages as a leading element of higher education in this age must remain a failure, whatever the perfection of the methods employed in their acquisition. Indeed, it becomes a serious question whether, broadly considered, perfected methods would not lead to worse failure than the existing practice. But we must postpone this aspect of the discussion to another time.

LITERARY NOTICES.

French and German Socialism in Modern Times. By Richard T. Ely, Ph. D. New York: Harper & Brothers. Pp. 262. Price, 75 cents.

Professor Ely has here presented in small compass and attractive form a large amount of information about the notable socialistic and communistic schemes that have been brought forward in the two countries where most of such projects have originated. The distinction between socialism and communism he states as follows: "The central idea of communism is economic equality. It is desired by communists that all ranks and differences in society should disappear, and one man be as good as another, to use the popular phrase. The distinctive idea of socialism is distributive justice. It goes back of the processes of modern life to the fact that he who does not work lives on the labor of others. It aims to distribute economic goods according to the services rendered by the recipients." The earliest leader to receive attention is Babœuf, whose career began about a hundred years ago. He and Cabet, who was born twenty-four years later, are described by the author as "the two leading French representatives of pure communism." Babœuf's plan for the reorganization of society was adapted to produce a cheerless monotony, but that of Cabet is more attractive. Under that of the latter, goods and labor are common property; executives are chosen by ballot; marriage and family are held sacred. Young persons may choose their own career, but overcrowding of any profession is to be prevented by competitive examination. Science and literature are encouraged. Professor Ely describes the system of Count Henry de Saint-Simon as the first example of pure socialism. Saint-Simonism regards the dead level of communism as even more unjust than the present state of things, and aims to proportion each man's share of benefits to the service he renders the world. Religion should be reformed, not abolished, and all men should regard each other as brothers. All privileges of birth, including inheritance, were to be abolished. We find Saint-Simon and Fourier thus compared: "Each was required as a complement of the other. The one started in his career as a man of wealth and social eminence, the other as a man of the people. The one observed society, studied its history, its development, and sought to find therein a clew to guide him in his work of regenerating the world, morally and economically; the other, regarding the past as such a series of blunders as to afford no proper basis for future formations, searched the depths of his own consciousness, and discovered a law which furnished premises enabling him to construct deductively an ideal and perfect society, and to explain with mathematical accuracy the past, present, and future." Recognizing the absurdity of a large part of Fourier's writings, our author maintains that this is no reason for condemning the social scheme which he originated. Chapters are devoted to Louis Blanc, Proudhon, and to "Socialism in France since Proudhon."

German socialism is distinguished by its profundity. "One of its leading characteristics," says our author, "is its thoroughly scientific spirit. Sentimentalism is banished, and a foundation sought in hard, relentless laws, resulting necessarily from the physiological, psychological, and social constitution of man and his physical environment." Rodbertus, one of the earliest and ablest of German socialists, selects as the two chief economic evils, which cause most of the others, pauperism and financial crises. These could only be abolished by securing to laborers "a share in the national product, which increases *pari passu* with increasing production." A clear account is given of social democracy, and of the views of Karl Marx and Lassalle, the most prominent members of the party. A short chapter is devoted to the professorial socialists, among whom Bismarck is numbered; and, lastly, the views of the Christian socialists are presented.

The spirit in which Professor Ely deals with his subject is most commendable. His book is entirely free from the partisan views and the epithets that we find in the writings of so many of those who view socialism from the outside. It will do a great deal to correct the ignorant notion that socialists are a set of vagabonds who are anxious to divide with any one who has more than they, and to distinguish the views that some socialists hold on other subjects from socialism itself.

The Vertebrates of the Adirondack Region. By Clinton Hart Merriam, M. D. From the Transactions of the Linnæan Society of New York for 1882. Press of L. S. Foster, New York.

The Adirondack Mountains have a more than local reputation as the happy hunting-ground of those who find in "roughing it" the panacea for most earthly ills. We have read much of the thrilling times when painted savages made their echoes ring with wicked cries, and are familiar with the pleasures that peace and later days give to the lover of deep woods. Now Dr. Merriam has taken up the natural history of the wilderness, and is the first to give us the characteristics which distinguish this tract, as a whole, from the surrounding country, and to present with scientific accuracy the peculiarities of its fauna and flora.

The first chapter treats of the location and boundaries of the Adirondacks, geological history, topography, climate, general features, botany, and faunal position, and contains much that is of general interest.

The author says: "From a geological stand-point, the Adirondacks are interesting as constituting one of the few islands that rose above the level of the mighty continental sea previous to Paleozoic time. Its stern Archæan shores were washed by the waves of countless ages before the undermost strata of the lower Silurian were deposited upon them, entombing and preserving many of the trilobites, brachiopods, and other curious inhabitants of that vast ocean. This lower Silurian zone marked the shore-line, so to speak, of the ancient island, and consists of Potsdam sandstone and the lime-rocks of the Trenton period. Though broken and interrupted, enough of it still remains to afford us tantalizing glimpses of the life of the time, torn pages of fragmentary chapters that constitute but a half-told story to excite our imagination and regret."

As to the forms of the mountains, they are in no sense a chain, but consist of more or less irregular groups, isolated peaks, and short ranges, having no regular trend, conforming to no definite axis, and sloping in all possible directions.

The entire region is studded with hundreds of beautiful lakes of various sizes and depths, two of them upward of four thousand feet above tide-level. Under the head of "Climate" the writer speaks at some length of the meteorology of the region, and states that the mean annual rainfall exceeds that of most portions of the State by about five inches. After dwelling upon the causes which serve to lower the temperature, increase the humidity, and promote great luxuriance of vegetation, he recounts the singular fact that many characteristic marsh-plants grow upon the highest summits, as the conditions previously described tend to produce upon them the effect of marshes. On the very top of Mount Marcy a number of these swamp-plants have been found; a matter of especial interest, as there are no trees to protect them from the sun, and they grow on the open summit nearly five thousand feet above tide-level.

In "Botany' he enumerates thirty-two species of forest-trees, fifty-seven of under-shrubs, and one hundred and seventy-eight of the most noticeable flowering-plants. As to the "Faunal Position," he is of the opinion that the temperature alone would show that the district belongs to the Canadian fauna, and a number of the resident birds and mammals are cited in support of this view.

The other five chapters are given to Mammalia, Aves, Reptilia, Batrachia, and Pisces, respectively. Of the "Mammalia" forty-two species are enumerated, but the first part ends with the consideration of the carnivora, and constitutes a most important original contribution to the literature of North American mammals. We have grown accustomed to the modern iconoclast haunting all paths of learning, and now it is Dr. Merriam who robs us of our time-honored panther, the bloodthirsty monster of the deep woods. Not that he takes him entirely away, but he only lets him do some fearful leaping to satisfy our old ideal. He says the panther is an arrant coward; that he is not fierce unless he is wounded, and cornered at that; he does not climb trees except at the point of the bayonet, as it were, and he does not scream screams that curdle the blood; at least, it is the testimony of the most reliable hunters that he rarely makes any noise at all. But he does eat porcupines until his mouth bristles with quills, and he does catch deer, even if he has to make quite a jump to do it.

Lack of space obliges us to refer the reader to the book itself for a further knowledge of its contents, which will abundantly repay perusal, and will confirm what indeed is apparent throughout the work, that the author is thoroughly acquainted with his subject, and writes about it in a style which is at once entertaining and instructive.

Van Nostrand's Science Series, No. 66, Dynamo-Electric Machinery. A series of Lectures by Sylvanus P. Thompson, Professor of Experimental Physics in University College, Bristol. New York: D. Van Nostrand. Pp. 218. Price, 50 cents.

This latest addition to the Science Series deals with a variety of machine which has so rapidly attained prominence that few persons have yet been able to gain an adequate idea of its forms or principles. In the first of these lectures, on "The Dynamo in Theory," Professor Thompson proposed a division of dynamos into three classes, according to the movement of their armatures in the field of electrical force. He then took up the conditions on which the amount of force generated depends, and showed how far the fulfillment of each is compatible with fulfillment of the others. In respect to the condition of size, he calculates that, if the size of a machine is increased n times in linear dimensions, the efficiency will be increased n^5 times. Under "The Dynamo in Practice" he has described the arrangement of the several elements as they appear in the machines of a large number of prominent electricians. The third lecture sets forth the principles on which is based the employment of the dynamo in converting the energy of electric currents into the energy of mechanical motion, and contains a demonstration of the mathematical law of efficiency of the dynamo as a motor. The volume is well supplied with illustrations.

Local Government in Illinois. By Albert Shaw, A. B.; and Local Government in Pennsylvania. By E. R. L. Gould, A. B. Pp. 37. Price, 30 cents. Local Government in Michigan and the Northwest. By Edward W. Bemis, A. B. Pp. 25. Price, 25 cents. Baltimore: Johns Hopkins University.

These pamphlets belong to the series of "Johns Hopkins University Studies in Historical and Political Science," and speak well for the practical value of the plan on which the studies are based. The paper on Illinois shows how the southern counties of that State, being settled from the South, were organized on the Virginia plan, in which the county is the chief factor and the township is insignificant; while the northern counties, settled later from New England, were organized on the New England plan, with the township as the principal factor. The two systems have met and struggled for the mastery; the New England plan is prevailing, and now only about one fifth of the one hundred and two counties in the State cling to the old county system. The history of the development of the Pennsylvania system is more complicated. As it stands, it occupies the middle ground between the New England township and the Southern county systems, and aims at a partition of power, for the terms of which we must refer to the pamphlet. The organization in Michigan is a transplantation of the New England system, with unimportant differences. In Mr. Bemis's paper, the Michigan system is compared with that of each of the older Eastern States and with the systems which have been or are being adopted in the other States of the West and Northwest, including the newer Territories; and the gradual introduction and growth of the township system in the Southern States is noticed.

The Sciences among the Jews before and during the Middle Ages. By M. J. Schleiden, Ph. D. Baltimore: D. Binswanger & Co. Pp. 64.

Four editions of this essay have been published in Germany, but this is the first time it has been given in an English dress. It presents, in a rapid view, the record of what the Jews achieved for the advancement of mankind during the period indicated in the title, by their labors in literature, philosophy, science, and art. Their schools in Europe were, it is claimed, among the best of the period, and were attended even by the Christian clergy, because they furnished almost the only means of mental culture. Having no doctrinal theology, they were able to pursue every branch of study untrammeled, and their literature is rich in the fruits of their many-sided work, particularly in philosophy, ethics, mathematics, astronomy, and hygiene. Down to the thirteenth century, they "far surpassed their Christian contemporaries, as well in point of intellect as in all the sciences having an important bearing on life." They contributed much to the revival of learning in the West, for they understood the languages in which the ancient learning was embraced, and, "had it not been for the efforts of Jewish translators, it is quite likely that the darkness of the middle ages would have enveloped us a good while longer." They were also active in the arts and trades, and carried on commerce. These statements are not bare assertions, but are sustained by abundant citations and references to authorities, which really constitute the bulk of the volume.

Lake Agassiz: A Chapter in Glacial Geology. By Warren Upham. Winona, Minn.: Jones & Kroeger, Printers. Pp. 24.

Lake Agassiz is the name given to a body of water which is supposed to have been formed in the basin of the Red River of the North and of Lake Winnipeg, during the final melting and recession of the ice-sheet. Measured by the shore-line it was 175 miles, in a direct line 142 miles, from north to south. At its greatest height its outlet was about 1,055 feet above the sea, and was then through the valley of the Minnesota River, the flow to the north which the rivers of the valley now take having been restrained at that time by the thickness of the continental ice-sheet. The elucidating of these hypotheses is accompanied by a study in detail of the geological features of the district supposed to have been occupied by the lake.

The Iroquois Book of Rites. Edited by Horatio Hale, M. A. Philadelphia: D. G. Brinton. Pp. 222. Price, $3.

This is the second volume of the "Library of Aboriginal American Literature" of which Dr. Brinton has undertaken the publication. The book itself is an aboriginal composition, partly in the Mohawk and partly in the Onondaga languages, and comprises the speeches, songs, and other ceremonies which composed the proceedings of the council when a deceased chief was lamented and his successor was installed in office. The ritual, which had been preserved by tradition for a period of unknown duration, was reduced to writing at about the middle of the last century, when many of the members of the tribes having learned to write in the orthography devised by the missionaries, the chiefs of the great council directed its composition in that form for permanent preservation. Copies of one part of the work were obtained by Mr. Hale from John Smoke Johnson, Speaker of the Great Council, and a descendant of Sir William Johnson, and Chief John Buck, Record Keeper; and of the other part, from the interpreter Daniel La Fort, of Onondaga Castle. Besides the ritual-books in their originals and English translations, with glossaries and notes, the volume contains a history of the Iroquois nation and league, an exposition of its policy, an account of the origin and composition of the books, a review of the historical traditions of the nation, and an analysis of the Iroquois language. The book is one of great ethnological value, in the light it casts on the political and social life, as well as the character and capacity, of the people with whom it originated.

"The Homœopathic Leader." Edited by Walter Williams Cowl, M. D., and Associates. Monthly: July, 1883. Pp. 78. Price, per year, $4.

This is the first number of a new magazine, the intended character of which is indicated by its name. It contains, besides a poetical salutatory, nine contributed articles on subjects of disease and treatment, editorial articles, notes, and proceedings of homœopathic societies. The editor reports upon a kind of election he has taken among the practitioners called homœopathic, for the purpose of determining to what extent they adhere to the original principles of the school, in which they have been accused of indulging a growing laxity. So far as the "returns" have come in, the majority still appear to "continue to believe in infinitesimals and dynamization, they still believe in the law of similars, and continue to honor the man who declared the fact and proved its truth."

A Practical Arithmetic. By G. A. Wentworth, A. M., and Rev. Thomas Hill, D. D., LL. D. Boston: Ginn, Heath & Co. Pp. 351. Price, $1.10.

There is much that is new in this book as compared with the arithmetics of ten years ago, notably in the arrangement. After five pages on "Numbers," "Decimal Fractions" are at once introduced, and are explained by means of the divisions of United States money, no separate chapter being given to this latter topic. Then follow the Four Rules, and after them "Metric Measures." The next chapter is on "Common Fractions," and "Measures in Common Use" come next, *after* the pupils have learned the metric system, an arrangement which can not fail to impress upon the young that the English measures are as absurdly inferior to the decimal system as British money is more inconvenient than American. The examples are not of the old-fashioned imaginary kind, but "are intended to convey, incidentally, a great deal of accurate and valuable information; so that, by means of the index, the book becomes a book of reference for many physical and mathematical constants."

The Yellowstone National Park. A Manual for Tourists. By Henry J. Winser. New York: G. P. Putnam's Sons. Pp. 96. Illustrated, with Maps. Price, 40 cents.

A convenient and acceptable description of the great national Yellowstone reservation, with its mammoth hot springs, the great geyser basins, the cataracts, the cañons, and other features of this land of wonders. The park is about 2,500 miles from New York by way of the Northern, and 3,000 miles by the Union Pacific Railroad. The Northern Pacific road carries, or will shortly carry, passengers directly to the park by its Yellowstone Park branch, while the Union Pacific will deliver them by 110 miles of staging from Beaver Cañon. The fare to the park and back is from $155 to $165.

How can we escape Insanity? By Charles W. Page, M. D. Hartford, Conn.: Case, Lockwood & Co. Pp. 22.

The author believes that hereditary bias must be taken account of, "although it has become too popular as an excuse for results which, through ignorance or design, are often obscure," but that insanity is largely promoted by intemperance, overwork, over-study, and many over-stimulating influences of American life. The escape from it must be prepared for by proper marriages, the cultivation of temperance in all things, and by counteracting the deteriorating influences that affect us.

Chemistry, Inorganic and Organic. With Experiments. By Charles Loudon Bloxam, Professor of Chemistry in King's College, London. Fifth edition. Philadelphia: P. Blakiston, Son & Co. Pp. 640. Price, $4.

Bloxam's "Chemistry" is a comprehensive text-book, intended "to give a clear and simple description of the elements and their principal compounds, and of the chemical principles involved in some of the most important branches of manufacture." The book is adapted to beginners, and the more special parts, that the general student would wish to omit, are put in small type. The promise in regard to technological subjects is well kept in treating of the extraction of the several useful metals, of glass, pottery, building materials, explosives, fuel, organic dyes, sugars, animal chemistry, etc. The volume contains a large number of cuts illustrative of the experiments introduced, and of the commercial processes described, and its table of contents is made very full, so as to afford the student a means of self-examination. This new edition "has been carefully revised, and some alterations have been made in the theoretical portion, to bring it into harmony with modern views." The volume is about equally divided between organic and inorganic chemistry.

Manual of Taxidermy. A Complete Guide in collecting and preserving Birds and Mammals. By C. J. Maynard. Illustrated. Boston: S. E. Cassino & Co. Pp. 101. Price, $1.25.

This little book consists of directions for collecting, skinning, and mounting birds and mammals, so that they may be not only ornamental objects, but also useful for the study of natural history. The last chapter is on "Mounting Reptiles, Batrachians, and Fishes."

Revista de Agricultura (Review of Agriculture), Nicomedes P. De Adan, Director. August, 1883. Havana: La Propaganda Literaria. Pp. 32.

The "Review" is the monthly organ of a circle of land-owners of Cuba, and aims at the development and improvement of the agricultural resources of the island. The contents relate predominantly to the cultivation of sugar-cane and the manufacture of sugar. An article is also published on the cultivation of the eucalyptus.

Brain-Rest. By J. Leonard Corning, M. D. New York: G. P. Putnam's Sons. Pp. 103. Price, $1.

Dr. Corning's treatment of this important subject consists first of an examination of the nature and phenomena of sleep, and of the relation of the blood-supply to the activity of the brain. Then follow some practical directions in regard to sleeping, and a discussion of the nature of several varieties of insomnia. Finally, some methods of diminishing the cerebral circulation are described, one of them being the "carotid truss," an invention of the author's for lessening the supply of blood through the carotid arteries.

On the Conservation of Solar Energy. By C. William Siemens, F. R. S., D. C. L., etc. With Illustrations. London: Macmillan & Co. Pp. 111. Price, $1.75.

This volume contains Dr. Siemens's Royal Society paper on this subject, the substance of which is included in his article entitled "A New Theory of the Sun," published in the "Monthly" for June, 1882. Other papers are, letters by MM. Faye and Hirn, T. Sterry Hunt, C. A. Young, and others, criticising his theory, and Dr. Siemens's replies to the same. There is also a paper "On Electrical Discharges in Vacuum-Tubes, and their Relation to Solar Physics," being an extract from a presidential address by the author before the British Association. The appendix comprises a paper entitled "On the Electric Furnace," by C. William Siemens and A. K. Huntington; one on "Sunlight and Skylight at High Altitudes," by Captain Abney; "Remarks of Professor Langley on Ceptain Abney's Paper"; and "Dissociation of Attenuated Compound Gases," by Professor Liveing.

A New Theory of the Origin of Species. By Benjamin G. Ferris. New York: Fowler & Wells. Pp. 278. Price, $1.50.

The author first examines Darwin's theory, and endeavors to show that the causes it assigns for the production of new species are insufficient. Some of his arguments are based on the non-production of new types in recent time, and on the great changes that the ape of to-day would have to make to develop into the man of to-day. He next discusses the nature of life, and the difference between human and brute life. A chapter is devoted to the question of the existence of a First Cause, which the author is disposed to answer in the affirmative. Finally, he proposes his new theory, which is, that, as "every living organism within historic times has required a receptacle or matrix for its conception, gradual development, and final birth, . . . if species are reproduced by this ordinary process, then it is fair to conclude that they must have originated not by an 'unusual birth,' but by an *extraordinary generation*"—that is, the first members of each new species were produced from a mother of another species by the influence of a "direct creative influx"—i. e., by a sort of miraculous conception.

The American Citizen's Manual. Part II. The Functions of Governments (State and Federal). By Worthington C. Ford. New York: G. P. Putnam's Sons. Pp. 184. Price, $1.

The purpose of this series—to make citizens at large acquainted with the theory, functions, and operations of the State and national governments, and with their rights and duties—is admirable, and the conception of the several books is well adapted to further it. The present volume treats of protection to life and property; the functions of the Federal Government in the matters of war, foreign relations, regulation of commerce, naturalization, post-offices and post-roads, Indians, the public lands, and patent and copyright laws; the functions of the State government in reference to corporations, education, charitable institutions, and immigration; and State finances.

Dr. B. C. Faust's Laws of Health. Edited by Dr. S. Wolffberg. Translated and improved by Herman Kopp. Brooklyn: H. Kopp & Co. Pp. 37. Price, 20 cents.

This work is a collection of more than a hundred and fifty admirable maxims tersely expressed, embodying sound hygienic principles and practical instructions for the preservation of health. Its peculiar merit is the conciseness with which the rules are phrased, whereby they are more sharply stamped upon the memory and borne in mind. The translator has arranged the manual with particular adaptation to its use in the fourth-reader grade of schools and for self-instruction.

How to get on in the World, as demonstrated by the Life and Language of William Cobbett: to which is added Cobbett's English Grammar, with Notes. By Robert Waters, Teacher of Language and Literature in the Hoboken (N. J.) Academy. New York: James W. Pratt. Pp. 551. Price, $1.75.

The literary style of Cobbett receives in this book about equal attention with the incidents and achievements of his life. Although he is not often named among the masters of English that students of rhetoric are advised to read, and his grammar has been allowed to go out of print, yet the author is able to quote several good judges who agree with him in a high rating of Cobbett's style. Many extracts from Cobbett's writings are given, partly as specimens of his English, and partly as affording a better picture of the man than description could give. The author has secured for his estimate of the character of Cobbett the presumption of correctness, in that he mentions and condemns Cobbett's faults as unhesitatingly as he praises his virtues. The grammar, which is in the form of letters to a son, occupies about half the volume.

French Forest Ordinance of 1669; with Historical Sketch of Previous Treatment of Forests in France. Compiled and translated by John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd. Pp. 150.

Dr. Brown was formerly Colonial Botanist at the Cape of Good Hope, and had his attention particularly directed to the subject of forestry by observation of the evils which had been brought upon South Africa by the reckless destruction of its woods. He has since become engaged in a kind of philanthropic work of publishing at his own risk books enforcing the necessity of renewing or preserving forests, and explaining the manner in which these objects are to be accomplished; the proceeds of one book, if there be any, being applied to the getting out of another in the series. The present volume embodies a translation in full of the famous ordinance from which it derives its name—a statute which the author claims has exercised a deeper, more extended, and more prolonged influence on the forest economy of Europe than has any other work known to him. As introductory to it, are given notices of the treatment of forests in France in prehistoric times; of the incursion of the Normans and the changes introduced by them; of the administration of the forests of France in the first half of the seventeenth century, and the abuses and devastation of forests which followed; of the method of exploitation then practiced—*jardinage*, or the system of felling a selected tree here and there, and leaving the others standing; of the method of *tire et aire*—or "cut and come again"; of the method of *compartiments*—or the division of the wood into equivalent instead of equal portions, as in the former system, each of which is to be cut in its order in a regular succession of years; and explanations of some of the old technical terms used in the ordinance.

The Pine Moth of Nantucket (*Retinia Frustrana*). By Samuel H. Scudder. Boston: A. Williams & Co. Pp. 22, with Plate.

The pines on the Island of Nantucket, set out some twenty or thirty years ago, are fast dying in large numbers from some cause hitherto unknown. Mr. Scudder began his investigations as to the cause of the destruction in 1876, and found it at the extreme tips of the living twigs, in the shape of a moth-larva, which is hatched out in the bud and eats its way to the heart, sapping the life of the needles, one by one, as it goes downward. As the insects are numerous and prolific they soon take possession of the tree and eat away its life. The present monograph gives an account of the insect and its life-history, as well as descriptions of its relatives, and suggestions as to the way of contending with it.

A Book about Roses. How to grow and show them. By S. Reynolds Hale. New York: William S. Gottsberger. Pp. 326.

The author has been a successful grower and exhibitor of roses, and essays in this book to tell how he has gained his success. With considerable copiousness of words and numerous digressions, all of which go to make his story lively and pleasant, he gives a great deal of information of practical value on all matters pertaining to the cultivation of good roses.

Authors and Publishers. A Manual of Suggestions for Beginners in Literature. New York: G. P. Putnam's Sons. Pp. 96.

The forcible presentation in this work of the publisher's side of the questions on which publishers and authors are supposed to be liable to controversy or misunderstanding has awakened a lively discussion in the literary journals relative to the merits and faults of the two classes. This is well, for the subject is important, vague ideas prevail about it, and the questions relating to it should be settled, so that all can understand the situation, and be ready to accept it. This matter is, however, only an incident in the general purpose of the book, which is to teach young authors how to compose their books and to make bargains with publishers, so as to secure the greatest advantages to themselves, and at the same time make matters easy for the trade. The work contains a description of publishing methods and arrangements, directions for the preparation of manuscript for the press, explanations of the details of book-manufacturing, instructions for proof-reading, specimens of typography, the text of the United States copyright law, and information concerning international copyrights, and useful general hints for authors. All this is of practical value to those who are bent on authorship, and are determined to disregard the advice given in the book to refrain from it.

Record for the Sick-Room. Philadelphia: P. Blakiston, Son & Co. Pp. 26. Price, 25 cents each, $2.50 per dozen.

The book is a set of blank tables, each ruled so as to give a record of the condition of a single patient during twelve hours. Columns are provided to show the condition of the pulse, temperature, respiration, and bowels, the medicines and nourishment given, the baths or lotions administered, the temperature of the room, and general notes on the condition of the patient, at each hour, with space at the foot of the table for the physician's directions and memoranda for the nurse. The second page of the cover is occupied with directions for nurses, lists of poisons and their antidotes, and instructions for emergencies.

Contributions to the History of Lake Bonneville. By G. K. Gilbert. Washington: Government Printing-Office. Pp. 32, with Plates.

This monograph is a part of the report of the Director of the United States Geological Survey. The study of which it records the results is one of a series designed to include all the lakes of the Quaternary formation. The geological structure of the Great Salt Lake Valley indicates that it was once the seat of an immense lake, with shores a thousand feet above the level of the present lake, while the mountains around bear the marks of shore-lines at different levels, testifying to a system of oscillations of the waters of this great sheet. Mr. Gilbert's studies were directed to the determination of the period at which this lake existed, and of the order of its oscillations. His conclusions are, that the history of the lake reveals the existence of two periods of maxima of moisture, separated by an interval of extreme dryness; that the time since the Bonneville epoch has been briefer than the epoch, and that the two together are incomparably briefer than such a geologic period as the Tertiary; that the period of volcanic activity in the Great Basin, which covered a large share of Tertiary time, continued through the Quaternary also, and presumably has not yet ended; that such earth-movements as are concerned in the molding of continents had not ceased in Western Utah at the close of the Bonneville epoch, and presumably have not yet ceased; and that the Wahsatch Range has recently increased in height, and presumably is still growing.

Libraries and Readers. By William E. Foster. Pp. 136. Libraries and Schools. Papers selected by Samuel S. Green. Pp. 126. New York: F. Leypoldt. Price, 50 cents each.

One of the good signs of the times is the increased attention that is given to the management of public libraries and the cultivation of correct reading habits and a taste for profitable reading in the general public. Both these books bear on these objects. The first relates to the direction of the attention of those who visit the libraries to the books that will be most advantageous to them—facts to be learned as to each reader by ascertaining the bent of his tastes and the nature of the subjects in which he has the most living interest—and to the inducement in him of the habit of systematic and methodical reading. The other book is a selection of papers by different authors, having in part a similar bearing with relation to the children in schools; and, in part, showing how the library, properly used, may be made a most efficient auxiliary to the studies of the school.

Handsaws, their Use, Care, and Abuse. How to select, and how to file them. By Fred T. Hodgson. New York: The Industrial Publication Company. Pp. 96. Price, $1.

This is a book of practical information on matters relative to the qualities and manipulation of all kinds of handsaws, for the benefit of those persons, whether operative mechanics or amateurs, who use them; and it possesses a value to such to which its price bears a really small proportion. It is well illustrated; and a list of works referred to in the preface shows that a considerable literature on the subject exists in out-of-the-way places.

Studies in Logic. By Members of the Johns Hopkins University. Boston: Little, Brown & Co. Pp. 203. Price, $2.

The "Studies" are the work of students of the university, with one essay contributed by Professor C. S. Peirce at their request. Two of the papers present new developments of the logical algebra of Boole. Another paper relating to deductive logic develops those rules for the combination of relative numbers of which the general principles of probabilities are special cases. In another essay, Dr. Marquand shows how a counting-machine, or a binary system of numeration, will exhibit De Morgan's eight modes of universal syllogism. A second paper by Dr. Marquand explains the views of the Epicureans, known to us mainly through a fragment of the work of Philodemus. Professor Peirce's paper contains a statement of what appears to him to be the true theory of the inductive process, and the correct maxims for the performance of it. The neophyte who takes up these essays with the view of mastering them will find abundant occupation.

Deep Breathing. By Sophia Marquise A. Ciccolina. Translated from the German by Edgar S. Werner. New York: M. L. Holbrook & Co. Pp. 48.

The subject is considered as a means of promoting the art of song, and of curing weaknesses and affections of the throat and lungs, especially consumption. The author speaks from experience, having had her voice—a rare one for song—restored after she had lost it, by practice in deep breathing. We are told, in the preface to the present edition, that a class in deep breathing was formed in a certain sanitarium after reading one of the chapters of the book; as a result of a few weeks of practice in which, one young woman invalid increased the size of her chest three inches and greatly improved her health, and all received much benefit.

Books for the Young. A Guide for Parents and Children. Compiled by C. M. Hewins. New York: F. Leypoldt. Pp. 94.

A classified list of the books most suitable for boys and girls, including both children and youth of from ten to sixteen years of age. The author is librarian of the Hartford Library Association. The list is prefaced by a terse review of children's books in general; a number of suggestions on the right use of books; notices of the best works for children in English and American history; and a "symposium," in which are quoted the expressions of several authors and authorities on the reading best suited for children.

The Modern Sphinx, and some of her Riddles. By M. J. Savage. Boston: George H. Ellis. Pp. 160. Price, $1.

A volume of Sunday-morning sermons, of which the first six, constituting a series, deal particularly with the objects of life, business, and education. In the first sermon, "The Modern Sphinx" is made to propound the question, What is the end of man? The answer given is that, as the earth and heavens glorify God by being, man can glorify God only by being himself. To help him accomplish this perfectly, business, brains, and education should be used and sought, not for themselves only, but as means and aids to help him give himself the highest development. The other sermons are on "The Newspaper—its Good and its Evil"; "A True Republic"; "Progress and Poverty"; "Religious Transition"; and "The Reign of the Dead."

On the Relations of Micro-organisms to Disease. By William T. Belfield, M. D. Chicago: W. T. Keener. Pp. 131.

This volume is composed of the four "Cartwright Lectures" delivered by the author in February last, before the Alumni Association of the College of Physicians and Surgeons of New York. It presents a clear and intelligent discussion of the subject, considering the nature and classification of the micro-organisms, their action on plants and animals, the diseases they occasion, and the methods of studying them, with remarks on the germ theory of disease, accompanied by good illustrations. We have been asked to name some comprehensive work on the bacteria. The present treatise is concise and methodical, and makes full use of the latest investigations.

Handbook of Vertebrate Dissection. By H. Newell Martin, D. Sc., and William A. Moale, M. D. Part II. How to dissect a Bird. New York: Macmillan & Co. Pp. 174. Price, 60 cents.

The intention of the series of which this book is a member is not to enable the student to determine species, but to give the young morphologist practical directions assisting him to learn for himself what a fish, an amphibian, a reptile, a bird, and a mammal are, when considered from an anatomical point of view and contrasted with one another. In the present volume are given specific and detailed directions for performing the several operations of dissection on a bird, which are made more clear by well-executed illustrations. The work has been composed chiefly by Dr. Moale, under the direction of Professor Martin.

Die Kupferlegirungen, ihre Darstellung und Verwendung bei den Volkem des Alterthums. (Copper alloys: their representation and application by the people of antiquity.) By Dr. E. Reyer. Vienna. Pp. 16.

The author, who is Professor of Geology in the University of Vienna, has already published a number of monographs on several of the metals which are the objects of man's mining enterprise and have been applied by him to his use, in which he has compressed much valuable information. In the present work he describes the uses that have been made of the alloys of copper, in sections treating of the geology and discovery of the metal, the characteristics of the alloys, the valuable uses that have been made of them, a summary, by nations, of the kinds of alloys that have been used by different people, and the literature of the subject.

Die Korperliche Eigenschaften der Japaner. (The Physical Characteristics of the Japanese.) An Anthropological Study. By Dr. Erwin Baelz. First Part. Yokohama: Press of the "Echo du Japan." Pp. 16.

The author of this study is Professor of Clinical Medicine in the University of Tokio, and the essay is a contribution to the "Transactions" of the German East-Asiatic Society. Authorities differ greatly in their estimates of the stature and other physical peculiarities of the Japanese, and betray great inaccuracy in their statements on the subject. Dr. Baelz has sought to remedy this difficulty by instituting a series of systematic and exact measurements. The paper gives the results he has reached. The present (first) part considers anatomical details. It is to be followed by a second part, treating of physiological peculiarities.

PUBLICATIONS RECEIVED.

Archæological Institute of America. Fourth Annual Report of the Executive Committee Cambridge: John Wilson & Son. 1883. Pp. 56.

The Journal of Physiology. Vol. IV, Nos. 2 and 3. Edited by Michael Foster, M. D., F. R. S. Supplement to Vol. IV, containing List of Titles of Works and Papers of Physiological Interest published in 1882. Baltimore: Johns Hopkins University. August, 1883.

The Sonnets of Shakspere: When, to Whom, and by Whom Written. Pp. 12.

New and Important Discoveries in Physiology. By George H. Russell. Newville, Pa. 1883. Pp. 14. 25 cents.

Observations on the Habits of the American Chameleon. By R. W. Shufeldt. 1883. Pp. 8. Illustrated.

The Relations of Pain to Weather. By Captain R. Catlin, United States Army, with Notes by S. Weir Mitchell, M. D. Philadelphia: Collins, printer. 1883. Pp. 19.

A Synopsis of Copyright Decisions. By W. M. Griswold. Bangor, Me. 1883. Pp. 8.

The Structure and Appearance of a Laramie Dinosaurian, pp. 4. with Plates; and On the Mutual Relations of the Bunotherian Mammalia, pp. 7. By E. D. Cope. 1883.

Notes on the Volcanoes of Northern California, Oregon, and Washington Territory. By Arnold Hague and Joseph P. Iddings. 1883. Pp. 13.

The Heart of Man. An Attempt in Mental Anatomy. By Putnam P. Bishop. Chicago: Shepard & Johnston, printers. 1883. Pp. 93.

A History of the New York State Teachers' Association. By Hyland C. Kirk. New York: E. L. Kellogg & Co. 1883. Pp. 174. Illustrated.

Syllabus of the Instruction in Sanitary Science. By Delos Fall. Albion, Mich. 1883. Pp. 7. 10 cents.

On the Right Use of Books. By William P. Atkinson. Boston: Roberts Brothers. 1879. Pp. 65.

God and the State. By Michael Bakounine. Translated from the French by Benjamin R. Tucker. Boston: Benjamin R. Tucker, publisher. 1883. Pp. 52. 15 cents.

A Dictionary of Music and Musicians. Edited by George Grove, D. C. L. Parts XVII and XVIII. London and New York: Macmillan & Co. 1883. Pp. 239. $1 per Part.

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POPULAR MISCELLANY.

School Examinations.—In an address before the Teachers' Association of Cook County, Illinois, Colonel Francis W. Parker, formerly of Boston, now Principal of the County Normal School, severely condemned the prevalent system of examining in schools. He believed that none were more faithful in their efforts than the teachers of to-day, and none were more anxious to do good than they. He had wondered why progress had not been greater, and had come to the conclusion that the greatest obstacle was the examinations. The standard for the work had a powerful influence on the work itself. He believed that examinations were the greatest curse the schools had, though they might be made the greatest blessing. "What is the true motive of examinations? Real teaching leads to the systematic, all-sided upbuilding of a compact body of knowledge in the mind. In this upbuilding or instruction, every faculty of the mind is brought into action—perception, judgment, classification, reason, imagination, and memory. Examinations, then, should test the condition and progress of the mind in its development. Is the common standard of examinations a test of real teaching? If I am not mistaken, the examinations usually given simply test the pupil's power of memorizing disconnected facts. The surest way to effectually kill all desire to study any subject, say history, when the pupil leaves school, is the memorizing of disconnected facts. A no less sure way of creating an intense desire to read history is to take one interesting subject and read from various books all that is said about it, and then under the guidance of a skillful teacher to put together this information, arranging events in logical order, and finally writing out in good English the whole story. It is very easy for an expert in examinations to judge of the true teaching power of the teacher in such work, by the written papers. If meaningless words have been memorized, if there is a lack of research, investigation, and original thought, the results will be painfully evident.

"Examinations should not be made the test of fitness for promotion. Those who understand children will readily appreciate the excitement and strain under which they labor, when their fate depends upon the correct answering of ten disconnected questions. It is well known to you that some of the best pupils generally do the poorest work in the confusion that attends such highly-wrought nervous states. How much better, then, it is to take the work of the pupil for the whole year, than the results of one hour, under such adverse conditions! If the teacher really teaches, and faithfully watches the mental growth of her pupils through the work of one or more years, she alone is the best judge of their fitness to do the work of the next grade. The examinations of a superintendent should be to ascertain whether the principals under his charge have the requisite ability and knowledge to organize, teach, and supervise a large school. The examinations of the principal should test the teaching power of his teachers. And, lastly, the teachers should test by examinations the mental growth of their pupils. This is the true economical system of responsibility. First ascertain that superintendent, principal, and teacher can be trusted, and then *trust them*. The testimony of countless good teachers has been uniform, when asked, 'Why don't you do better work? why don't you use the methods learned in normal schools, and educational periodicals, and books?' 'We can not do it. Look at our course of study. In three weeks or months these children will be examined. We have not one moment of time to spend in real teaching.' No wonder that teaching is a trade and not an art! No wonder there is little or no demand for books upon the science and art of teaching!"

The Alps in Roman Times.—The ancient Romans, says Professor H. Nissen, of Strasburg, saw in the Alps a kind of a wall completely shutting them out from the people living beyond them, and so for centuries they hesitated to take possession of the mountain-lands, although their legions had subjected all the country at the base of the Alps to the Rhine, and had made demonstrations toward Germany and England. So great was their dread of those unknown heights that they quietly endured the audacity of the rapacious tribes inhabiting them till about fifteen years B. C. Yet Hannibal had crossed them for the first time in September of 218 B. C. This was considered a deed of such magnitude that its success was ascribed by the southern people to the assistance of the heavenly powers. The darkness that rested over the Alps was first illuminated by the historian Polybius, who visited them and described them from his own observations. Roman power was extended over them by Augustus Cæsar, B. C. 15. Afterward roads were built over them, fourteen at least, the laying out of which shows that they were made after careful studies of the situation by the engineers. The opening of the mountains to travel was followed by a great streaming of adventurers in search of the riches to be found in the regions beyond, and scenes were enacted very much like those which were witnessed a few years ago in California. At one time gold was found in such abundance that the price of the metal was depreciated thirty-four per cent through all Italy. The treasure-hunters carried vines with them and planted them wherever they settled down; and to this, in part, Germany owes its wealth in vineyards. The forests were laid waste, as a matter of course, just as they are now wherever a new settlement is planted, and with similar results. The Romans had no appreciation of the beauty and grandeur of the mountains, so highly admired by modern taste, but expressed only dread of them and abhorrence of their savage aspect, which they considered well represented in the barbarous names their indwellers gave to them. They entertained the wildest ideas of the height of the mountains, which they exaggerated tremendously. Pliny, who was a native of Como, at their very foot, speaks of one of the peaks as being fifty miles high, or sixteen times as high as Mont Blanc.

The Venom of Snakes.—Drs. S. Weir Mitchell and Edward T. Reichert have obtained the venoms from several snakes in the shape of a turbid, yellowish fluid, varying in viscidity, odorless, and having an acid reaction. All the venoms are soluble in water at ordinary temperatures, save for a slight cloudiness which but slowly settles. The poisonous principle of the venom of the moccasin and the rattlesnake appears to reside in two out of three proteids which it contains, one of which is analogous to peptones and is a putrefacient, while the other is akin to globuline and is a much more fatal poison, probably attacking the respiratory centers and destroying the power of the blood to clot. The third proteid resembles the albumens, and is probably innocent. The poisons of the rattlesnake, copperhead, and moccasin are capable of being destroyed by bromine, iodine, bromohydric acid (thirty-three per cent), sodium hydrate, potassium hydrate, and potassium permanganate.

Antiseptic Qualities of Copper.—A few years ago copper was universally regarded as a deadly poison, and any questioning on the subject would, as M. Gautier observes, have been regarded as absurd. This opinion has been shaken by recent investigations. M. V. Burq claims for copper beneficial properties as a disinfectant and prophylactic. He has observed for thirty years that workmen in copper and players on musical instruments of brass, who were liable daily to absorb notable quantities of pure copper-dusts, enjoyed a remarkable immunity from infectious diseases. This was established in the case of the cholera in 1869 and 1873, during the epidemic which prevailed in Paris in 1876 and 1877, and in the recent visitation of typhoid fever, which was the immediate occasion of M. Burq's making a communication to the French Academy on the subject. M. Burq has been encouraged, by his own experiments and those of other physicians whom he cites, to recommend the administration of salts of copper as a preventive and remedy in cases of infectious disease. M. A. Gautier has recently published a book on "Copper and Lead in Food and Industry," in which he denies that copper is as dangerous a substance as it has been considered to be. Citing the observations of Burq, Galippe, and other authors, he discusses, in substantial agreement with them, the effect which copper has in industry and in general use upon workmen engaged with it, and upon public health. He represents it as a normal constituent in many of our foods. Wheat, barley, rice, beans, coffee, etc., constantly contain of it quantities varying from four to ten milligrammes per kilogramme. Prepared foods—greened pickles, chocolate, etc.—contain much more copper, from ten to two hundred milligrammes per kilogramme; and the author shows that, as a rule, we consume five milligrammes of metallic copper a day without receiving any serious injury from it. These quantities could be increased without much danger, but the taste of the salts of the metal is so disagreeable, and their color so conspicuous, that stronger doses would make the food nauseous and repulsive, so that the danger of one taking a fatal dose of copper is really quite remote. All food becomes uneatable when it contains four grammes per kilogramme of copper salts; even voluntary poisoning by copper is almost impossible. A practical inference from these observations would be, that the care we take to tin our copper cooking-vessels is useless. M. Gautier maintains, that it is even dangerous; for most tin contains lead, a deadly poison even in small doses; and it is this metal, in M. Gautier's opinion, that is guilty of the damage that has been attributed to copper. It meets us everywhere, and always leaves its mark in some damage to our system, slight in the detail, but cumulative in the aggregate. We absorb it with our preserved foods, from glazed papers and oil-cloths, from paint, from enamels and crockery, from tin-ware, and from cosmetics, a little every day, till at last enough of the poison is accumulated in the system to make its strength very plainly felt.

How Raisins are dried.—Malaga raisins are made from two distinct kinds of grapes—the Muscat, which is indigenous; and the Pero-Ximenes, which was imported from Germany two hundred or more years ago. Opinions differ concerning the respective merits of the two varieties. The vines are strongly manured, and are allowed to stretch themselves over the ground and absorb all atmospheric heat. The fruit is not all gathered at one time, but the same piece of ground is gone over three times, so that all the grapes may have the necessary ripeness. The raisins are prepared by washing, by drying by steam, or by simple drying in the sun. To dry the grapes by the washing method, furnaces of feeble draught are made in which wood is used as fuel. A round kettle of three or four hundred quarts' capacity receives a lye formed from the residue or refuse of the grapes after pressing, which is either that obtained from the present year or some that has been kept from a previous vintage. The raisins, held in wire colanders holding from five to eight pounds each, are plunged in this lye while it is boiling. After the immersion, the workmen examine the skins to see if they are shriveled enough. If not, they immerse the grapes a second time, which is usually the last. The process of immersion is a very delicate one, requiring skillful watching and keen judgment on the part of the workmen. The grapes must not be allowed to burst, nor the skins to crack. The grapes must not get too hot or be too sweet, or the raisins will mold. Raisins dried by this process are considered inferior. To prepare raisins by steam, the grapes, after having been sunned for twenty-four hours, are put on drying-shelves in a room heated by steam to 160° Fahr., and kept there for twenty-four hours, when they are taken to a cooling-room to be gradually cooled till they are ready to be packed. Drying in the sun is preferred to the other processes wherever the sun affords enough heat. Stagings are built of brick or stone, on which the grapes are exposed at such an angle of inclination as to be in the sun throughout the day. A temperature of 145° is thus attained in August. At night, the grapes are covered with canvas or with boards. During the process of drying, those grapes that remain green or are spoiled are carefully removed, and each grape is turned, in order to preserve a uniformity in the darkening of color. Raisins prepared by the scalding process dry in four days, while those dried in the sun take ten days, but the difference of time is largely compensated for by the economy of expenditure. The raisins are not ready for packing immediately after being dried, but have to be kept for several days in the stores on the planks on which they are carried. Those that are spoiled or defective are picked out, especially if they appear broken or bruised, for one drop of moisture from them would probably damage a whole box. The crop of raisins produced in the Malaga district from the vintage of 1880 and 1881 is estimated at between 2,000,000 and 2,050,000 boxes of 22 pounds each.

Centripetal and Centrifugal Movements of the Limbs.—Dr. G. Delaunay controverts the theory of Carl Vogt, that the direction of the lines in writing, whether from right to left, the result of a centripetal, or from left to right, the result of a centrifugal, movement of the hand, depends upon exterior conditions rather than a physiological necessity. His investigations have taught him to believe that the general direction of all movements is determined by physiological and anatomical influences. Quadrupeds, he says, as a rule are capable only of vertical or forward and backward movements; a few of them, as the cat and monkeys, can make centripetal movements. Man is the only one who can execute centrifugal ones. The physiological evolution from vertical to lateral—first centripetal, then centrifugal—movements, is a result of an anatomical evolution that has been well described by Broca, in his work on the "Order of Primates." According to M. Delaunay's researches, movements are rather centripetal than centrifugal with primitive or inferior races—rather centrifugal than centripetal with superior races; and the change from one to the other takes place as the race advances. Formerly watches were wound from right to left—now they are wound from left to right. Some English watches are an exception, but the Americans, who are more advanced in evolution (so M. Delaunay says) than the European English, wind their watches from left to right. As it is with watches, so it is with most other machinery. Writing from right to left was characteristic of the earlier nations, and is still so of the less advanced peoples, but has given way to writing from left to right as the races have improved. As between the sexes, women are more inclined to centripetal, men to centrifugal, movements; this is seen in drawing and in the adjustment of clothing. Children are more inclined to centripetal than to centrifugal movements; they strike with their palms rather than with the backs of their hands, draw from right to left, and have a propensity to spell and write in the same direction. M. Delaunay sees in this a tendency to atavism. As between individuals, the more intelligent persons, better scholars, are more ready in left to right, or centrifugal; the less intelligent, poor scholars, in right to left, or centripetal motions. Idiots can hardly strike with the back of the hand, and are not at ease in lateral movements. In a psychological respect, centripetal gestures denote primitive, egoistic, retrograde ideas, as is seen in the attitude of the miser holding his treasure, and of the coward in the presence of danger. Centrifugal gestures express generous, expansive, altruistic, brave ideas and passions. The gesture of acclamation or applause, for example, is as elevated, as outward, as centrifugal, as possible. "Pleasure," says M. Charles Richet, "corresponds with a movement of blooming, of dilatation, of extension. In grief, on the other hand, we shrink, we withdraw upon ourselves in a general movement of flexion." Thus, in the psychological as well as in other points of view, centripetal gestures mark inferiority, centrifugal ones superiority.

Ancient Love of Honey.—The bodies of Alexander the Great and of the Spartan King Agesipolis were preserved in honey. The ancient Assyrians also used the same substance for embalming. Its preservative effects are, however, only temporary, for, although it prevents the entrance of the germs of decay for a time, it is itself ultimately overtaken by decay, and the bodies it covers must follow it. The ancient use of honey for food was much more important than its application to purposes of embalming. The Greek mythology attributes its origin to Jupiter, who in his youth was fed by goats with milk and by bees with honey. He adopted ambrosia, a compound of milk and honey, to be the food of the gods, and, taking care that the earth should be supplied, caused it to fall as a dew from the sky, and taught the bees to make cells of wax and store honey in them. Aristotle said that honey fell from the air at the rising of the stars and whenever there was a rainbow; Pliny, that it comes out of the air at about daybreak; whence, he adds, "we find the leaves bedewed with honey when the morning twilight appears, and persons in the open air may feel it in their clothes and hair." He also regrets that it can not reach us as pure as it starts, but has to be polluted by the various substances it meets in coming through the air. The northern sagas likewise represent honey as a heavenly product, and relate that it drops upon the earth from the holy ash, and is food to the bees. The ancients used honey as extensively as they did, probably, because they had not learned to extract sugar from the cane. Nearchus says the Macedonians found the sugar-cane in India, referring probably to the bamboo and its sweet juices, and Diodorus and Theophrastus speak of the sweet juice produced by a cane or reed-like plant; but, if cane-sugar was known at all in antiquity, it was known only as a rarity, and honey was still the pre-eminent sweetener. The ancients were well acquainted with the variations in the quality of honey, according to the season when it was stored and the plants whence it was derived. Honey was also used as a medicine for affections of the throat, inflammations of the lungs, and pleurisy, and as an antidote for snake and mushroom poisoning. It was given with mead in apoplexy; mixed with rose-oil it was applied to diseased ears; and it was used to kill vermin in the head. The ancient Germans had a mead or honey wine, which was made by the fermentation of a mixture of honey, water, and herbs, and contained about seventeen per cent of alcohol. Some ancient writers imagined that bees were developed in the decomposing bodies of animals, and an Arcadian shepherd is credited with having discovered the art of cultivating them in this way. Melanchthon believed something of the kind, and saw in it evidence of Providence and a noble symbol of the Christian Church. Honey formed an important article of trade in the middle ages, but gradually declined under the competition of cane-sugar. The destruction of the monasteries at the time of the Reformation caused also a limitation in the use of wax-lights, and a reduction in the demand for comb.

Trees of Lake Chad.—Dr. Nachtigal in his "African Journeys" describes some curious trees that grow in the region of Lake Chad. The butter-tree, called in that country *tôso-kan*, bears a green round fruit, ripening into yellow, about as large as a small citron. This fruit consists of a nut resembling a horse-chestnut in color and size, and a palatable, fleshy, smooth-skinned covering like a plum. The nut affords an oil, which solidifies under a slight decrease of temperature, and is used throughout North Africa as a substitute for butter. The *Parkia biglobosa* (*runno-kan*) of the same region, a leguminous plant, furnishes an excellent food in its seeds, which are eatable while still unripe. The ripe seeds contain a thick, saffron-colored marrow inclosing black, shining grains. The meal made from them forms when mixed with water or milk a pap, which has a sweet and pleasant taste at first, but soon cloys. Relieved with sour milk or tamarind-juice, it forms a dish healthful and enjoyable to all. The wool-tree (*Eriodendron anfractuosum*) is the third characteristic tree of the country. It rises straight up, with thick, horizontal branches arranged in whorls one above the other, and derives its name from its fruit, which bursts like the pods of cotton and discloses a similar mass of fibers, lustrous and soft as eider-down. This "wool" is used for the stuffing of cushions and mattresses and for the wadding-armor of the heavy cavalry. It has the valuable property of never becoming so compact but that it can be restored to its original volume by a short exposure to the sun. The tree is a favorite place of refuge for the negroes in time of danger. Taking their children and goods up with them, they secure an excellent natural fortress among the whorls of its limbs.

Disposition of Sewage.—Professor Henry Robinson remarks, in a paper on "Home Sanitation and Sewage Disposal," that the latter question should be regarded as involving a combination of sanitary and agricultural interests, of which the first is paramount and the latter should be disregarded when incompatible with it. Sewage is purified in passing through the soil by one or more of three processes: 1. By simple filtration or removal of the suspended matter; 2. By the precipitation and retention, in the soil, of ammonia and various organic substances previously in solution; and, 3. The oxidation of ammonia and of organic matter with the aid of living organisms. A filter-bed may be constructed so as to have a greater oxidizing power than would be possessed by ordinary soil and subsoil, by laying over a system of drain-pipes a few feet of soil obtained from the surface of a good field, care being taken to select a soil containing a considerable amount of carbonate of lime and organic matter. Such a filter-bed would be far more porous than a natural soil and subsoil, and would possess active oxidiizng functions throughout its whole depth. The presence of antiseptics interferes with the fermentation, and refuse from chemical works hinders the progress of purification. Much valuable information has been published by Drs. Lawes and Gilbert on the chemical changes that take place in the soil under varying circumstances; and Dr. Angus Smith, a rivers pollution inspector, has much to say in his last annual report on the action of air on sewage and the mode of treating sewage so as to hasten aëration; while in a previous report he has discussed the treatment of sewage by chemicals. Much information on these subjects may also be found in Mrs. Robinson's work on "Sewage Disposal" (Spon, London). Well-adapted lands have been found capable of purifying the sewage of about five hundred people per acre. The average amount disposed of in nineteen towns where broad irrigation was practiced was equivalent to the sewage of one hundred and thirty-seven people per acre.

Communicability of Disease by Food.—Except the diseases associated with tapeworm and trichinæ, the only animal diseases which there is or has been ground for regarding as transmissible to man, through ingested meat, are cattle-plague, swine-typhoid, epizoötic pleuro-pneumonia, foot-and-mouth disease, anthrax and anthracoid diseases, erysipelas, and tuberculosis. Mr. Francis Vacher, medical officer, of Birkenhead, England, having examined the evidence in respect to the communicability of these seven diseases, has announced the conclusion, in the "Sanitary Record," that only two of them—foot-and-mouth disease and anthrax—can as yet be pronounced communicable to man by infected flesh, while the communicability of the others, although it can not be positively denied, remains unproved. Cattle-plague has been supposed to be allied to various forms of human disease, but pathologists now refuse to accept such kinship in any shape. The possibility of communicating even a mild form of disease by eating meat infected with rinderpest is not supported by any recorded instance; yet experiments whether such food would convey infection must have been tried millions of times. Instances are cited in which thousands of affected cattle were eaten during epizoöties with no bad results. Typhoid fever of swine was declared by Dr. William Budd, in 1865, to be the exact counterpart of enteric fever in man, but his conclusion has recently been found untenable after a most exhaustive research. The meat of swine ill with it is of inferior quality and diminished nutritive value, and is unfit for food in an advanced stage of the disease, but it does not carry typhoid fever. Epizootic pleuro-pneumonia taints the whole carcass of the animal affected, and communicates blood-poisoning by inoculation. Dr. Livingstone says that in South Africa the meat of animals that died of it caused malignant carbuncles in those who ate it. Dr. Letheby relates that a number of persons were made sick by eating sausages made of it in London in 1860. Dr. Gamgee mentions a prevalence of carbuncles in a convict establishment where such meat was used, which ceased when the use was discontinued; but similar meat has been used largely in Paris, the north of France, at Lille, and even in England, without visible dangerous effects. Cattle fed on parts of diseased hogs, and made to drink the food from diseased pleuræ, and animals in the Zoölogical gardens fed on the meat, suffered no ill effects. The communication of foot-and-mouth disease to man, according to Gamgee, "admits of no doubt." The disease has been transmitted by drinking the milk of animals affected and by inoculation, and there is a strong presumption that it can be conveyed by ingested meat. The existence of anthrax is determined by the presence of the *bacillus anthracis* in the blood of the subject. It is communicable by contact, for the bacilli can make their way through capillaries and large vessels, and can pierce the skin and insinuate themselves where it has not been broken. Experiment shows that the disease "can be as readily conveyed by food as in any other way. If any portion of food ingested contains live bacilli, or their spores, the consumer runs a terrible risk; and the tenacity of life of these organisms is so great we can not assign a limit to it." Several forms of disease have been referred to anthracoid causes. Whether they are anthracoidal or not can be ascertained by searching for the bacillus, which, if present, may be seen with a glass of not very high power. The communicability of erysipelas to man from infected food, though exceedingly probable, is hardly capable of direct proof. To convey it through food by inoculation only requires that it be present in the food, that the food be imperfectly cooked, and that the consumer have a minute wound in his mouth. With regard to tuberculosis, Mr. Vacher contends that direct evidence of the human form of the disease having been conveyed by ingested flesh from animals affected by bovine tuberculosis, or "pearl-disease," is wanting, although such flesh is daily sold and bought in the open market, and daily consumed by all classes. The indirect evidence "has really little bearing upon the point at issue."

Massage and Mental Hygiene as Curative Agents.—Dr. Playfair has given accounts in the "British Medical Journal" of three really wonderful recoveries from serious disease by the "Weir Mitchell" treatment, in which massage and mental hygiene are the principal agents relied upon. One patient, who had been unable to retain food in any quantities for five years, began to recover in three days, and in ten days had an enormous appetite; another, a sufferer for four years from partial paralysis, began to recover in forty-eight hours, and was well in a month; the third had been epileptic and partly paralytic for sixteen years. She began to improve in a few days, was out driving and walking in six weeks, and two months afterward went on a sea-voyage to the Cape of Good Hope, in the course of which she attended her former nurse through a fit of sickness, and from which she came back in robust health. The treatment in these cases consisted of removal of the patient from her home surroundings, and her complete isolation with her nurse; and systematic muscular movement, with the use of the faradaic current, and vigorous feeding—to which the appetite was found ready to respond. Dr. Playfair attributes the chief value of the treatment to the fact that it appeals not to one only but to many influces of a curative character. The "Louisville Medical News," reviewing the cases, believes that the imagination is the most prominent agent in effecting the cures, and is ready to class them with "faith-cures."

Phosphorescence in Plants.—M. Crié remarks, in a communication to the French Academy of Sciences, that "it is known that the flowers of phanerogams are capable under certain circumstances of producing phosphorescent light. The phenomenon has been verified, especially of the nasturtium and the marigold. Some years ago I myself saw phosphorescent lights emitted in stormy weather from the flowers of the *Tropoëlum majus*, cultivated in a garden. The emission is especially noticeable in the mushrooms The agaric of the olive, which grows in Provence, at the foot of the olive-trees, is distinguished for its white, quiet, uniform light, which resembles that of phosphorus dissolved in oil." Several other species of luminous agaric are known, but the property is not limited to that genus. The *Rhizomorpha*, or the vegetative apparatus of a considerable number of mushrooms, are also phosphorescent. These cryptogams, which are common in mines, give a light by which miners can see their hands. The luminous threads of *Rhizomorpha subterranea* are easy to perceive in the Pontpean mine, near Rennes. Luminous filaments of a rhizomorpha have been observed in branches of the elder. The *Xylaria polymorpha*, collected from old stalks in a garden, has been seen to emit a feeble white glow, like that of phosphorus in the air.

Professor Virchow on Humboldt.—A monument to William and Alexander von Humboldt was unveiled at the University of Berlin on the 28th of May. Professor Virchow delivered an address on the occasion, in which he spoke in the highest terms of the character and value of the work of the two brothers. "We older men," he said, "who have learned personally from Alexander von Humboldt, and have in part worked with him, feel our strength renewed when we see how the memory of the time of the new birth of our people is perpetuated to posterity in the many monuments of our city. One who walks through our streets will discover that Goethe and Schiller, Stein and the Humboldts, Blücher and Schwarnhorst, did not casually live side by side, but that a recognizable connection prevailed in their development, and wove their works together to a single end. Every German will look with pride upon the men who have risen from out of the midst of the people to the highest places of honor, because they wakened and unfettered the noblest forces of the nation. Especially could our academic youth, who have these models before their eyes every day, learn from the history of such men what recompense genuine work can gain. Humboldt, who completed the 'Cosmos' in extreme age, and who wrote in the last year of his life, 'For thirty years I have had no rest, except at night,' was at one time a sickly lad, whose teacher in the first years of his childhood doubted whether he would ever manifest any more than the most ordinary mental faculties. He, whose youth fell in an age when hardly anything but speculative wisdom, poetic invention and dogmatic tradition were held in honor, had, in his incessant struggles in nearly all the domains of natural science, brought into avail that stronger objective method of thought, comprehensive in its grasp, which has since become the pride and the common estate of the learned of modern times. When he at last, like the world-sages of antiquity, united in himself all the knowledge of his time on natural subjects, and with it the comprehension of its historic growth, it was not the knowledge of a compiler that he displayed, but the fruit of long special work in each single field. He served in the ranks as a national economist and as a miner, as an astronomer and as a physicist, as a chemist and as a geologist, as an anatomist and as an experimenter in vegetable and animal physiology. He was the first scientific traveler who independently studied all the natural and political conditions of the countries visited by himself. Political and physical geography, the study of terrestrial magnetism, plant-geography, and ethnography, grew under his care to be independent branches of science. His example was operative everywhere, as that of one of the most self-active masters in the shop. He has been called vain and selfish; but his vanity was never so strong as to overcome his love of the truth, and his selfishness never prevented his fostering all budding talent and joyfully greeting every advance in knowledge. He refused high positions, so strongly was his innate inclination turned toward the advancement of knowledge. Long after he had become one of the recognized teachers of mankind, he did not cease to learn; but he learned as an investigator learns; and, even as against the most adept, he never gave up the right of testing by his own proofs. It was thus that we learned to know Alexander von Humboldt. His frame was bent under the burden of years and labors, but his spirit was high-set, and his eyes still looked clearly into the world. He was valuable to us as one who had the highest knowledge, and was at the same time perfectly discreet, as a high-priest of truth and humanity, as a true friend of civic freedom. Feeling this, we have erected his monument. May it be a symbol to many generations of the efforts of this age!"

The Physicians' Part in Evolution.—The "Lancet" has been asked, "Why, if it be natural and expedient that only the 'fittest' should survive, are we [the medical men] as a profession chiefly interested in prolonging the lives of those who have been rendered unfit by disease or accident?" It admits that, "if it were really a fact that the whole business of our lives, the work to which we devote the best of our strength and intelligence, had for its object to antagonize the natural course of progress as regards the race, although compassion for the individual might impel us to continue the effort, it would certainly damp the ardor of our enterprise to reflect that those we are striving to keep alive ought in the interests of posterity to be left to die." The seeming paradox the "Lancet" reasons is, however, in truth a fallacy. It is founded on an imperfect view of the inter-relations of the world. "Survival of the fittest" is not the same thing in its result as "adaptation to circumstances." Development, through and by the environment, is the method of Nature, but this does not necessitate that man should be the creature of circumstances. The environment is not a constantly progressive agency of development. It is itself subject to the law of survival. It can not, therefore, be absolutely or abstractly true that the fittest for the existing conditions of life in any particular place or epoch ought to survive. It is wholly out of our power to determine whether the particular type of development which seems to be making its way in the world and asserting its superiority by survival, and is for a time regarded as normal, is the best type, or that which is destined to endure and be perfected. The surroundings of life are progressively changing as well as the subjects of life. There is a perpetual struggle for supremacy between the two, and it is always an open question whether the resultant of this struggle will be found to embody a greater or less modification of subject or circumstance. "Our duty as practitioners of the art of healing does not relate to the surroundings, except in so far as these may be regarded a tributary to the central fact of life. If we can modify the conditions and circumstances of existence so as to render life easier, it is in our day's work to do this, and to do it heartily; but the commission we hold is to prolong life, and to fight against all that tends to destroy or weaken it. In so doing, we are not merely benefiting the individual, but the race, because, so far as we know, man is the highest created organism, and as such he is destined to dominate circumstances. For us 'man' takes the form of *men.* The race may be higher than the individual, but it is with the latter we have to deal."

Ancient and Modern Egyptian Schools and Libraries.—Mr. Reginald Stuart Poole has attempted to trace an historical connection between the ancient Egyptian schools and library at Heliopolis and the Alexandrian Library and University, and even the present Moslem University at Cairo. The sources of information respecting the ancient schools are chiefly old hieratic papyri, some of which were actually exercise-books of students, and they tell us of temples attached to colleges in various large towns.

At Heliopolis, where were the most famous schools, religion, law, mathematics, medicine, and language were taught. Primary schools were provided for all classes; and libraries were attached to the temples. The old methods were adopted in the institutions founded at Alexandria by the Ptolemies, but, as these were intended for a mixed population of Egyptians, Greeks, and Hebrews, law and religion were excluded, to avoid controversy. Learned men were maintained by the state to prosecute research, and a botanical garden and a menagerie were added. The first Alexandrian Library was burned when Julius Cæsar captured the place. The second disappeared at the time of the Arabian conquest. The university was restored by one of the caliphs two centuries after the conquest. The great University of Cairo, which has five thousand students, and practically includes all the Alexandrian faculties except medicine, was founded by a Greek officer of the Fatimite caliphate, A. D. 969–970.

The Jackal, the Fox-Fables, and the Dog-Star.—Herr O. Keller, in a paper on "The Jackal in Antiquity," urges that the Western nations, who had foxes but no jackals, borrowed the traits ascribed to jackals, in Oriental fables, with the fables, and transferred them to their foxes. Thus the Grecian foxes were endowed with the attributes of two animals, and the most curious fox-fables of Æsop are in their origin Indian jackal-fables. Some of Æsop's fables represent the fox as the follower and servant of the lion, which he is not known to be in any sense. The jackal, however, is in the habit of following the lion at a respectful distance, and lives on what he can pick up from the deserted repasts of the king of beasts. This trait was observed by the ancient Indians, and it was a natural result of the observation that their vivid imaginations, discovering royal prerogatives in the lion, should endow his follower with the qualities of a minister and counselor, and make him to assist his majesty by using in his behalf the qualities of slyness and cunning in which the royal beast was deficient. The Greeks substituted foxes for jackals because they knew nothing about them, and their foxes came nearer than any other animal to answering the descriptions of them. The transfer was made easier by the gradual development of the fables from simple nature-stories into moral lessons, in the course of which absolute truth to nature grew less essential, and the representation of abstract qualities under purely conventional masks became more prominent. The incongruous association by the Greeks of the supposed evil influences of Sirius with the harmless dog are susceptible of a similar explanation. The Chinese, however, who also attributed evil qualities to the dog-star, called it the jackal-star, and appropriately; for as the heat and drought of which it is the forerunner are destructive to the crops, so likewise are the jackals, which make their home in the fields, and are constantly running through them in gangs, destroying myriads of plants, in search of their food. To the Egyptians, Sirius was also the jackal-star, but foreboded good, for it appeared just before the time of the inundation. The Mesopotamians also recognized in it a forerunner of beneficent inundations, and gave it the name of the dog, an animal which they held in high esteem. The Greeks borrowed the Mesopotamian name, and kept the Chinese idea, which harmonized well with the character of their own dog-days. The origin of the dog-star has been associated by some other writers with the idea that Sirius, the chief of the stars, was the shepherd-dog to the host of the heavenly sheep, represented by the other stars.

Deforestization and Floods in China.—The country of the lower Yangtse-Kiang in China suffered terribly from floods last July and August. Dr. Macgowan has taken advantage of a trip up the river, for the distribution of relief to sufferers, to make inquiry whether any connection existed between the inundations and the removal of the forests. China, old as it is, is not so old but that the process of denuding the land of trees may be distinctly traced. The treeless aspect of the hills of the lower Yangtse now attracts attention from every voyager; yet no mention is made of their barren condition by Ellis or Davis in their narratives of Lord Amherst's embassy in 1816, but wooded hills are alluded to; from which it would seem that the deforestization is recent. The inundations by which the lower country is frequently submerged come from the Poyang Lake, concerning which very little is actually known, either as regards its floods or its rain-falls. It is known only that there is evidence of a great thinning out of forests on the mountains of Southern Kiangsi, although it has not been carried to the extent that Che-kiang has experienced, where arboriculture is systematically pursued to meet demands for timber. In the hills near the coast, which are stripped annually of grass, ferns, and bushes for fuel, the process of the gradual denudation of the hills is distinctly observable. The soil is never carpeted by leaves; no humus forms; rain, instead of slowly percolating as through a sponge, rushes in water-courses as from the roof of a house into gutters, speedily filling them, and carrying with it soil, which tends to increase the evil. In this way the lakes are destined to become desiccated much sooner than they otherwise would be. It is because of the occasional sudden rush of waters that freshets are always attributed to the spouting of *chias*—subterranean monsters. Several of those are reported as being concerned in the late floods. While there is conclusive evidence that there has been in recent times a great destruction of forests, it is not clear that floods have proportionately increased in number or rapidity; it is, however, what might be expected, and it is what is affirmed by natives when accosted on the subject. Deforestization has had one favorable effect in the south of China, in reducing the ravages of jungle malaria, which recedes with the advance of agriculture.

New Serviceable Metallic Alloys.—Three new metallic alloys have been recently introduced, which seem fitted to serve as substitutes for bronze, imitation gold, and imitation silver. Delta, a bronze made by Mr. Alexander Dick, of London, is a compound of iron, zinc, and copper, the proportions of the ingredients being varied according to the color it is sought to obtain, and has the advantages of extraordinary tenacity and flexibility. It can be beaten, and forged, and drawn when cold, takes a perfect polish, and, exposed to the air, is less liable to tarnish than brass. Aphthite is a "gold," which does not change, and is composed of eight hundred parts of copper, twenty-five of platinum, and ten of tungsten. Its shade of color may be changed by varying the proportions of its constituent metals. Sideraphthite is a similar "silver" metal, and is composed of sixty-five parts of iron, twenty-three of nickel, four of tungsten, five of aluminum, and five of copper. These alloys are capable of resisting hydrosulphuric acid, are not attacked by organic acids, and are only slightly attacked by inorganic acids.

NOTES.

Mr. F. H. King, State Geologist, estimates the bird population of Wisconsin at sixty-six per square mile, or 3,565,000 for the State. Each bird is assumed to eat fifty insects a day, or 6,000 for the summer. Hence all the birds will consume 21,384,-000,000 insects a year. "Add to this amount the work which these birds do in their Southern homes, and we have a low estimate of the influence they exert over insect life."

An improvement on the Bunsen cell, by M. Azapis, consists in substituting for the acidulated water a solution of about fifteen per cent of cyanide of potassium, caustic potash, common salt, or sal-ammoniac. The intensity in the new form is as great as in Bunsen's, and the advantages are, greater constancy, less waste of zinc, and very little smell; further, the zinc does not need amalgamating.

H. T. Cresson has obtained, from Aztec clay flageolets, the fourth, seventh, and octave tones of the diatonic scale, and the additional sounds or semitones which constitute the chromatic scale. These notes are produced by means of the four finger-holes and by stopping or half stopping the bell of the instrument. The flageolets are pitched in different keys, and, if the Aztecs knew the full capacity of their instruments, their music must have far surpassed that of other uncivilized peoples.

Professor Archibald Geikie remarks, concerning the future history of the Grand Cañon of the Colorado, that it has still about a thousand feet to remove from the bottom of its channel before its slope will become so slight that its erosive power will nearly cease, and that it is conceivable that, should no geological revolution occur in the region, the cañon may still be deepened to that amount. There are indications, however, that a limit may be set to the possible depth of the chasm. As in the "creep" of a coal-mine, the bottom of the cañon, relieved from the weight of the overlying column of rock, may be forced upward by the pressure of the walls on either side. In that case, the channel might rise as fast as the river cut it down, so long as nothing occurred at the surface materially to diminish the height of the walls.

Shad, which were first introduced there seven years ago, are now to be found all along the coast of California, and are rapidly making their way northward. The "run" in the Columbia River this year was described as wonderful, and the fish were a drug in the market. In California they have not yet come into popular use, owing partly to the fact that the closed season established by law is just when they are in the rivers. The order of their running in that State is different from that in the Atlantic States. They appear in San Francisco Bay in October, and leave it in May; while for other parts of the coast their run begins later as the latitude increases.

The Convocation of the University of Oxford has voted £10,000 for building a laboratory, working-rooms, and lecture-room for the Waynflete Professor of Physiology, Dr. Burdon-Sanderson. The grant was opposed by some of the members of the board, on the ground of their objections to vivisection, but was carried by a majority of three in a house of one hundred and ninety-three members.

A curious application is made of liquid carbonic acid at Krupp's foundry, in Essen, Prussia. The cannon made there are bound with rings, which are put on in nearly the same manner as the tires are put on wagon-wheels; that is, they are heated very hot, and driven on over the cold cannon, so that when they cool they hold it very tight. Sometimes it is desirable to get the rings off. This is done by freezing the cannon by means of the evaporation of liquid carbonic acid, when they contract and leave the rings loose. The French journal, "La Production," calls the operation "a formidably neat one, and of really Herculean elegance."

Dr. Chaillé, of New Orleans, has made a study of the influence of the inundations to which Louisiana is subject upon health. He finds that they do not cause inevitably or generally any notable increase of malaria or of other disease, and that they certainly do not usually either cause or promote epidemics. Their direct influence is, therefore, not usually to be dreaded. They may, however, in certain soils and conditions be charged with after-influences of a deleterious character, as when the soil is loaded with malaria, or deposits of filth have accumulated upon it. Such soils and deposits, festering in the sun after the floods have retired, may develop very serious evils.

M. Perrier describes an Asteria (*Caulaster pedunculatus*) that was dredged up in the Travailleur expedition, which appears to furnish a link between the ancient crinoids and the modern star-fishes. It is a star-fish, having on its back a peduncle quite similar to that of the crinoids, which is surrounded by a system of plates resembling those that composed the "calyx" of those animals. The peduncle probably served as a support for the young star-fish while it was temporarily fixed, and was probably destined to disappear by the progress of development; but this view needs to be confirmed by further examination.

M. Marchand, having repeated with water some of the experiments which Professor Tyndall has performed on the air, declares that there is no really clear water in existence. Filling a bottle with the liquid, he covered it with black paper, and pierced in the paper two holes at opposite points. Looking through the holes at the light, the dust-particles floating in the water were made plainly visible. They were transparent, only two millimetres in diameter, and elastic enough to pass through the closest filters.

Mr. Joseph Willcox remarked at a recent meeting of the Academy of Sciences of Philadelphia on the scarcity of springs and running streams in Canada. Where streams exist, they are almost exclusively the outlets of lakes. He ascribes the feature to the fact that the ancient glaciers swept away a large proportion of the soil of the country, leaving the underlying rocks usually near the surface, and in many cases visible above the ground. Thus the material is deficient which, in countries where springs and streams abound, soaks up the rain and melting snow, and afterward gives out a perennial flow of water.

"La Nature" records the death, at Catania, Sicily, in the thirty-third year of his age, of M. Tedeschi di Ercole, an investigator of earthquakes and volcanic and other physical phenomena, and a frequent contributor to it on subjects relating to them.

Mr. Jacob Ennis specifies as two great works to be done on our sidereal system—to ascertain what way the great ring of the milky way revolves, and to discover in what direction to look for the center of the system and estimate its distance. The tasks are to be wrought out gradually by observing and measuring the proper motions of the stars, and composing a map by the aid of which the relations of those motions to each other and to the common center may be determined. The details of his method are explained in a pamphlet of twelve pages published by Judd & Detweiler, Washington, D. C.

ALEXANDER VON HUMBOLDT.

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ALEXANDER VON HUMBOLDT.*

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PROPERLY to appreciate ALEXANDER VON HUMBOLDT's life-work, one must form a conception of the intellectual atmosphere from which he issued. The opinion may not unfrequently be found among laymen that there was no real German naturalist before Humboldt. They are accustomed, as if to a Hercules, to ascribe all deeds to him. It is not necessary to say that this is all a mistake; but even professional naturalists frequently remember too little of our older history. I do not speak of the almost ancient figures of Copernicus, Kepler, and Otto von Guericke; nor of Leibnitz, who had as clear a comprehension of the fundamental ideas of nature as we; but the eighteenth century displays names worthy of the highest degree of respect, almost as brilliant as these.

The Bernoullis developed analytic mechanics, Euler recognized the feasibility of achromatic glasses, Tobias Mayer reformed the theory of the moon, Lambert laid the foundation of photometry, Kant conceived the nebular hypothesis, and William Herschel, whom we count among our own, enlarged our knowledge of the starry heavens almost as if the telescope had just been discovered. Had the Dutch physicists left him time, the Canon of Camin would have certainly possessed a perfect

* From a memorial address delivered in the hall of the university, August 3, 1883. The speaker began his address by referring to the custom of annually celebrating the foundation of the university and the memory of its founder, King Frederick William III of Prussia; he then related the history of the efforts to raise funds to erect the statues of the brothers William and Alexander von Humboldt, just placed in the grounds of the university. Following this account with a brief comparative estimate of the talents of the two brothers, he continued, speaking more especially of Alexander.

title to have the Leyden-jar called by his name. Volta's electrophore is really Wilcke's discovery. Segner's water-wheel, Leidenfrost's and Sulzer's experiments, became the germs of important discoveries and applications. Stahl's phlogiston, even if it was a false conception, and Haller's *elementa*, in the long run, made chemistry and physiology German sciences. Herr Hofman has very lately taught us how to appreciate Marggraf's services in technical chemistry. Vater and Lieberkühn are still mentioned in the finer anatomy, and the first part of Sömmering's classical activity belongs to the same category. Caspar Frederick Wolf reformed the development-history and outlined the doctrine of the metamorphosis of plants. As early as 1785 Blumenbach, the founder of physical anthropology, led a class in comparative anatomy. In natural history, Rösel earnestly advanced the labors of Swammerdam and Réaumur; Ledermüller described the creatures which he called *infusoriæ*. Gleditsch performed the experimental demonstration of the sexuality of the phanerogams by fertilizing the palms in our botanical gardens with pollen from Leipsic. Even in classification, in which the rivalry of the seafaring nations with the Germans was so arduous, a few, like the creator of our fish-collection, Bloch, won imperishable fame. Germans also approved themselves as scientific travelers: the two Forsters, Cook's companions around the world; and in connection with the Russian expedition for observing the second transit of Venus, our Pallas, as a student of the Siberian fauna. Finally, in geognosy had Werner secured the uncontested leadership for the Germans as the pre-eminently mining people, among whom Agricola had previously created mineralogy.

This enumeration, which might be considerably extended, shows what good progress German natural science had made in the last century. Indeed, it is doubtful whether any other people can boast of a greater richness of notable achievements during the same period. But, toward the end of the century, the aspect was changed, to our disadvantage, and not without our fault.

After its early bloom in the middle ages, and the activity of the Reformation, the German mind, disturbed in its development by the Thirty Years' War, remained, as respects literary production, in the background. At most, it trifled a little in a tasteless way. Then, all at once, in the second half of the century, it rose to so mighty a flight that it not only recovered its lost rank, but placed itself, in some kinds of poetic creation, at the head of modern mankind. A constellation of talent arose, the like of which the ages of Augustus and Louis XIV did not see, nor the fifteenth century, except in other fields. Who can describe the intoxication of the nation, when immortal songs announced that the king's son had come whose kiss was to awaken the thorn-rose of German poetry out of its half a thousand years' slumber? At the same time there pressed upon us the new naturalism and emotionalism from England, and enlightenment and gushing philanthropy from France. German society now acquired a strong literary interest. But while that part of the educated world which was susceptible to the more tender emotions led an æsthetic dream-life, the stronger minds were chained to the contemplation of the antique, or were sunk in the profundities of the simultaneously ripened critical philosophy. Thus the thought of the nation was far removed from realities, and directed toward beautiful fancies and ideal truths. If this had had the result of only diverting some from research and observation, the loss might have been borne. But, with the thoroughness with which the German does everything, the damage went deeper. The distinctions between æsthetic and scientific demands were effaced from the universal comprehension. The intuitions of art usurped the place of induction and deduction. Even the critique of the reason, just achieved by Kant, was pushed aside as narrow-minded scholasticism. An arrogant speculation believed its synthetic judgments *a priori* had grown so strong that it could undertake to construct the world from a few delusive formulas, and it looked down with extreme insolence upon the unpretentious daily work of the empiric. In short, the day came of that false philosophy which redounded to the shame of German science for a quarter of a century, whose advocates threatened our own generation, and which the best heads, elevating vague fancy and taste above the practical, were least able to resist.

The recollection of this perversion of the German mind is the more mortifying because it occurred simultaneously with the brightest phases of science outside of Germany, especially in France. While under the first republic and the first empire the muses were hushed to silence, there was gathered in Paris a circle of learned men of whom not only has each one left a bright trace behind him, but also in which as a whole lived the comprehension of the true method to which the Academy of Sciences has always persistently adhered. Coulomb and Lavoisier, Laplace and Cuvier, Biot and Arago, were partly the forerunners, partly the *coryphées* of that great epoch from which is dated the leadership which, during the first half of this century, made Paris the scientific capital.

The period of this momentous transformation in Germany, when æsthetic contemplation of the world and overweening speculation were mutually crowning each other and pushing intelligent experiment, like Cinderella, into a corner—this period was that of Alexander von Humboldt's youth. A remarkable youth he must have been, exuberant of thought, and yet burning with the thirst for action; eloquent and enthusiastic like a poet, and yet devoted with all his mind to the study of Nature; in knowledge already a reflection of the Cosmos, and yet indefatigable in accurate examination and experiment; a born master of the German speech, yet at home in every idiom; in such guise he appeared in the intellectual center of the Germany of the day, in Jena, younger than Goethe by twenty, than Schiller by ten years, and yet welcomed by both as if he were their peer in age.

He figured as the friend of Willdenow, Georg Forster, and Leopold von Buch, as the pupil of Blumenbach, Lichtenberg, and Werner, already known by minor writings in which his industrious manysidedness had early displayed itself, already a much-traveled man according to the ideas of the day, and, although of independent means, a servant of the state, on the way to the highest honors. In what was he not interested, and what did he not take up? Ancient weaving, subterranean flora, basalt, meteorological phenomena, the theory of logarithms, had engaged him; but, when it was worth while, he knew how to concentrate his strength upon a single point. Galvani's discovery had recently stirred naturalists and physicians to effort. "In the fall of 1792, having become acquainted with it in Vienna, Humboldt, traversing Germany in every direction as a miner, physicist, and botanist, 'wandering upon desolate and remote mountains where he was sometimes cut off from all literary intercourse,' already revolving the plan of his tropical journey in his head, had still found time to make thousands of most delicate experiments. Even on horseback, besides hammer, glass, and compass, he was never without 'his galvanic apparatus, a pair of metal rods, pincers, a glass stand and an anatomical knife,' and the curse which the Bolognan anatomist had invoked upon the poor race of batrachians overtook them under Humboldt's hand, even in places in which they had previously been secure from it." Now he had talked with Alessandro Volta, in his villa on the Lake of Como, of the crucial experiment in animal electricity, Galvani's convulsion without metals, and was preparing to collect the results of his investigations in the book on "Excited Muscular and Nervous Fibers." He must confirm his own researches with experiments on frogs' legs, and he opportunely called not only his brother, but also "Herr von Goethe," to be his witnesses.

Among the various individualities which were united in him into a complicated whole, and which we meet in analyzing this being, is first of all an artist. The "Rhodian Genius," the "Views of Nature," the address at the opening of the assembly of naturalists, are art-works. That work of Humboldt's which, like Goethe's "Faust," contemplated from youth, was completed with an astonishing energy only in an advanced old age, may certainly claim to be an artist's production. We shall for the present leave unanswered the question of the utility of this kind of mingling of the poetic element with the scientific, in which we may recognize a return to the models of Plato and Lucretius. Aside from his native propensity, Humboldt was led toward it by the æsthetic manner of thinking then prevailing in Germany, which had become a second nature to him, and especially by his intercourse with our great poets. It must not, however, be forgotten that something of the same kind had been observed a little while before in France. Buffon's

"Epoques de la Nature," his sketches, flowing in splendid word-waves, of men and animals, Bernardin de Saint-Pierre's magnificent pictures of tropical nature, were well fitted to spur Humboldt's literary ambition in emulation of them. If his style has lately been criticised, that shows that he had a style. Indulgence in the creation of beautiful forms of language was agreeable to the taste of his age; and why should I not tell how he, presuming upon a similar receptivity in myself, read to me from the proof-sheets of his "Cosmos" passages which particularly pleased him, such as the one in which he ingeniously summarizes all that the moon is to our earth; enlivening the firmament by its changes, comforting the heart with its mild luster, and in geological periods carving out continents through the erosive work of the tides?

More subject to criticism is the other influence which the dominating mind of Humboldt exercised over Germany in his ninetieth year. At nothing are laymen more surprised than when they hear that Humboldt did not stand on the extreme height as a naturalist, but that his situation in a mental respect was like that he found himself in on Chimborazo, when an impassable chasm separated him from the summit. The gap which opened between him and the topmost peak of natural science was the want of physico-mathematical knowledge. Not that this was denied his talents. He had in his youth an inclination to pure mathematical research. But the taste, and later also the mental habit, of analyzing phenomena within a certain scope and tracing them to their ultimate recognizable principles, deserted him. He became satisfied with establishing and examining facts. The mere telling, even at large, of those things that occupied his vision, and which he comprehended to the most minute details, or could deduce at every instant, was tiresome to him. It was, indeed, the cosmos; only there is, in that highest sense, no scientific comprehension of the cosmos. Mathematical physics knows of no difference between cosmos and chaos. By blind natural necessity, by the central forces of atoms independent of time, or by some other equivalent hypothesis of the constitution of matter, it concedes that cosmos may have come out of chaos. The cosmos, the beautiful and harmonious aggregate of nature, is an æsthetic anthropomorphism. Humboldt explained the title "Cosmos" with the phrase, "Sketch of a physical description of the universe." According to Herr Gustav Kirchhoff's definition of mechanics, one might easily place these words upon Newton's "Principia" or Laplace's "Mécanique céleste." But, by description, Humboldt understood only a graphic, not a mechanical description, and there is the same difference between his description of the world and that of Newton or Laplace as between the description of a plant and the calculation of a disturbance. In that he adhered to his conception through his whole life, and attached the highest value to it, he showed himself a genuine child of a stage of discipline more fitted for artistic methods of view than for scientific analysis.

While German science was involved in the enervating network of æsthetic speculations, his own energy and happy skill enlisted Humboldt in wider spheres of healthy activity for its salvation. Even in our fast-living age, it is hard to conceive that only two years after he had been enjoying in the Saal Valley those visions, short indeed, but in a certain sense, like a young love, decisive as to his life, he was observing in Cumana the first periodical shower of stars, and discovering the electric folds in the brain of the torpedo-eel; was exploring the caves of Caripe resonant with the cries of the *guachero;* was threading in a pirogue, environed with alligators, the stream-net of the Rio Negro and the Cassiquiare between the Orinoco and the Amazon; and in Esmeralda, on the upper Orinoco, was observing the concoction by the natives of the weird arrow-poison, curare, which owes its name to him. Nothing was wanting to raise the fantastic charm of these journeys, from which, nevertheless, Humboldt brought back a greater sum of acute, distinct observations in every conceivable field of science, in geography and anthropology, than any single observer ever collected either before him or after him. No! The world will "never see his like" in comprehensive, restless activity, combined with lofty thought; in dauntless venture for ideas, with the wisest saving of means and strength; in soaring height of feeling, the expression of which frequently, in view of the sad contentions of mankind or of the horrors of slavery, for instance, has an elegiac tone, as in a similar way a delicate haze adorns his sketches of the giant heights of the Cordilleras.

It is essential to the success of a scientific journey, first of all, that the traveler return. But, besides threatening him with physical dangers, which Humboldt's apparently not very strong body resisted wonderfully, long journeys in wild regions have other inconvenient consequences. Habituation to perfect freedom in solitude, to constant change and external stimulation, even excitement, the diversion from accustomed literary occupations, render it very hard for travelers to feel themselves at home again, to give themselves up to the complicated demands of cultivated society, and to be satisfied to make the most of the treasures they have brought with them. They seem to prefer to such allegiance a return to the wilderness, so that it is said of African travelers that the greatest danger that threatens them is the unconquerable propensity, when they have once escaped the perils of the journey, to try them again. Thus it was with Humboldt's fellow-traveler, Bonpland, who was drawn back to South America, where it was his fate, not to perish, but to be lost to science, a prisoner to Dr. Francia. He left to Humboldt, in whom no trace of such weakness could be found, the fruit of many of their common labors.

Humboldt had lived in Paris before his journey. He now permanently fixed his place of labor there, as the only place where he could perfect the literary undertakings he had planned; and as with curious facility he had become a Spaniard in New Spain, so, without denying his German, he made the Parisian academicians forget that he was not a Frenchman. In this, that gift of ready wit with which, while a student at Frankfort, he had troubled the more serious William, and which he used as a powerful weapon in his subsequent court-life, was of much advantage to him. Associated with Gay-Lussac and Provençal in labors which are still instructive, he was received into that small circle of learned men that gathered around the venerable Berthollet at Arcueil. All of these and numerous other friendships of Humboldt's are thrown into the shade by the life-long connection he formed with Arago, to which the contrast of their natures lent a peculiar charm.

Humboldt was at first sight of insignificant, flattering, and pliant appearance, Arago of imposing bearing, a type of fiery Southern manhood; Humboldt of encyclopedic mind and knowledge, Arago an astronomer and mathematico-physicist of so sharply limited a scope and so strict a school that, while he analyzed according to three axes the modifying effects which neighboring masses of metals exercise upon magnetic deflections, he left it to Faraday, who could not square a binomial, to find out their causes. Like Humboldt, Arago was a master of comprehensive scientific description; but, while Humboldt inclined to melting pathos, the dazzling polish of Arago's keen language becomes a tiresome mannerism. Sympathy in political views was a bond between them. Arago was a republican, Humboldt called himself a democrat of 1789. Probably this was the reason of the contemptuous condescension with which Napoleon I, among whose faults was not want of respect for science, used to meet him.

In connection with Arago, Humboldt, as he was fond of telling, ruled for twenty years what was then the first scientific body in the world. If not of his fame, this period was the climax of his life. As in the primitive forest he had watched through nights undisturbed by the murmur of the cataracts, the humming of the mosquitoes, the near roaring of the jaguars, and the fearful cry of the beasts in the tree-tops above him, so now were the confusing pressure of the world's metropolis, the thousand personal demands daily thrust upon him, the brilliant society of the *salon*, the intrigues of academical lobbies, to him only a pleasant, stimulating life-element. He found gratification in this mental tumult, which, busy with the air and matter of life, overlooked him while he built up the gigantic coral structure of the many-membered story of his travels. More and more consumed with an inextinguishable enthusiasm for science; in unlimited devotion to knowledge, neglecting domestic fortune; drawing into the line of his activity hosts of learned men and artists, and skillfully utilizing their talents for his own objects; not, indeed, teaching *ex cathedra*, but inspiring youth by his example and continually encouraging them—he was at that time in Paris, as afterward in Berlin, a central figure, from which force radiated on every side, and in which numerous threads ran together.

That was the time when he, sometimes with an essay only a few pages long, created new studies, like that of plant-geography; or by some suggestive medium of graphic representation, such as the isothermal curves, revealed the law hidden in formless masses of single facts. As the whole real world waved before his inner vision, so "swelled before him also the historical flood of floods," only that he festooned the bare scaffold of civic history with the fruit and flower garlands of the history of civilization, of discovery, and of art. As Uhland composed some of his finest romances in Paris, there likewise originated the "Views of Nature," Humboldt's favorite work.

While the reminiscences of Jena were thus revived in him, his mind was nevertheless permanently purified from much dross that had clouded it in those days. In the interval that separates Humboldt's labors after the journey to the tropics from the "Experiments on Excited Muscular and Nervous Fibers," we recognize the influence of his intercourse with the Parisian academicians, of their always careful, frequently exaggeratedly skeptical views. In one point, excelling through the greater depth of German thought, he left his masters behind him. While a kind of shallow vitalism was prevailing in France, Humboldt had long passed the position he had once sustained in the "Rhodian Genius," and had explained the process of life as a result of the physical and chemical qualities of the matters combined in the organic texture.

It is perhaps less known that Humboldt was a pre-Darwinian Darwinian. He gave me the "Essay on Classification," sent him by Louis Agassiz, in which, only three years before the appearance of the "Origin of Species," a book Humboldt did not live to see, the doctrine of periods of creation and teleological views were portrayed with unblunted sharpness, and supported by numerous plausible arguments. Humboldt's expressions on this occasion left me no doubt that he, far from sympathizing with Agassiz's views, was a believer in mechanical causation, and an evolutionist. If we may credit certain Parisian traditions, Humboldt and Cuvier were not on the best footing with each other. Perhaps Humboldt was more inclined toward the doctrines of Lamarck and Geoffroy Saint-Hilaire.

It is time to consider what had become of German science during this period. It had, in a certain sense, sunk deeper and deeper. Philosophical speculation had won ground at nearly all points, and in nearly all the universities its subtilties were announced as ready wisdom by professional philosophers as well as by naturalists and doctors, and were eagerly taken up by the misguided youth. Goethe's false theories and maxims, supported by his fame as a poet, increased the confusion. The wars of Napoleon did harm to German science, not only by external force, but also through the Christian-romantic reaction against the Hellenistic classicism of the preceding period that came in with the national rising.

Not that there were wanting voices to protest against the disorder, or men who knew better, but who disdained to engage in contention with persons talking like madmen. Germany could still boast of one of the first mathematicians and mathematico-physicists of all time. On his return, Humboldt had found the academy at Paris full of the fame of the youthful author of "Disquisitiones Arithmeticæ." Besides Humboldt, there were then in Paris to save the reputation of German science our Paul Erman, who received from the academy the prize in galvanism founded by Napoleon, and whose anatomy of the *Echinoderms* was also crowned by it, and pre-eminently Gauss. But even Gauss illustrates how small a place science and mathematics had in German ideas. Our pleasure in the dainty jest which Heinrich Heine, in his "Reisebildern," utters against the scientists of Göttingen, in the sportive parallel between Georgia Augusta and Bologna, is somewhat troubled when we remember that among those scientists was the immortal Gauss. Never on a similar occasion would a young French poet have overlooked the existence of Laplace.

Finally, the revolution approached. "The brilliant and brief saturnalia of a purely ideal natural science," as Humboldt mildly described it, was drawing toward an end. Natural philosophy had fulfilled none of its glittering promises ; its draught, foaming and pungent at first, had grown stale. And just as, two generations before, a race of poets and thinkers had been produced all at once, so it happened, by a coincidence so remarkable that we guess a law in it, that there arose at this time a healthy and strong crop of genuine naturalists. There was, however, another element by which the external fortune of German science was henceforward materially affected. Frederick the Great had kept the eyes of the world turned toward the capital of his monarchy for half a century. By the calling of such men as Maupertius, Euler, and Lagrange, he had given the Academy of Sciences, recently founded by him, a temporary high luster, partly borrowed from abroad. A seat of German intellectual life, Berlin did not become, under him. The center of culture in Berlin lay in the French colony. If we abstract Lessing's brief residence, Moses Mendelssohn, the prototype of his Nathan, the correct, frigid Ramler, and the author of "The Joys of the Young Werther," Berlin had, in the last century, hardly attained any importance in German literature.

That since then Berlin, having become the political capital of Germany, has also pushed into the advance of the other German cities in an intellectual respect, was not the effect of a single cause, nor the work of any one man. Chief in the succession of circumstances that contributed to it was unquestionably the creation of the University of Berlin. The university could, indeed, not raise a new German Parnassus, even if the Berlin of that time had been the place for it ; and it could also only indirectly contribute to the blossoming of art. But it became, in the pursuit of its work from the first, the most important center of German knowledge as a whole. In reality the general enlightenment which had so often comforted the nation in its divisions, still remained spread over Germany to its salvation. In some points Berlin saw itself surpassed by small universities like that of Giessen. Between these and Berlin there was, however, always the difference that, while now and then some one or another small university would blaze up like a variable star to the first magnitude in some branch or another, to sink in a little while back into comparative obscurity, the sum of the aggregated mental forces in the Berlin University and Academy was the same, or rather increased, from the beginning.

Almost simultaneously with the blossoming of the university, in alliance with the national rising, and favored by the growth of the city and its prosperity, there had also been developed here a real German culture, and a perhaps not very productive but cleverly critical society had collected whose influence on German intellectual life was more perceptible because of the preponderance with which Berlin had come out of the war for freedom. As far as the habitual influence of so many older centers of learning and the independent spirit of the Germans, hostile to centralization, permitted, Berlin henceforth maintained the rank of intelligence appropriate to it as the capital of the state. That illustrious circle of writers, artists, and actively sympathizing women is now inconceivable without the background of the Berlin University; without Schleiermacher and Frederick Augustus Wolf, Savigny and Carl Ritter, Boeckh and Lachmann, Buttmann and Bopp, Hegel and Gauss; and in this sense we may say, that, through the foundation of the university, William von Humboldt elevated Berlin to be the intellectual capital of Germany.

While the University of Berlin fully represented science in nearly every direction, every mental phase of the nation was likewise reflected in it. Here was fought out in jurisprudence the battle between the historical and the philosophical schools; here was seen, in theology, dogmatic reaction to give way to rationalism. Here unrestrained speculation continued to have its way for a long time, natural philosophy blew its last party-colored bubbles, and Goethe's *Farbenlehre* was taught *ex cathedra*. Here it was, also, that that host of men arose who, in connection with many illustrious minds still adorning the Fatherland, repaired the faults of philosophical error, and gave to natural science an activity which was full of consequence for the world as well as for Prussia and Germany, and which still continues. Is it necessary to name them, when so many of them are looking down upon us from these walls—Eilhard Mitscherlich, Heinrich and Gustav Rose, Encke and Poggendorff, Weiss and Lichtenstein, Ehrenberg and Johannes Müller, Dove and Gustav Magnus, and besides them the mathematicians, Lejeune-Dirichlet and Steiner, and later still

Jacobi; and finally, yet remaining among us, the last of his race, Herr Peter Riess? It was a glorious time for German science, little as a precocious and spoiled youth is wont to esteem the men who, themselves almost without teachers, trained their teachers; a time to write whose connected history, the materials for which lie at hand in numerous memorial addresses, would be a thankful task and a patriotic duty; for it was the time when the German nationality, to which so much importance is now attached, grew strong in science also, to proud independence. But the crowning was reserved for the epoch in which Alexander von Humboldt exchanged his former residence in Paris for Berlin. The Italian double-entry book-keeping, which he had learned when young in the trade-school at Hamburg, enabled him, as he told me, to observe how his originally quite considerable means were wasting away in the sums which the publication of his travel-work consumed. When this occasion compelled him, in obedience to the wish of King Frederick William III, much against his inclination, to remove to Prussia, we can only see in this turn of fortune the fulfillment of his high calling, and in the epos of his "much-moved life" admire the remarkable concatenation by means of which, during Alexander's long absence, his brother William, by the foundation of the Berlin University, had prepared a suitable location for his continued activity.

It is hard in this all-leveling time to give an idea of the dominant position that spontaneously fell to him here. In consequence of the long depression of science in Germany and its contemporaneous bloom in France, Paris was endowed in the eyes of German naturalists with a luster of which the present generation knows nothing. We learned from French text-books, we worked with instruments made in Parisian shops, and a long residence in Paris was considered an indispensable finish to a good scientific education. We may conceive, from this consideration, what a halo would surround the head of a man who had played such a part in Paris as Humboldt had done. He returned home as a king comes back to his kingdom after a long campaign of conquest, and was received by the circle of Berlin naturalists, which had grown up in the mean time, as a prince is received by his magnates.

We can more easily represent to-day the favorable circumstances that assured to the brother of William von Humboldt his familiar place in the highest circles of society and his relations to the court. The Cosmos-lectures, the meeting of the German naturalists at Berlin in 1828, the journey into Central Asia, made under the commission of the Czar of Russia, pressed Alexander von Humboldt's figure before the German public far in advance of that of any other scientific man. His peculiar dependent-independent position between the court and ministry; the impregnable footing of scientific fame and unselfish exertion on which he stood; his profound knowledge of men and affairs, and his perfect tact; a power for work that was equal to numerous visits, notes, and letters, as well as to days and nights of continuous observations of magnetic terms; and, finally, a grace in intercourse that disarmed all contradiction—all of these things together made him a real power; and how frequently did he use his power for the good of this university!

At that time, when the limited means of the state made it harder to raise a couple of hundred thalers for scientific purposes than as many thousand marks now, no emergency arose for which Humboldt did not obtain the needed means by his personal intercession; and as now the Academy of Sciences will on satisfactory assurances advance money to young men engaged in merely prospective scientific enterprises, so was Humboldt then the earthly providence of all students. What matter is it that his zeal was sometimes mistaken, and that among the number of those to whom he opened the way was now and then one who came short of fulfilling the hopes set upon him? Even academicians are not infallible in the choice of their *protégés*. If he had a preference for travelers, for his own specialty, did he not also let his sun shine on philologists as well as on naturalists? Who would examine as with a psychological lens the secret motives that impelled him to such touching sacrifices for things quite remote from him? Of course, Humboldt had the faults of his virtues. Ambition is the source of all greatness, but it is hard to draw the line that separates it from vanity. Humboldt used his sharp tongue and pen not only as weapons of defense, but he frequently gave them freer license than was perhaps good. But what signifies the dread that some felt of his criticisms, in the face of such testimony as that of August Boeckh, that he never came away from Humboldt's presence without feeling exalted and inspired with new love for all that is good and noble? There is one other example of a personality which, like Humboldt's, reached such power by pure intellectual force that peoples on both sides of the great sea waited for his words, and kings listened to him: this was Voltaire, in the eighteenth century. The two men, notwithstanding the deep-reaching differences between them, afford many points of resemblance. Both were born in a capital—Voltaire in Paris, Humboldt in Berlin; Voltaire reaching out of the "grand century" into a new period which he had helped to introduce; Humboldt from the classical period of our literature to a new scientific period that had been partly prepared for by him; in both a poet was paired with a naturalist, but the poet predominating in Voltaire, the naturalist in Humboldt; both disappearing from the scene for a period in youth, Voltaire to return after his study-travel to England, Humboldt from his tropical journey, with great acquisitions; Voltaire afterward in Berlin, Humboldt, at least in his later abode in Paris, living near the throne; both occasionally intrusted with diplomatic business; both animated to the noblest exertions, but not above a well-directed jest; both regarding mankind as their family, without a domestic hearth; Voltaire powerfully grasping the tragic fate of Calas, Sirven, and De la Barre, Humboldt in happier times only summoning his force to obtain a salary for poor Eisenstein, or to prosecute Haupt's appeal; the fame of both suffering from the fact that their teachings and discoveries having long ago become common property, only a few know whom to thank for them; finally, both in extreme old age glowing "with that youth which never forsakes us," and active to the latest breath; Voltaire busy with his "Irène" and the "Dictionnaire de l'Académie," Humboldt with the "Cosmos." What the "Experiments on Excited Muscular and Nervous Fibers" was for the youth Humboldt, and the "Travels" and "Views of Nature" for the man, the "Cosmos" was for the old man. We have already questioned the fundamental thought of this famous book from the point of view of theoretical natural history, and of the doctrine of the persistence of force. We have frequently entertained the query whether such a mixture of styles as rules in it is correct or not. It certainly is not becoming to the naturalist. But it is clear that it is exactly this form of representation that makes possible the immense influence of the book, that has over the whole inhabited earth prompted hundreds of thousands to join in asking questions they had not thought of before; that, particularly in Germany, lifted the ban under which natural science had lain in the ideas of the cultivated, as if it were a domain from which common men were excluded, and were accessible only to a few particularly qualified to enter it, and about which one need not be concerned unless he have some special inclination or calling for it. It has been remarked that by *science* the French understand only natural science, by *Wissenschaft* the Germans only mental science. Goethe's scientific efforts, in consequence of their semi-æsthetic character, their desultoriness, and the bitter hostility he showed to all associated research, could not change the case. If it is now different, and the state recognizes the full importance of science, it is, of course, immediately the result of the technical triumphs science has achieved. But the turn for the better we ascribe originally to the Cosmos-lectures, which, for the first time in Germany, led a cultivated German audience to imagine that there was something else in the world than *belles-lettres* and music, than the "Morgenblatt" and Henrietta Sonntag. And although Humboldt himself, as we have already said, did not rise to the very apex of science, it was, nevertheless, this less exalted height at which he stopped that permitted him to make himself comprehensible to the ordinary children of men.

While, indeed, he was not as sublime as Newton or Laplace, while he did not mirror one side of the world in absolute perfection like Gauss, he was able to make an entrance among the multitude for the truths discovered by those archangels of science. While he shared with them the universal human feeling for the beautiful in sublime things, he was incited to project a "picture of Nature," at the risk that it would not give back the measure of the depth, and that no frame could inclose the infinity of the object. Having once come out from Heyne's philological school, and still, when sixty years old, with the college portfolios under his arm, taking his place in our audience-rooms among Boeckh's students, he was the man to lay the bridge between the old and the new time, between the philological-historical, æsthetic-speculative Germany, as the turn of the century saw it, and the mathematico-scientific, technical, inductive Germany of our days.

The German people, indeed the world, has remembered his loving, enthusiastic devotion. Not the thousands of well-observed, important, and new facts with which he has enriched single branches; not the happy and suggestive thoughts thrown out as seed-corns and sometimes grown up to new sciences; still less his historical and geographical works composed with ceaseless industry—furnish the reasons why he sits out there in a marble image. The composition of the whole world into an artistically harmonious figure attempted by him, the combination of the ideal with the real realized in him, of the poet with the naturalist, made him, in Emerson's sense, a representative man of science, and educated manhood in that statue has set up Alexander von Humboldt as a personification of a new phase of its own genius, of which it became conscious through him.

The custom of honoring the memory of a great man by a monument would have little significance if the monument had no other purpose than to keep up that memory; for, if the remembrance would be lost without the monument, it would not be worth keeping up. The monument should rather, calling back to thought the hero who has gone out from among us, lead us, in reflecting on his virtues, to renew the determination to emulate them. We should ask ourselves how the man to whom we look up in grateful admiration would judge us if he should return to us, and whether he would recognize us as worthy prosecutors of the work he had begun.

Alexander von Humboldt died in a gloomy time. The reign of a king friendly to the muses, to whom he had personally stood closer than it is often allowed to a subject to stand, had fallen short of fulfilling expectations. The rule of Napoleon III, personally hateful to him, a friend of the house of Orleans, weighed upon France. A new and strong hand had taken the reins of Prussian state life; but it was sad to close his eyes at the instant when even to us a momentous decision seemed unavoidable.

With how deep satisfaction Humboldt would now see the imperial banners waving from the palace of the prince regent, and how the revolution in the fortune of the Fatherland, which we have witnessed since his death, would gratify him! But how deeply would it pain him to learn at what price the recovered power of the German Empire had to be bought!—that instead of the feeling of mutual esteem and friendship which during his life had bound Germany and France, and to the confirmation of which he had contributed so much, had come in on the side of the French vengeful hatred and unappeasable hostility. Humboldt, a son of the eighteenth century, was, like Goethe, cosmopolitan in his feelings, without being on that account any less a patriot. Nothing would have shocked him, who spent the best part of his life in Paris, in intercourse with the noblest men of the nation, more than the preponderance of Chauvinism; nothing would have troubled him more than to observe that mental disease suggesting a back-sliding into the barbarism of primitive society which is becoming epidemic over Europe, and more seriously threatens the progress of mankind than the rivalry of dynasties ever could do.

Among the articles of faith with which Humboldt was thoroughly permeated, was that of the unity of the human race. On it he theoretically based his abhorrence of slavery, the worser side of which in practice he had observed in its very home, and he spared no opportunity to make his convictions public. The Abolitionist party in the United States did not fail to make use of so desirable a confederate, and at many an anti-slavery meeting, besides "Uncle Tom's Cabin," brought the "Cosmos" into the fight. Humboldt did not live to see the melancholy drama of the war of secession. The final defeat of the slave-holders and the abolition of slavery would have given him great joy. But how would we have stood before him, the friend of the house of Mendelssohn, who corresponded with Henrietta Herz in the Jewish current hand, if he had heard of the race-persecution we have instituted?

In science we could, however, point with peculiar pride to the insight into the unity of the forces of Nature which has become so clear: to spectrum analysis; to the recognition of the nature of comets, a sequel to his observations in Cumana; and to the establishment of the doctrine of descent, and the associated one of persistent natural selection. To-day, when the nebular hypothesis has, through the mechanical theory of heat, been combined with geology, and the hand of the doctrine of descent is reaching through paleontology over the hiatus of spontaneous generation; when we can so far survey the birth of cosmos out of chaos as to be able clearly to define the really doubtful points—now, perhaps, a "Cosmos" might be written, but no one longer thinks of doing it. Two qualities which Humboldt possessed in the highest degree, and would be missed by us with regret were necessary to it, and can no more be found—the view over the whole field of science, and the careful effort to create beautiful forms. Humboldt would also deeply lament the decay of the historical sense, which often in the growth of science first teaches us the true connection of things.

Since Alexander von Humboldt was a universal naturalist, and thought historically, while William, not less universal in the mental sciences, sometimes acted as a naturalist, the two brothers met at many points where the natural and mental sciences march upon each other, and together formed, in the measure of the enlarged condition of knowledge, a *universitas litteraria*, as Leibnitz called it in his time. The statues of the two brothers, in whom, by the rarest coincidence, the various faculties of the human mind diverged and were again drawn together, as in a German university, are therefore the most significant ornament of our edifice, and lend it at once, by a speaking symbolism, the character of a palace of science. The situation of this building, opposite the palace of the ruling house, was a significant mark of the capital of the Hohenzollerns. The Humboldt statues confirm and perfect its significance. As fences and troops guard against marauders by night, so do the spirits of these brothers keep watch against the tricks of blockheads. Where William and Alexander von Humboldt are sentries, there will always be the seat of the noblest manly effort, of free investigation and free teaching.

SUGGESTIONS ON SOCIAL SUBJECTS.

PASSAGES SELECTED FROM PROFESSOR W. G. SUMNER'S NEW BOOK, ENTITLED "WHAT SOCIAL CLASSES OWE TO EACH OTHER."

IN the introduction to his little volume, Professor Sumner remarks: "During the last ten years I have read a great many books and articles, especially by German writers, in which an attempt has been made to set up 'the state' as an entity, having conscience, power, and will sublimated above human limitations, and as constituting a tutelary genius over us all. I have never been able to find in history or experience anything to fit this concept. I once lived in Germany for two years, but I certainly saw nothing of it there then. Whether the state which Bismarck is molding will fit the notion is at best a matter of faith and hope. My notion of the state has dwindled with growing experience of life. As an abstraction, the state is to me only All-of-us. In practice—that is, when it exercises will or adopts a line of action—it is only a little group of men chosen in a very hap-hazard way by the majority of us to perform certain services for all of us. The majority do not go about their selection very rationally, and they are almost always disappointed by the results of their own operation. Hence 'the state,' instead of offering resources of wisdom, right reason, and pure moral sense, beyond what the average of us possess, generally offers much less of all these things. Furthermore, it often turns out in practice that 'the state' is not even the known and accredited servants of the state, but, as has been well said, is only some obscure clerk hidden in the recesses of a government bureau into whose power the chance has fallen for the moment to pull one of the stops which control the government machine. In former days it often happened that 'the state' was a barber, a fiddler, or a bad woman. In our day it often happens that 'the state' is a little functionary on whom a big functionary is forced to depend."

In Chapter I—"ON A NEW PHILOSOPHY: THAT POVERTY IS THE BEST POLICY"—Professor Sumner says: "It is commonly asserted that there are in the United States no classes, and any allusion to classes is resented. On the other hand, we constantly read and hear discussions of social topics in which the existence of social classes is assumed as a simple fact. 'The poor,' 'the weak,' 'the laborers,' are expressions which are used as if they had exact and well-understood definitions. Discussions are made to bear upon the assumed rights and misfortunes of certain social classes; and all public speaking and writing consists in a large measure of the discussion of general plans for meeting the wishes of classes of people who have not been able to satisfy their own desires. These classes are sometimes discontented and sometimes not. Sometimes they do not know that anything is amiss with them until the 'friends of humanity' come to them with offers of aid. Sometimes they are discontented and envious. They do not take their achievements as a fair measure of their rights. They do not blame themselves or their parents for their lot as compared with that of other people. Sometimes they claim that they have a right to everything of which they feel the need for their happiness on earth. To make such a claim against God or Nature would, of course, be only to say that we claim a right to live on earth if we can. But God and Nature have ordained the chances and conditions of life on earth once for all. The case can not be reopened. We can not get a revision of the laws of human life. We are absolutely shut up to the need and duty, if we would learn how to live happily, of investigating the laws of Nature, and deducing the rules of right living in the world as it is. These are very wearisome and commonplace tasks. They consist in labor and self-denial repeated over and over again, in learning and doing. When the people whose claims we are considering are told to apply themselves to these tasks, they become irritated and feel almost insulted. They formulate their claims as rights against society—that is, against some other men. In their view they have a right not only to *pursue* happiness, but to get it; and, if they fail to get it, they think they have a claim to the aid of other men—that is, to the labor and self-denial of other men—to get it for them. They find orators and poets who tell them that they have grievances so long as they have unsatisfied desires. . . . The humanitarians, philanthropists, and reformers, looking at the facts of life as they present themselves, find enough which is sad and unpromising in the condition of many members of society. They see wealth and poverty side by side. They note great inequality of social position and social chances. They eagerly set about the attempt to account for what they see, and to devise schemes for remedying what they do not like. In their eagerness to recommend the less fortunate classes to pity and consideration, they forget all about the rights of other classes; they gloss over all the faults of the classes in question, and they exaggerate their misfortunes and their virtues. They invent new theories of property, distorting rights and perpetrating injustice, as any one is sure to do who sets about the readjustment of social relations with the interests of one group distinctly before his mind and the interests of all other groups thrown into the background. When I have read certain of these discussions, I have thought that it must be quite disreputable to be respectable, quite dishonest to own property, quite unjust to go one's own way and earn one's own living, and that the only really admirable person was the good-for-nothing. The man who by his own effort raises himself above poverty appears, in these discussions, to be of no account. The man who has done nothing to raise himself above poverty finds that the social doctors flock about him, bringing the capital which they have collected from the other class, and promising him the aid of the state to give him what the other had to work for. . . . On the theories of the social philosophers to whom I have referred, we should get a new maxim of judicious living: 'Poverty is the best policy. If you get wealth, you will have to support other people; if you do not get wealth, it will be the duty of other people to support you.'"

In his second chapter, the author dilates upon the proposition that "A Free Man is a Sovereign, but that a Sovereign can not take 'Tips.'" He discourses as follows: "A free man, a free country, liberty and equality, are terms in constant use among us. They are employed as watchwords as soon as any social question comes into discussion. It is right that they should be so used. They ought to contain the broadest convictions, and most positive faiths of the nation, and so they ought to be available for the consideration of questions of detail. . . . Probably the popular notion is, that liberty means doing as one has a mind to, and that it is a metaphysical or sentimental good. A little observation shows that there is no such thing in this world as doing as one has a mind to. There is no man, from the tramp up to the President, the Pope, or the Czar, who can do as he has a mind to. Moreover, liberty is not a metaphysical or sentimental thing at all. It is positive, practical, and actual. It is produced and maintained by law and institutions, and is therefore concrete and historical. Sometimes we speak distinctly of civil liberty; but if there be any liberty other than civil liberty—that is, liberty under law—it is a mere fiction of the school-men which they may be left to discus. . . . The notions of civil liberty which we have inherited is that of *a status created for the individual by laws and institutions, the effect of which is that each man is guaranteed the use of all his own powers exclusively for his own welfare.* It is not at all a matter of elections, or universal suffrage, or democracy. All institutions are to be tested by the degree to which they guarantee liberty. It is not to be admitted for a moment that liberty is a means to social ends, and that it may be impaired for major considerations. Any one who so argues has lost the bearing and relation of all the facts and factors in a free state. A human being has a life to live, a career to run. He is a center of powers to work and of capacities to suffer. What his powers may be, whether they can carry him far or not; what his chances may be, whether wide or restricted; what his fortune may be, whether to suffer much or little—are questions of his personal destiny which he must work out and endure as he can; but for all that concerns the bearing of the society and its institutions upon that man, and upon the sum of happiness to which he can attain during his life on earth, the product of all history and all philosophy up to this time is summed up in the doctrine that he should be left free to do the most for himself that he can, and should be guaranteed the exclusive enjoyment of all that he does. If the society—that is to say, in plain terms, if his fellow-men, either individually, by groups, or in a mass—impinge upon him otherwise than to surround him with neutral conditions of security, they must do so under the strictest responsibility to justify themselves. . . . It is not at all the function of the state to make men happy. They must make themselves happy in their own way and at their own risk. The functions of the state lie entirely in the conditions or chances under which the pursuit of happiness is carried on, so far as those conditions or chances can be affected by civil organization. Hence, liberty for labor and security for earnings are the ends for which civil institutions exist, not means which may be employed for ulterior ends. . . . Democracy, in order to be true to itself, and to develop into a sound working system, must oppose the same cold resistance to any claims for favor on the ground of poverty as on the ground of birth and rank. It can no more admit to public discussion, as within the range of possible action, any schemes for coddling and helping wage-receivers than it could entertain schemes for restricting political power to wage-payers. It must put down schemes for making 'the rich' pay for whatever 'the poor' want, just as it tramples on the old theories that only the rich are fit to regulate society. One needs but to watch our periodical literature to see the danger that democracy will be construed as a system of favoring a new privileged class of the many and the poor. . . . In a free state every man is held and expected to take care of himself and his family, to make no trouble for his neighbor, and to contribute his full share to public interests and common necessities. If he fails in this, he throws burdens on others. He does not thereby acquire rights against the others. On the contrary, he only accumulates obligations toward them; and, if he is allowed to make his deficiencies a ground of new claims, he passes over into the position of a privileged or petted person—emancipated from duties, endowed with claims. This is the inevitable result of combining democratic political theories with humanitarian social theories.

Chapter III. "That it is not wicked to be rich; nay, even that it is not wicked to be richer than one's Neighbor." "We all agree that he is a good member of society who works his way up from poverty to wealth, but, as soon as he has worked his way up, we begin to regard him with suspicion as a dangerous member of society. A newspaper starts the silly fallacy that 'the rich are rich because the poor are industrious,' and it is copied from one end of the country to the other, as if it were a brilliant apothegm. 'Capital' is denounced by writers and speakers who have never taken the trouble to find out what capital is. . . . The great gains of a great capitalist in a modern state must be put under the head of wages of superintendence. Any one who believes that any great enterprise of an industrial character can be started without labor must have little experience of life. . . . Especially in a new country, where many tasks are waiting, where resources are strained to the utmost all the time, the judgment, courage, and perseverance required to organize new enterprises and carry them to success are sometimes heroic. Persons who possess the necessary qualifications obtain great reward. They ought to do so; . . . the ability to organize and conduct industrial, commercial, or financial enterprises is rare; the great captains of industry are as rare as great generals. . . . The aggregation of large fortunes is not at all a thing to be regretted. On the contrary, it is a necessary condition of many forms of social advance. If we should set a limit to the accumulation of wealth, we should say to our most valuable producers, 'We do not want you to do us the services which you best understand how to perform, beyond a certain point.' It would be like killing off our generals in war. . . . Human society lives at a constant strain forward and upward, and those who have most interest that this strain be successfully kept up, that the social organization be perfected, and that capital be increased, are those at the bottom. . . . Those who to-day enjoy the most complete emancipation from the hardships of human life, and the greatest command over the conditions of existence, simply show us the best that man has yet been able to do. Can we all reach that standard by wishing for it? Can we all vote it to each other? If we pull down those who are most fortunate and successful, shall we not by that very act defeat our own object? Those who are trying to reason out any issue from this tangle of false notions of society and of history are only involving themselves in hopeless absurdities and contradictions. If any man is not in the first rank who might get there, let him put forth new energy and take his place. If any man is not in the front rank, although he has done his best, how can he be advanced at all? Certainly in no way save by pushing down any one else who is forced to contribute to his advancement."

Chapter V. "That we must have Few Men if we want Strong Men." "Undoubtedly the man who possesses capital has a great advantage over the man who has no capital, in all the struggle for existence. . . . If it were not so, capital would not be formed. Capital is only formed by self-denial, and if the possession of it did not secure advantages and superiorities of a high order, men would never submit to what is necessary to get it. . . . The man who has capital has secured his future, won leisure which he can employ in winning secondary objects of necessity and advantage, and emancipated himself from those things in life which are gross and belittling. The possession of capital is, therefore, an indispensable prerequisite of educational, scientific, and moral goods. This is not saying that a man in the narrowest circumstances may not be a good man. It is saying that the extension and elevation of all the moral and metaphysical interests of the race are conditioned on that extension of civilization of which capital is the prerequisite, and that he who has capital can participate in and move along with the highest developments of his time. Hence it appears that the man who has his self-denial before him, however good may be his intention, can not be as the man who has his self-denial behind him. Some seem to think that this is very unjust, but they get their notions of justice from some occult source of inspiration, not from observing the facts of this world as it has been made and exists.

The author expresses the opinion, in Chapter VI, "That He who would be well taken care of must take care of Himself," and in enforcing this idea he observes: "The fashion of the time is to run to government boards, commissions, and inspectors, to set right everything which is wrong. No experience seems to damp the faith of our public in these instrumentalities. The English liberals in the middle of this century seemed to have full grasp of the principle of liberty, and to be fixed and established in favor of non-interference. Since they have come to power, however, they have adopted the old instrumentalities, and have greatly multiplied them since they have had a great number of reforms to carry out. They seem to think that interference is good if only *they* interfere. In this country the party which is 'in' always interferes, and the party which is 'out' favors non-interference. The system of interference is a complete failure of the end it aims at, and sooner or later will fall of its own expense and be swept away. The two notions—one to regulate things by a committee of control, and the other to let things regulate themselves by the conflict of interests between free men—are diametrically opposed; and the former is corrupting to free institutions, because men who are taught to expect government inspectors to come and take care of them lose all true education in liberty. If we have been all wrong for the last three hundred years in aiming at a fuller realization of individual liberty as a condition of general and widely diffused happiness, then we must turn back to paternalism, discipline, and authority; but to have a combination of liberty and dependence is impossible."

Chapter VIII is a very spicy discussion "ON THE VALUE AS A SOCIOLOGICAL PRINCIPLE OF THE RULE TO MIND ONE'S OWN BUSINESS," and here the author remarks: "Every man and woman in society has one big duty. That is, to take care of his or her own self. This is a social duty. For, fortunately, the matter stands so that the duty of making the best of one's self individually is not a separate thing from the duty of filling one's place in society, but the two are one, and the latter is accomplished when the former is done. The common notion, however, seems to be that one has a duty to society as a special and separate thing, and that this duty consists in considering and deciding what other people ought to do. Now, the man who can do anything for or about anybody else than himself is fit to be the head of a family; and when he becomes head of a family he has duties to his wife and children in addition to the former big duty. Then, again, any man who can take care of himself and his family is in a very exceptional position if he does not find in his immediate surroundings people who need his care and have some sort of personal claim upon him. If, now, he is able to fulfill all this and to take care of anybody outside his family and his dependants, he must have a surplus of energy, wisdom, and moral virtue, beyond what he needs for his own business. No man has this; for a family is a charge which is capable of infinite development, and no man could suffice to the full measure of duty for which a family may draw upon him. Neither can a man give to society so advantageous an employment of his services, whatever they are, in any other way as by spending them on his family. . . . The danger of minding other people's business is twofold: First, there is the danger that a man may leave his own business unattended to; and, second, there is the danger of an impertinent interference with another's affairs. The 'friends of humanity' almost always run into both dangers. I am one of humanity, and I do not want any volunteer friends. I regard friendship as mutual, and I want to have my say about it. I suppose that other components of humanity feel in the same way about it. If so, they must regard any one who assumes the *rôle* of a friend of humanity as impertinent. The reference of the friend of humanity back to his own business is obviously the next step. . . . Yet we are constantly annoyed, and the Legislatures are kept constantly busy, by the people who have made up their minds that it is wise and conducive to happiness to live in a certain way, and who want to compel everybody else to live in their way. Some people have decided to spend Sunday in a certain way, and they want laws passed to make other people spend Sunday in the same way. Some people have resolved to be teetotalers, and they want a law passed to make everybody else a teetotaler. Some people have resolved to eschew luxury, and they want taxes laid to make others eschew luxury. The taxing power is especially something after which the reformer's finger always itches. Sometimes there is an element of self-interest in the proposed reformation, as when a publisher wanted a duty imposed on books, to keep Americans from reading books which would unsettle their Americanism; and when artists wanted a tax laid on pictures, to save Americans from buying bad paintings. . . . Amateur social doctors are like the amateur physicians—they always begin with the question of *remedies*, and they go at this without any diagnosis, or any knowledge of the anatomy or physiology of society. They never have any doubt of the efficacy of their remedies. They never take account of any ulterior effects which may be apprehended from the remedy itself. It generally troubles them not a whit that their remedy implies a complete reconstruction of society, or even a reconstruction of human nature. Against all such social quackery the obvious injunction to the quacks is, to mind their own business. . . . We have inherited a vast number of social ills which never came from nature. They are the complicated products of all the tinkering, meddling, and blundering of social doctors in the past. These products of social quackery are now buttressed by habit, fashion, prejudice, platitudinarian thinking, and new quackery in political economy and social science. . . . Society, therefore, does not need any care or supervision. If we can acquire a science of society based on observation of phenomena and study of forces, we may hope to gain some ground slowly toward the elimination of old errors and the re-establishment of a sound and natural social order. What we gain that way will be by growth, never in the world by any reconstruction of society on the plan of some enthusiastic social architect. The latter is only repeating the old error over again, and postponing all our chances of real improvement. Society needs, first of all, to be freed from these meddlers; that is, to be let alone. Here we are, then, once more back at the old doctrine—*laissez faire*. Let us translate it into blunt English, and it will read, 'Mind your own business.' It is nothing but the doctrine of liberty. Let every man be happy in his own way. If his sphere of action and interest impinges on that of any other man, there will have to be compromise and adjustment. Wait for the occasion. Do not attempt to generalize those interferences, or to plan for them *a priori*. We have a body of laws and institutions which have grown up as occasion has occurred for adjusting rights. Let the same process go on. Practice the utmost reserve possible in your interferences, even of this kind, and by no means seize occasion for interfering with the natural adjustments. . . . To mind one's own business is a purely negative and unproductive injunction; but, taking social matters as they are just now, it is a sociological principle of the first importance. There might be developed a grand philosophy on the basis of minding one's own business."

Chapter IX considers "THE CASE OF A CERTAIN MAN WHO IS

NEVER THOUGHT OF." "Almost all legislative effort to prevent vice is really protective of vice, because all such legislation saves the vicious man from the penalty of his vice. Nature's remedies against vice are terrible. She removes the victims without pity. A drunkard in the gutter is just where he ought to be, according to the fitness and tendency of things. Nature has set up on him the process of decline and dissolution by which she removes things which have survived their usefulness. Gambling and other less mentionable vices carry their own penalties with them.

"Now, we can never annihilate a penalty. We can only divert it from the head of the man who has incurred it to the heads of others, who have not incurred it. A vast amount of 'social reform' consists in just this operation. The consequence is, that those who have gone astray, being relieved from Nature's fierce discipline, go on to worse, and that there is a constantly heavier burden for the others to bear. Who are the others? When we see a drunkard in the gutter we pity him. If a policeman picks him up, we say that society has interfered to save him from perishing. 'Society' is a fine word, and it saves us the trouble of thinking. The industrious and sober workman, who is mulcted of a percentage of his day's wages to pay the policeman, is the one who bears the penalty. But he is the Forgotten Man. He passes by, and is never noticed, because he has behaved himself, fulfilled his contracts, and asked for nothing.

"The fallacy of all prohibitory, sumptuary, and moral legislation is the same. A and B determine to be teetotalers, which is often a wise determination, and sometimes a necessary one. If A and B are moved by considerations which seem to them good, that is enough. But A and B put their heads together to get a law passed which shall force C to be a teetotaler for the sake of D, who is in danger of drinking too much. There is no pressure on A and B. They are having their own way, and they like it. There is rarely any pressure on D. He does not like it and evades it. The pressure all comes on C. The question then arises, Who is C? He is the man who wants alcoholic liquors for any honest purpose whatsoever, who would use his liberty without abusing it, who would occasion no public question, and trouble nobody at all. He is the Forgotten Man again, and, as soon as he is drawn from his obscurity, we see that he is just what each one of us ought to be.

"The doctrine which we are discussing turns out to be in practice only a scheme for making injustice prevail in human society by reversing the distribution of rewards and punishments between those who have done their duty and those who have not.

"It is plain that the Forgotten Man and the Forgotten Woman are the real productive strength of the country. The Forgotten Man works and votes—generally he prays—but his chief business in life is to pay. His name never gets into the newspapers, except when he marries or dies. He is an obscure man. He may grumble sometimes to his wife, but he does not frequent the grocery, and he does not talk politics at the tavern. So he is forgotten. Yet who is there whom the statesman, economist, and social philosopher, ought to think of before this man? If any student of social science comes to appreciate the case of the Forgotten Man, he will become an unflinching advocate of strict scientific thinking in sociology, and a hard-hearted skeptic as regards any scheme of social amelioration. He will always want to know, Who and where is the Forgotten Man in this case, who will have to pay for it all?

"Certainly there is no harder thing to do than to employ capital charitably. It would be extreme folly to say that nothing of that sort ought to be done, but I fully believe that to-day the next most pernicious thing to vice is charity in its broad and popular sense."

THE HABITATION AND THE ATMOSPHERE.

By M. R. RADAU.

IN a former article we endeavored to elucidate some of the principles which have been developed from the later researches and experiments on the relations of our clothing with the atmosphere (see "Popular Science Monthly," October, 1883). The house, also, may be regarded as a kind of clothing, as a large and ample garment, designed to regulate our relations with the surrounding medium, and to deliver us from its tyranny, but not to isolate us. It ought not to deprive us of air, though that point is too often forgotten. Fortunately, no voluntary prison is so tightly calked up that air from out-of-doors does not find entrance without our perceiving it. The fact that water will readily penetrate a wall or ceiling is known to all, for they can see the spots it makes; but the air that passes through walls is not seen, and so we imagine that it does not penetrate them. This is a mistake. Walls would not prevent us from being in communication with the outside air, even if no cracks were left around the doors and windows. If water can find a way through them, what is to hinder a subtile gas from doing the same? The porosity of walls is very far from being an evil; and we shall shortly see that it is necessary to prevent houses being damp.

A very simple experiment by Dr. Pettenkofer illustrates the permeability of building materials. He took a cylinder of dry mortar twelve millimetres (4·7 inches) long and one third as thick, and waxed all of it except the ends, in which he fastened two glass funnels, one of which was extended by an India-rubber tube, while the other terminated in a very fine orifice. Blowing through the India-rubber tube, he was able to drive the air through the cylinder with force enough to extinguish a candle at the other extremity. Similar results may be obtained with wood and such varieties of stones as allow air to pass through them without difficulty; while other stones, like compact limestones, are hardly permeable.

All materials become impermeable to the air when they are wet. The experiment with the cylinder of mortar will not be successful if the mortar is moistened. It has also been found less easy to drive moisture through bricks and mortar than to make air pass through them; only a few drops of the liquid can be made to appear on the free surface. Water is therefore not easy to dislodge from the pores it has occupied, and is at most removed very slowly by evaporation. But, when water stops the pores, it prevents the air from circulating through them—a mischievous effect upon the permeability of building materials, which is more perceptible in proportion as their grain is finer and more compact.

In ordinary weather, and when they are dry, walls perspire. They are continually traversed by feeble atmospheric currents, which renew the air of closed rooms and rid it of the moisture with which it is loaded. The atmosphere of a house is saturated with moisture by the respiration and perspiration of its inmates, and by the water daily used in housekeeping, even if we do not take account of the dew that is deposited whenever some air from without gets into cold rooms. This moisture, which is always undergoing renewal, ought to be absorbed by the walls, to be evaporated from the outside, under the action of the sun and wind. For this reason it is well for building materials to be porous and permeable, and for them to interpose no obstacle to the circulation of the air which is depended upon to promote evaporation. This remark is especially applicable in the North, where the windows can not always be wide open; it is perhaps of less importance in the South.

The moisture which the walls receive from the exterior atmosphere, from fogs and rain, generally disappears quickly enough under the operation of the winds that constantly lick the surface of the house. But the moisture that comes from within, which is deposited on the walls of poorly ventilated rooms, passes away with difficulty when the walls are not porous. Even the heating apparatus only causes it to change its place, by leaving the surfaces that become warmed and settling farther away where the heat has not yet reached. Inconveniences from interior moisture are especially sensible in newly built houses, where the mortar still contains a large proportion of water, and in ground-floors built on a damp soil, which become impregnated by capillarity. The water stops up the invisible channels through which the air should circulate, and the wall remains damp notwithstanding the evaporation that takes place at the surface, to the great harm of the inmates. Like wet clothes, damp walls are unhealthy because the water they contain increases their conductibility, and, consequently, the flow of heat from within outward; and also because evaporation absorbs or neutralizes much heat. M. Bouchardat, remarking in his "Treatise on Hygiene" on the exposure to which the tenement population are subjected in wind-penetrated Mansard-roofs and in damp basements, adds that the commissioners of unhealthy dwellings are wrong when they rank overcrowding and uncleanliness among the worst sources of danger.

Dr. Pettenkofer calculates that a house having a cellar and basement and two stories of five rooms and a kitchen each, would take 800,000 kilogrammes of bricks, and that these would hold about 40,000 kilogrammes of water. The mortar, although less bulky, would hold as much more water. Thus, the entire masonry would hold, in a house just built, 80,000 kilogrammes or eighty cubic metres of water—a quantity which it is by no means easy to drive out. Among the various means that have been devised for quickly drying the walls of newly-built houses preparatory to tenants moving in, only those can be of real effect that depend on the employment of heat combined with an active aëration. The question is wholly one of promoting ventilation. The lower the temperature, the greater the quantity of air that is needed. At 50° Fahr. a cubic metre of air, which may be already supposed to be three fourths saturated, contains seven grammes of vapor, and is only capable of receiving a little more than two grammes more. Thus, nearly 40,000,000 cubic metres of air at 50° will be needed to absorb the 80,000 kilogrammes of water in the masonry. A moderate wind might, it is true, bring this volume of air in contact with the exposed surface in the course of twenty-four hours; but it is evident that the moisture can not be carried off any faster than it can get through the thickness of the wall to the outer surface; and, when this has to be done, the time required for a more or less complete desiccation would be very long. A suitable degree of heating would greatly hasten the drying, provided the air were continually renewed. If, for example, the temperature of the room were raised to 68° Fahr., the effect—depending partly on the increased capacity of the air to absorb vapor, and partly on the greater rapidity of ventilation—would be five or six times as great.

Aëration is thus the sovereign remedy for the moisture of dwelling-houses, and it is favored by the use of porous materials. Viewed with respect to this point, direct determinations of the porosity, permeability, and hygroscopicity of different building materials are of great interest. Messrs. F. and E. Putzeys, in their work on "Hygiene in the Building of Private Houses," have compiled nearly all that has been published on this subject. It appears from their tables that, in the stones most usually employed, the pores occupy an important fraction of the whole volume. According to Hunt, the decimal of porosity is from 0·07 to 0·20 for some sandstones, from 0·06 to 0·14 for various dolomites, and 0·30 for the soft Caen limestone and Maltese sandstone. These figures do not, however, permit us to predict the relative permeability of walls into which the stone in question may enter, for that will depend as essentially on the proportion of mortar used and the kind of wash or plaster that is put over the stones, as on the kind of stone employed. It must, then, be determined by direct experiments. These are not wanting. Märker has shown that walls of brick let more air through than walls of cut sandstone. Arranged in the order of increasing permeability, the building materials here mentioned would stand—sandstones, rough stones, limestones, brick, calcareous tufa, and adobe. Adobe has been found to be twice as permeable as burned brick, having a porosity of sixty per cent, while brick has only twenty-five per cent, by volume. Mr. Lang has made more complete researches on the co-efficient of permeability of different materials, and puts calcareous tufa at the head of his table. Then follow, in the order of decrease, bricks of slag, pine-wood, mortar, *béton*, hand-made bricks, green sandstone, molded plaster, oak-wood, and enameled bricks. Plaster is extremely compact, and little favorable to natural ventilation.

Paints, washes, and paper-hangings diminish the permeability of walls. The following surfaces are mentioned by Lang, in the order of their increasing effects: whitewash, mastic, glazed papers, common papers, and oil-colors. Common papers are more impermeable than glazed papers, according to Messrs. Putzeys, on account of the greater quantity of starch with which they are impregnated.

Indispensable as is the renewal of the air as a means of preventing moisture in dwellings, it is still more so as a precaution against impurities of every kind that would finally make the atmosphere unfit for respiration. It is, then, important to learn by what sign we may know when an atmosphere is vitiated, and what is the volume of air which a man requires for free breathing in a close room. Normal air, according to the mean of the results of five years of observations at the observatory of Mont Souris, contains about three ten-thousandths by volume of carbonic acid. Immense quantities of this gas are, however, produced in cities by the respiration of the inhabitants and by the fires, but the whole is so rapidly removed by the winds that the atmosphere is not sensibly vitiated by it; and it is not necessary to estimate the proportion of carbonic acid, even in the most densely crowded localities, at more than four ten-thousandths.

In an occupied inclosure, like a sleeping-room, a school-room, or a public assembly-hall, the air undergoes a progressive change through the consumption of oxygen and by exhalations from the lungs and the skins of the people; and, unless a sufficient ventilation is kept up, it will in time become unfit for respiration. This will be the case when the impurities with which the atmosphere is charged become perceptible to the smell and provoke the uneasiness which is usually attributed to a close atmosphere. It is generally agreed that this condition is reached when the proportion of carbonic acid approaches one thousandth.* Observation shows, in fact, that the proportion of carbonic acid increases in the same degree as the insalubrity of the air, and may, up to a certain point, afford a measure of it; but the inconvenience we suffer from bad air is in reality attributable rather to the putrescible organic products of respiration and transpiration which it contains. According to Péclet, the air driven out from the ventilating chimneys of crowded rooms exhales an odor so noxious that it can not be borne with safety, even for a short time. According to some chemists, the disagreeable odor that characterizes close air is due to a particular substance possessing an alkaline reaction and the property of giving off ammonia, which escapes from the lungs.† The real culprits are these miasms which affect the smell. The carbonic acid, which is comparatively an inoffensive gas, only indicates the change the air has undergone. The experiments of MM. Regnault and Reizet go to show that an animal can live in an atmosphere containing seven hundredths of carbonic acid, provided the proportion of oxygen is maintained at twenty-one hundredths. Animals have been observed to perish in a tight inclosure even when the carbonic acid is eliminated as fast as it is formed, and the lost oxygen is restored; and Mantegazza has shown that if two birds are placed under two different bell-glasses, and the carbonic acid formed by one is absorbed by quicklime, and the organic matter exhaled by the other is taken up by animal charcoal, the latter bird will survive considerably longer than the former. We add that Dr. Pettenkofer has been able to breathe for several hours, without inconvenience, air containing one hundredth of carbonic acid developed, not by respiration, but by a chemical process. These facts indicate that the few thousandths of carbonic acid diffused in it are not the cause of the effects produced by an atmosphere vitiated by respiration. The oxygen content diminishes in nearly the same proportion as carbonic acid is developed; but the effects produced by "close air" can not be explained by the deficiency—say of one per cent—of oxygen; that may be remedied in part by more active breathing.

Carbonic acid has sometimes been wrongfully charged with effects which were really due to a small proportion of carbonic oxide, a product of imperfect combustion and of the reduction of carbonic acid. Carbonic oxide is a deadly poison, and destroys the red globules of the blood. To its disengagement may be attributed the unhealthy effects

* According to M. de Chaumont's observations in English barracks, the odor begins to be perceptible when the proportion reaches 0·0008; and this hygienist is inclined to reduce the admissible proportion to 0·0006; but I believe it sufficient to adopt one thousandth as a limit which we shall be fortunate if we never exceed in practice.

† It blackens sulphuric acid, discolors permanganate of potash, and communicates to water in solution a fetid odor (A. Proust, "Traité d'Hygiène").

of cast-iron stoves, effects from which sheet-iron stoves, which are not pervious to it, are free; and it is one of the products of the combustion of poor illuminating gas. It is, nevertheless, customary to measure the degree of insalubrity which any atmospheric medium has reached by the quantity of carbonic acid it contains. This is found to increase rapidly in school-rooms, hospital-wards, and assembly-rooms of all kinds, but not nearly so rapidly, unless the room is extremely close, as the gas is actually developed by the life-processes of the inhabitants of the rooms. This fact indicates that, even in rooms regarded as close, a considerable renewal of air is all the time going on by natural or spontaneous ventilation.

Dr. Pettenkofer has made an ingenious use of the estimation of the proportions of carbonic acid to measure the spontaneous ventilation, or the speed with which the air gradually renews itself in rooms. It is sufficient for this purpose to develop artificially in a room an exactly ascertained quantity of the gas, and to determine by repeated analyses the quantity of acid that disappears in a certain time. The method is a good one, provided there is no opportunity for the acid to be absorbed by fresh mortar. By gauging in this manner the ventilation of a number of places, and then observing in the same places the degree of alteration in the atmosphere resulting from the presence of a given number of persons, Dr. Pettenkofer found that the atmosphere remained of a satisfactory quality when it was renewed at the rate of sixty cubic metres an hour per head. The proportion of carbonic acid continued under these conditions to be less than a thousandth. Experiments were made in a room with brick walls, and having a capacity of seventy-five cubic metres. On the first day when the temperature was 66° in the room and below the freezing-point out-of-doors—the difference being nearly 36°—the rate of change (seventy-four cubic metres) was sufficient to renew all the air in the room in an hour; with a good fire in the stove, the rate of ventilation was raised to ninety-four cubic metres an hour. With paper pasted over the joints of the doors and windows, it fell to fifty-four cubic metres. On another day, when the difference between the inner temperature and that out-of-doors was about seven degrees, the rate of ventilation was only twenty-two cubic metres an hour; and with a window half open it was only increased to forty-two cubic metres; thus an opening of eighty square decimetres was of less effect upon ventilation than the simple transpiration through the walls assisted by a difference of about 36° between the outer and inner temperatures. A calculation based on these experiments indicates that a difference in temperature of 1° C. (1·8° Fahr.) causes to pass every hour about two hundred and forty-five litres of air for each square metre of exposed wall-surface.

The question of the volume of air needed by a man for free respiration is a complex one, on which hygienists do not readily agree. The answer to it must depend, not only on the exterior conditions in view, but also upon the limit of variation, or tolerance, which is regarded as admissible in the normal composition of the air. In a room hermetically closed, where the volume of available air is limited by the capacity of the inclosure, the proportion of carbonic acid will soon reach the one thousandth, which we have adopted as the tolerable limit; and the more speedily as the size of the room is diminished, the more tardily as it is enlarged. The volume of air required will also evidently be proportioned to the time the man stays in the room. Assuming that about twenty litres of carbonic acid are exhaled in an hour from the lungs of an adult man, we find that he will require about thirty-three cubic metres of fresh air every hour; for this quantity of air already has a normal content of thirteen litres of carbonic acid; and the addition to this of the twenty litres exhaled will bring up the whole amount to thirty-three litres, or the one-thousandth part of the volume of air, which we have accepted as the tolerable limit. Consequently the space a person must have, if he is to live in a really close room for an hour, is thirty-three cubic metres; if he is to live there two hours, sixty-six cubic metres. More will be needed if lamps or gas-lights are kept burning in the room, for a candle in burning will consume as much oxygen as a man; but the carbonic acid produced by combustion is not so dangerous as are the exhalations from a living being. The case of a perfectly close room will, however, never be realized; for, however tightly we may close the doors and windows, the air will always get in through some crack, and, if there are no cracks, it will penetrate through the walls. The most thoroughly calked room is not proof against the natural ventilation that results from inequalities of temperature. Houses are great centers of draughts in cold weather, and are permeated by a spontaneous ventilation that is dependent at once on the degree to which the outer atmosphere is agitated, on the number and sizes of the doors and windows, on the condition of the chimneys, and lastly on the permeability of the walls. It may be increased by a suitable distribution of ventilators, and is aided by the draught of the chimneys when fires are kindled in them; but fires may be regarded as artificial means of ventilation. These agencies of natural ventilation diminish in a notable degree the danger of the air within houses stagnating, and will always prevent its becoming vitiated to the extent that might otherwise be apprehended from the causes of contamination which we have reviewed. Their effect should be taken account of in estimating what extent of artificial ventilation may be required; otherwise, we might make exaggerated provisions for it.

When an inclosure containing a given number of persons is subjected to a regular ventilation, there is established, at the end of a certain time, a permanent *régime*; the adulteration of the air, having reached a certain limit, does not vary any more, the noxious gases being eliminated as fast as they are developed. The proportion of carbonic acid is from that time constant; we obtain it simply by assuming that the acid disengaged is distributed through the volume of air introduced by the ventilation. This proportion-limit is, then, independent of the disposable cubic space. A ration of forty cubic metres of air, for example, with a production of twenty litres of carbonic acid, to which are added the sixteen litres of acid contained in the forty cubic metres of fresh air, gives the proportion of 0·0009, whatever may be otherwise the disposable space. The capacity of the inclosure plays no other part than that of delaying the moment when the constant *régime* is established; the space acts as a reservoir which is gradually filled till it contains the same proportion of acid as the current of air that traverses it; but, once *saturated*, it intervenes no more in the course of the phenomenon. The advantage of a considerable cubic space consists, then, chiefly in the fact that it retards the approach of the moment when the alteration of the air attains the limit which it will not pass. This consideration becomes of some importance in fixing the size of rooms that are to be occupied only for a definite number of hours at a time; for it will be always possible to arrange matters so that the proportion-limit shall not be reached before the end of the contemplated time.

Let us suppose, for example, that the ventilation can supply six cubic metres of fresh air per person per hour. This is the ration of air which, according to Péclet, might be sufficient in case of extremity, because six cubic metres of air, half saturated at 60°, can absorb the thirty-five or forty grammes of vapor given out by transpiration. The fresh air containing already a proportion of 0·0004 of carbonic acid, to which respiration adds 0·0033, we find that the proportion-limit will be 0·0037. This limit will be almost reached and the *régime* will be constant when the air has been renewed three times, for the proportion of air will then exceed 0·0035. If the allotted space is only one cubic metre, as we know happens sometimes to be the case in theatres and other assembly-halls, a half an hour will be long enough to bring about this state of things; if the cubic space is increased to ten cubic metres, five hours will be required, and ten hours if it is increased to twenty cubic metres, to reach the same degree of alteration. Such, then, would be the effect of a ventilation at the rate of six cubic metres an hour, according to the capacity of the building. By raising the ration of air to thirty cubic metres, the proportion-limit becomes 0·0011, and we may assume that this has been reached when the air has been renewed twice (the real proportion being then 0·0010). This will happen at the end of four minutes in a space of one cubic metre, after forty minutes in ten cubic metres, etc. But the prolongation of time obtained under these circumstances is not of the same importance as in the preceding case, for the limit of 0·001 is a characteristic of respirable air. With so energetic a ventilation as this, the consideration of cubic space becomes a minor affair; but it is of great importance when the only dependence is upon natural ventilation, for that is greatly facilitated by any increase of the extent of exposed surfaces, and of doors and windows. We should also keep in view that a like quantity of air will more readily traverse a large than a small space without producing inconvenient currents; and that the air in a large space requires less frequent renewal, and does not have to be kept in as rapid motion. Natural ventilation, which is uniform and almost insensible, must not be confounded with draughts and currents of air, with the injurious effects of which all are acquainted.

The rules as to the amount of space that should be allowed in connection with natural ventilation are various and indefinite. Aëration from this source can not always, however, be depended upon; and even the opening of windows on opposite sides of an apartment frequently fails to produce the changes of air that are needed. General Morin, who has distinguished himself as an apostle of ventilation, and who made numerous experiments bearing upon the subject, has given the following estimates of the volume of air that should be withdrawn and introduced every hour, for each person, in public institutions of different kinds: Children's schools, twelve to fifteen cubic metres; schools for adults, twenty-five to thirty cubic metres; amphitheatres, thirty cubic metres; assembly-halls and long-continued meetings, sixty cubic metres; play-houses, forty cubic metres; barracks, thirty cubic metres during the day, forty to fifty cubic metres at night; hospitals for the ordinary sick, sixty to seventy cubic metres; hospitals for the wounded and for women in childbirth, one hundred cubic metres; the same in times of epidemic, one hundred and fifty cubic metres; prisons, fifty cubic metres; stables, one hundred and eighty to two hundred cubic metres. These numbers certainly represent the maximum of reasonable demands; and M. Bouchardat thinks that they are exaggerated and not justified by clinical experience. Besides effecting the renewal of the air, ventilation also furnishes the means of obtaining a nearly constant temperature—in winter by means of the circulation of hot air through the house, in summer by air drawn from the cellar. The latter method is quite effective for securing an agreeable temperature in hot weather without much expense, whenever a sweet, dry cellar can be had. The cabinet of the Conservatoire des Arts et Métiers, in Paris, is kept cool in this way, the draught of air being promoted by gas-jets kept burning in the ventilating shafts; as is also M. Daville's laboratory at the Normal School, where the opening of a few squares in the glass-roof furnishes the required stimulus to the circulation. Similar principles have been adopted at the palace of the Corps Législatif. The subject of applying the artificial refrigeration of the air in colonial life in hot countries has been studied by M. Dessoliers, and elaborated by him with a number of ingenious devices, among which the storing of cold night-air for use during the day plays a part.

In temperate climates the principal object of ventilation is the replacement of vitiated air with fresh. Artificial ventilation is produced either by inducing a movement of air by means of draught-chimneys, or by forcing in air through the agency of mechanical ventilators. A trial has been made at the Lariboisière Hospital of a system of ventilation in which the air is drawn from the roof and forced into flues that ramify into the several halls to be ventilated. At the moment of entering the halls the air is heated by being brought in contact with steam-pipes, so that a uniform temperature of 78° is maintained in the wards, with an atmosphere free from odor. Notwithstanding purity of air is secured, the mortality in this institution is not inferior to that in non-ventilated hospitals. This is attributed by M. Bouchardat to the mischievous influence of the high temperature which they endeavor to maintain. He favors heating and ventilation by open fire-places. This method is preferred in London, where fires are kept up in summer as well as in winter, at least in the principal office of the institution, and the windows are opened at all times when it is possible, while mechanical ventilating apparatus is used only exceptionally. The air, sucked in by the strong draught of the chimneys, enters by the joints of the doors and windows. The patients enjoy the sight of the fire and the pleasant feeling of direct radiation, while they collect around the hearths and breathe an air that has not been changed by contact with a heated surface. Possibly the English go too far in this direction. "The importance of pure air," says M. Proust, "has perhaps been exaggerated in some cases by the English physicians, whose example the Americans have followed. It is advisable, according to them, to leave the larger openings, no matter what the weather may be, the windows of dormitories and bedrooms, open during the night. These principles, almost universally observed in the countries of which we speak, entail, in our opinion, great inconveniences." There is really some danger in exposing one's self to cold during sleep.

The study of the questions of heating and ventilation has made considerable progress in France during the last fifteen or twenty years. The construction of numerous school-houses has especially been the occasion of many praiseworthy improvements, but much still remains to be done. Dr. Larget, in an interesting work on rural habitations, has pointed out an apparent relation between the number of openings indicated in the tax-list of doors and windows and the mortality. The general average, for France, of the number of openings per inhabitant, is one and a half. In one hundred departments, in which the number is less than the mean, fifty-five show a higher mortality, and forty-five a mortality equal to the average; while, in a hundred departments in which the number is greater than the mean, sixty show a lower rate of mortality than the average, and only twenty-five a higher rate.

Another point which is too easily forgotten is that, like the walls, floors are permeable to the air. The atmosphere is not bounded by the level of the soil, but extends below it to a considerable depth. The most compact soils include a considerable volume of air, as well as an ever-varying quantity of moisture. When we pour water into a vessel full of well-packed gravel, and displace the air which is present, we find that it generally forms one third of the total volume of the mass. The porosity of the earth sometimes reaches fifty per cent; and miners and well-diggers accidentally buried under cavings-in have sometimes been known to live for several days by the aid of the air circulating through the earth.

Porous soil does not become impermeable to air till below the level at which the subterranean water ceases to exist. Frozen ground does not lose its porosity by the solidification of the water. Incessant interchanges are taking place between the underground air and the free atmosphere. It is by such means that infiltrations of lighting-gas impregnate the soil of the street, penetrate sewers, and cause ills which are wrongly attributed to typhoid affections; and this is most liable to take place in winter when the rise of gas from the soil is promoted by the draught of the chimneys. Ventilation is thus partly carried on through the floor, to such an extent that the atmosphere of a room sometimes contains from ten to fifteen per cent of air from the ground. Hence the danger from impurities absorbed by the soil. They rise, pitilessly returning from the earth, as if to chastise us for our carelessness. The air included in a garden-soil, and generally in any soil rich in organic matters, always contains a strong proportion of carbonic acid. At the same time the oxygen is in diminished quantity, proving that the carbonic acid proceeds from slow combustions, and not from subterranean emanations. According to the observations of Pettenkofer, Fleck, and Fodor, the proportion of acid increases with the depth, and at a few yards beneath the surface sometimes exceeds ten per cent. This presence of carbonic acid is a sign of the activity of the life in the soil. We do not know the exact manner in which the soil and subsoil intervene in the etiology of endemic diseases and the appearance of epidemics. It is a subject of active controversy. We can, nevertheless, approve the teaching of the hygienists who advise us to render our dwellings independent of the soil-air by making provisions for aëration under the basements, or by making the floors impermeable.

Parks and gardens are beneficial, not only because they give a degree of shade and coolness in hot weather, but also because vegetation absorbs waste matter and purifies the soil, and thus diminishes the liability to epidemics.* It is well, for other reasons, to increase these oases in cities where the air is not directly vitiated. But the quantity of oxygen which the plants disengage is too small to be made an object. The phenomena of vegetation are extremely slow of accomplishment. Vast spaces and a long time are needed to produce the grass and the wood

* We may here take notice of a scheme of M. Autier's for serving the citizens of Paris in their houses with pure air brought through pipes from the forests.

that are consumed in a few hours. Oxygen is absorbed more rapidly than it is set free. We shall also have to give up the prevalent idea that a little verdure can improve the atmosphere of a room. The advantage of plants, as Dr. Pettenkofer remarks, is rather in their moral than in their physical influence. Public gardens are also desirable because they enliven the view. Even on hygienic grounds, we should be careful not to underestimate the importance of whatever acts upon the mind. We have endeavored, in this and a former essay,* to study clothing and the habitation, with particular reference to their relations with the atmosphere; but, even as thus limited, the subject has proved to be a very complex one, and in our progress we have struck upon more than one question that is still imperfectly elucidated. It may, however, not have been without use to attract attention to these questions, which demand new investigations. Hygienic societies are multiplying; departments of hygiene have been created in numerous cities; and the hygienic conferences which have been held at Paris, Turin, and Geneva, attest the growing interest that attaches to the development of a science all of whose conquests redound to our physical and moral profit. Every facility should be given for widening its scope and extending its sphere of action. Diseases that might have been avoided constitute the heaviest taxes that can be laid upon a city.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

A BELT OF SUN-SPOTS.

BY GARRETT P. SERVISS.

EVERYBODY who watched the sun with a telescope last summer must have wondered at the great belt of spots lying across the southern part of the disk during the last half of July. Several of the spots and groups were of extraordinary size, and their arrangement was very singular. When the belt extended completely across the sun, there was visible at one time almost every characteristic form that sun-spots present. There was the yawning black chasm with sharply defined yet ragged edges, vast enough to swallow up the whole earth, with room to spare, and surrounded by a regular penumbral border as evenly shaded as an artist could have made it; there was the double or triple spot whose black centers, though widely separated from one another, were tangled, as it were, in one twisted and torn veil of penumbra, or connected by long, shadowy bands; there was the monstrous spot of grotesque form surrounded by a crowd of smaller spots of even more fantastic shape, and enveloped in a broad, irregular penumbra as *bizarre* and wonderful as the mighty sun-chasms inclosed

* "Popular Science Monthly" for October, 1883, p. 787.

in it ; there was the great spot, often of singular outline, accompanied outside its shadowy borders by one or more swarms of minute black specks pitting the white photosphere in the most extraordinary fashion ; there was the huge group, visible even to the unassisted eye, and consisting of half a dozen or more large spots intermingled with smaller ones whose number seemed to defy counting, and enveloped in a penumbral cloak of becoming amplitude ; there, near the edges of the disk, were the crinkling lines and heaped-up masses of faculæ, the mountainous hydrogen - flames which marked the places where the intensest solar action was going on—in short, there was a panorama in which every variety of sun-spot seemed to be passing in a gigantic procession across the disk. And what a procession it was ! —long enough, nearly, to reach from the earth to the moon and back again three times !

But the most extraordinary feature of this great solar display was the linear arrangement of the spots making a belt, or band, that half encircled the sun ; there was also a noticeable regularity in the distances separating the groups composing this singular belt, and this peculiarity increased the likeness to a procession which must have impressed every observer who beheld the gradual march of the sun-spot army across the

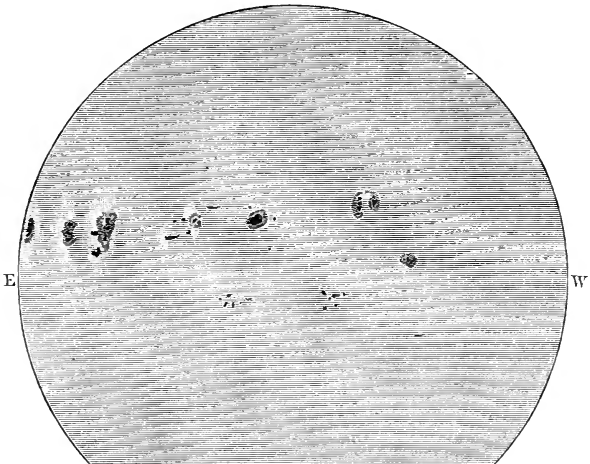

Fig. 1.

solar disk. It was like watching a parade of masqueraders ; each company of spots had its own characteristic and conspicuous make-up, and each kept its place in the line at a nearly invariable distance from the group in front of it and the one that followed.

The separate spots and groups did not, however, present an unvarying appearance. There was change as well as variety in this un-paralleled pageant on the sun. Changes were continually going on in the shape and even the size of the spots, and in the configuration of the different members of the groups—minor evolutions in the ever-advancing column. New spots of small size made their appearance in the neighborhood of larger ones; and in one instance, at least, a perfect swarm of little spots broke out near one of the largest components of the belt, as if the surface of the sun had been suddenly punctured by huge needles.

A very good idea of the appearance of the band of spots, and of their progressive motion from east to west with the revolution of the sun, as well as of the principal changes that took place in their form and arrangement, can be obtained from the series of sketches accompanying this article. The originals of these sketches I made at the time the spots were visible, and they represent with approximate accuracy the appearance of the spots with a magnifying power of sixty-five diameters. They do not, however, by any means show all the details visible with such a power. With higher magnifying powers the crowd of details in some of the larger groups was so great and confusing as to defy the power of the pencil to represent them. Some remarkable phenomena were also observed with the spectroscope dur-

Fig. 2.

ing this sun-spot display. When the huge group, seen near the left-hand edge of the sun in Fig. 2, was just coming around the edge, its approach was announced by an outburst of gas which M. Thollon observed as a small but extremely brilliant protuberance, that exhibited very marked displacement of the C-line toward the violet end of the spectrum. In a communication to the French Academy of Sciences, M. Thollon says that an hour before his observation on the C-line he had observed in the same region a slighter displacement not only of the lines of hydrogen and of the *b*-group but also of the coronal line 1,474. He observed on several days other remarkable spectroscopic phenomena, and noticed that nearly the whole southern half of the sun's disk gave manifest signs of violent agitation. In view of these facts, it seems surprising that little apparent effect was produced upon the earth by these solar outbursts. Two or three times in 1882 the earth responded instantly with magnetic storms and brilliant auroral displays to the solar activity, but this year the great sun-spots and their accompanying phenomena have shown comparatively little power to affect terrestrial magnetism.

Fig. 1 shows the sun as it appeared on the 16th of July, when the advancing procession of spots had reached two thirds of the way across the disk.

Fig. 2 represents the sun on the 20th of July, when the spot belt extended completely across the disk.

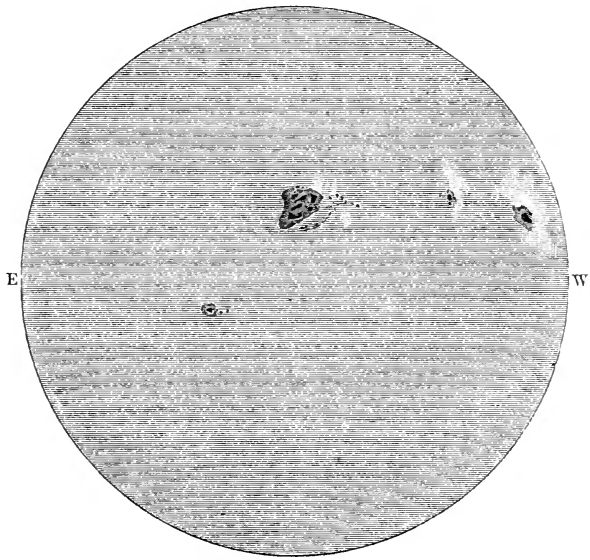

Fig. 3.

Fig. 3 shows the appearance of the sun on the 25th of July, when more than half of the procession had disappeared around the western edge, and the great group bringing up the rear was near the meridian.

In the latter part of August and early in September a row of spots, principally in the southern hemisphere, was again seen upon the sun, but it was shorter, more crooked, and composed of fewer spots and groups, than the great belt of July.

There is one point of view from which the sun-spot belt just described appears particularly interesting, and that relates to the supposed resemblance between the larger planets, and more especially Jupiter, and the sun. Everybody knows that Jupiter has a conspicuous dark-colored belt on each side of his equator, for those belts are one of the commonest objects of celestial sight-seeing. Saturn too has belts similarly situated, although they are less conspicuous than those of Jupiter. All the trustworthy evidence we have points to the conclusion that these huge planets are yet in a state which has more points of resemblance to the condition of a sun than to that of a cool and solid globe. There can be little doubt that Jupiter is surrounded by a cloud-laden atmosphere of great depth, and that his geological development, so to speak, is in a stage much earlier than any whose former existence is recorded in the present rock strata of the earth. In other words, Jupiter probably has not yet a continuous solid crust, even if the formation of such a crust has been begun. But, accepting the nebular hypothesis, we must conclude that Jupiter is gradually cooling and contracting, and that eventually he will have as solid a surface as the earth's. He seems, then, to be in a transition state between a luminous sun and an opaque world, and, if so, his present condition may throw light upon the future condition of the sun, just as the moon throws light upon the future condition of our own earth. For this reason it may be interesting for the reader to compare

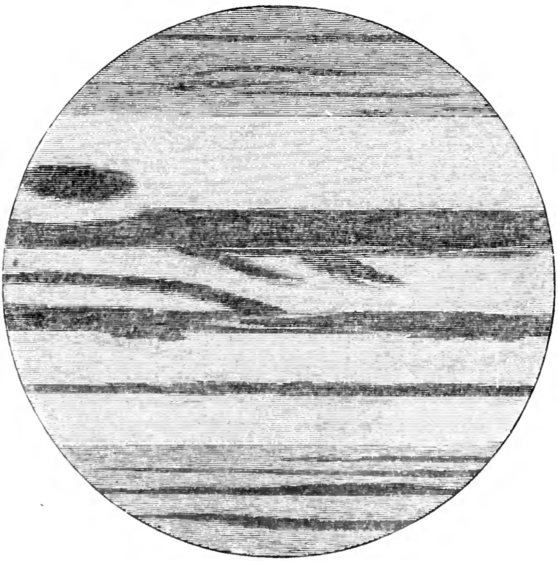

Fig. 4.

with the figures representing the belt of sun-spots seen last summer a picture of Jupiter and his belts, shown in Fig. 4. It is, of course a long step from the string of separate spots in one case to the unbroken bands in the other, and yet it is easily seen that some resemblance exists, which becomes all the more striking if we believe that Jupiter was once a true sun, which has parted with most of its light and heat, and is approaching the condition of a crusted globe. It would only be necessary to increase the number of sun-spots in order to make a continuous belt around the sun, and, when one such belt was formed, it is likely that there would be another to match it on the other side of the equator, for, as is well known, the regions in which the greatest number of sun-spots appear lie on each side of the solar equator, and any general cause which increased the absolute number of sun-spots would proportionally increase the number seen in the two regions of their greatest frequency.

There are other points of resemblance between the sun and Jupiter which add strength to the suggestion that the sun may now be just entering upon a stage which is the precursor of the gradual loss of its light and heat, and of its approach to the present condition of Jupiter. Careful observation has shown that different portions of the sun rotate in different times, the equatorial region moving faster than any other part, and curiously enough the same peculiarity is seen in Jupiter. This fact came out very clearly through the study of the great red spot which made its appearance in the southern hemisphere of the planet in the summer of 1878, and which has only just now faded out of sight. It was found that the red spot lagged behind the equatorial spots, so that the latter made a complete circuit of the planet, with respect to the red spot, in about forty-four and a half days.

It must not be overlooked, however, that belts of sun-spots, no matter how numerous the spots composing them might be, would bear only a superficial resemblance to the belts of Jupiter, for the latter have a cloud-like appearance, while sun-spots are clearly huge chasms in the photosphere. In fact, a continuous band of sun-spots, as such, could not exist. But in view of the close resemblance between the situation of Jupiter's belts with respect to his equator, and that of the zones of sun-spots with respect to the sun's equator, it is easy to conceive that similar causes may be concerned in the production of both phenomena, the effects varying with the difference in condition of the two bodies. One of these causes, which would probably be operative in both cases, is the rotation of the body acting upon its fluid envelope. Even on the earth we have a zone of winds and violent revolving storms produced in the atmosphere on each side of the equator. On Jupiter, in corresponding latitudes, we see the great belts and spots, whose broken and ever-changing aspect indicates the action of tempestuous forces in the deep and dense atmosphere of that planet of a magnitude incomparably greater than anything of the kind upon the earth. On the sun, still in corresponding latitudes, we have the spot-zones wherein rage solar tornadoes and hurricanes, as far exceeding the storms upon Jupiter as the latter exceed those upon the earth. We see, then, that in three members of the solar system—the Earth, Jupiter, and the Sun—representing stages of development separated by vast intervals of time, certain regions north and south of their equators are the scene of violent disturbances in their fluid shells or envelopes. But it will not do to liken these phenomena upon the three different globes too closely to one another, for they unquestionably differ not merely in magnitude but in kind and in mode of operation, and this is specially true as to the earth and the sun. We may speak of a sun-spot as a solar cyclone, but we must not forget that it is very different from our West Indian cyclones or East Indian typhoons. The point is that in each case—that of a solidified globe like the earth, surrounded by a comparatively rare atmosphere ; that of a partially cooled globe, like Jupiter, enveloped in a dense atmosphere of great depth ; and that of a completely gaseous globe like the sun, possessing a sort of shell of partly condensed gases—certain regions near the equator are those in which the greatest disturbance is visible, and in every case, probably, the force of rotation is a powerful factor in the production of these zones of commotion. This shows a sort of survival of the action of certain causes under changed conditions, as a globe proceeds in the process of cooling and condensation from the condition of a sun to that of an unsolidified planet, and so on to the condition of a crusted or solid earth. So, then, we may with some show of reason suggest that the half-belted appearance of the sun last summer was in a certain sense prophetic of its future condition, and that in time its spot-zones will be succeeded by continuous belts resembling those of Jupiter. But no human eye will ever behold the sun thus robbed of his majesty, with his glorious light extinguished by bands of gloomy vapors ; for, long before he could reach such a condition, life would cease in the solar system, from want of his vivifying radiations.

The picture of Jupiter here given possesses some interest in itself, as it is a representation of the planet as it appeared in September, 1879, when the celebrated red spot was a very striking object. The spot is seen at the left hand edge of the disk, just above the great southern belt which is narrowed, or indented, in a very singular way, opposite the spot. The red spot is no longer visible, and as it was, perhaps, the most remarkable marking, except the belts themselves, ever seen upon Jupiter, pictures of it will possess great interest in the future.

THE MORALITY OF HAPPINESS.

BY THOMAS FOSTER.

I. INTRODUCTORY.

IT is known to all who watch the signs of the times—obvious, indeed, to them, and known to many who are less observant—that those moral restraints which claim to be of sacred origin are no longer accepted by a large and increasing number of persons. I have no wish to inquire here whether those restraints should be regarded as of divine origin or not. I note only the fact that by many they are not so regarded. I am not concerned to ask whether it is well or ill that their authority should be rejected, and their controlling influence be diminishing or disappearing among many; it suffices, so far as my present purpose is concerned, that the fact is so. The question then presents itself, Does any rule of conduct promise to have power now or soon among those who have rejected the regulative system formerly prevalent? We need not consider whether such a rule of conduct, necessarily secular in origin, is in itself better or worse than a rule based on commandments regarded as divine. All we have at present to ask is whether such a regulative system is likely to replace the older one with those over whom that older law no longer has influence.

Here at the outset we find that those who hold extreme views on either side of the questions I have left untouched agree in one view which is, I think, erroneous. On the one hand, those who maintain the divine character of the current creed insist, not only that it is sufficient for all, but that, in the nature of things, no other guide is possible. On the other hand, those who reject the authority of that creed most energetically, assert as positively that no new regulative system, no new controlling agency, is necessary. As Mr. Herbert Spencer has well put it, "both contemplate a vacuum, which one wishes and the other fears." But those who take wiser and more moderate views, who, in the first place, recognize facts as they are, and, in the next, are ready to subordinate their own ideas of what is necessary or best for the ideal man to the necessities of man as he really is, perceive that for the many who no longer value a regulative system which, so far as they are concerned, is decaying, if not dead, another regulative system is essential. Again, to use the words of the great philosopher whose teachings are to be our chief guide in this series of papers, "Few things can happen more disastrous than the decay and death of a regulative system no longer fit" (for those we are considering), "before another and fitter regulative system has grown up to replace it."

My purpose in these papers is to show how rules of conduct may be established on a scientific basis for those who regard the so-called religious basis as unsound.* I shall follow chiefly the teachings of one who has inculcated in their best and purest form the scientific doctrines of morality, and may be regarded as head, if not founder, of that school of philosophy which, on purely scientific grounds, sets HAPPINESS as the test of duty—the measure of moral obligation. To Mr. Herbert Spencer we owe, I take it, the fullest and clearest answer to the melancholy question, "Is Life Worth Living?" whether asked whiningly, as in the feeble lamentations of such folk as Mr. Mallock, or gloomily and sternly, as in the Promethean groans of Carlyle. The doctrine that happiness is to be sought for one's self (but as a duty to others as well as to self), that the happiness of others is to be sought as a duty (to one's self as well as to them)—happiness as a means, happiness as the chief end—such has been the outcome of the much-maligned philosophy of Mr. Herbert Spencer, such has been the lesson resulting from his pursuance of what he himself describes as his "ultimate purpose, lying behind all proximate purposes," that of "finding for the principles of right and wrong, in conduct at large, a scientific basis."

If I can help to bring this noble and beautiful doctrine—for noble and beautiful even those must admit it to be who deny its truth—before the many who regard Herbert Spencer's teachings with fear and trembling, not knowing what they are, I shall be content. But I would advise all, who have time, to read the words of the master himself. Apart from the great doctrines which they convey, they are delightful reading, clear and simple in language, graceful and dignified in tone, almost as worthy to be studied as examples of force and clearness in exposition as for that which nevertheless constitutes their real value—the pure and beautiful moral doctrines which they offer to those over whom current creeds have lost their influence.

Let me hope that none will be deterred from following this study, by the inviting aspect of the moral rules advanced by the great modern teacher—even as in past times men were anxious, or even angry, when another teacher showed more consideration for human weaknesses than had seemed right to the men of older times. I will not ask here whether doctrines of repellent aspect are likely to be more desirable than those which are more benignantly advanced. It suffices that with many the former now exert no influence, whether they should do so or not. So that, as far as these (for whom I am chiefly writing) are concerned, all must admit the truth of what Mr. Spencer says respecting the benefits to be derived from presenting moral rule under that attractive aspect which it has when undisturbed by superstition and asceticism. To close these introductory remarks by a quotation from the charming pages of his "Data of Ethics":

* I say "so-called," referring rather to the *word* "religious" than to any question concerning the divine origin of current creeds. Strictly speaking, the word religious may be as correctly applied to moral rules based on scientific considerations as to those formulated in company with any of the diverse creeds prevailing among men.

"If a father, sternly enforcing numerous commands, some needful and some needless, adds to his severe control a behavior wholly unsympathetic—if his children have to take their pleasures by stealth, or, when timidly looking up from their play, ever meet a cold glance, or more frequently a frown, his government will inevitably be disliked, if not hated; and the aim will be to evade it as much as possible. Contrariwise, a father who, equally firm in maintaining restraints needful for the well-being of his children, or the well-being of other persons, not only avoids needless restraints, but, giving his sanction to all legitimate gratifications, and providing the means for them, looks on at their gambols with an approving smile, can scarcely fail to gain an influence which, no less efficient for the time being, will also be permanently efficient. The controls of such two fathers symbolize the controls of morality as it is and morality as it should be."

II. CONDUCT AND DUTY.*

Morality relates to those parts of our conduct of which it can be said that they are right or wrong. Under the general subject conduct, then, morality is included as a part. On regarding the word "duty" as implying all that we ought to do and all that we ought to avoid, we may say that duty is a part of conduct. All actions which are not purposeless may be regarded as included under the word "conduct," as well as some which, though purposeless at the time, result from actions originally done with purpose until a fixed habit had been acquired. But only those actions which we consider good or bad are referred to when we speak of duty; and the principles of what we call morality relate only to these.

Here, however, we have already recognized a connection between duty and conduct generally, which should show all who are familiar with scientific methods that morality can not properly be discussed in its scientific aspect without discussing conduct at large. Every student of science knows that, rightly to consider a part, he must consider the whole to which it belongs. In every department of science this general law holds, though it is not always recognized. No scientific subject has ever been properly dealt with until it has been

* I remind the reader that in these papers, as stated in the introductory one, I am following the lines along which Mr. Herbert Spencer has already traced the general doctrine of the morality of happiness. Where his reasoning seems open to objection or too recondite to be quite readily followed, I shall indicate such objections, and my own opinion respecting them, or endeavor to remove such difficulties; but the moral doctrine I am here dealing with is that of which he has been the chief teacher, if he may not be regarded as its only founder. Even if the scientific study of ethics, on principles analogous to those which have made astronomy, geology, and more recently biology, true sciences, has been taken up by others and pursued till new truths have been recognized and perhaps some errors pointed out in his treatment of it, it remains still true that he was the first to indicate the true scientific method, and to show where hitherto it had been departed from even by the founders of the school of philosophy to which he belongs.

considered in its relations to its surroundings as well as separately. Even in matters not usually considered from a scientific stand-point the same law holds. To go no further than our own pages, the writer who is dealing with the question "How to get strong?" would not consider how the arms are to be strengthened without duly considering that the arms are part of the body, their exercise related to the exercise of other portions, their development associated with the development of other limbs, with the action of other parts of the body, with the regimen proper for the whole frame.

It may not by many be regarded as a *fault* of most systems of morality that they overlook the necessary connection between conduct in general and conduct as guided by moral considerations. For many are content to regard moral laws as existing apart from any of the results of experience—whether derived from individual conduct, the conduct of men generally, or conduct as seen among creatures of all orders. With many, morality is looked upon as a whole—the whole duty of man—not as a part of conduct. They even consider that moral obligations must be weakened when their dependence on conduct in general is insisted upon. Moral rules, with them, are right in themselves and of necessity—and whether inculcated by extra-human authority, or enjoined by law, or perceived intuitively, are open neither to inquiry nor objection. Clearly if this were so, morality would not be a fitting subject for the scientific method. Its rules would be determinable apart from the discussion of evidence based on experience, whether observational or experimental. I do not here inquire whether this view is right or wrong. Later on it will fall into my plan to do so. At present I only note that we are considering our subject from the stand-point of those who desire to view morality in its scientific aspect. For them it is essential that, as conduct in general includes conduct depending on duty, the discussion of questions of duty can not be complete or satisfactory unless it is conducted with due reference to the whole of which this subject forms a part.

If any doubt could exist in the mind of the student on this point, it should be removed when he notes that it is impossible to draw any sharply defined line between duty and the rest of conduct not depending on considerations of duty. Not only are those actions which under particular circumstances seem absolutely indifferent found under other circumstances to be right or wrong and *not* indifferent, not only do different persons form different ideas as to what part of conduct is indifferent or otherwise, but one and the same person in different parts of his life finds that he draws different distinctions between conduct in general and conduct to be guided by moral considerations. In the evolution of conduct in a nation, in a town, in a family, or in the individual man, the line separating conduct regarded as indifferent from conduct regarded as right or wrong is ever varying in position—sometimes tending to include among actions indifferent those which had been judged bad or good, oftener tending to show right or wrong in conduct which had been judged indifferent.

If moral laws, then, are to be established on a scientific basis, it is essential that conduct at large should be carefully considered ; and not conduct only as it is seen in man, but as it is seen in animals of every grade. Thus and thus only can the evolution of conduct be rightly studied ; by the study of the evolution of conduct only can the scientific distinction between right and wrong be recognized ; from and out of this distinction only can moral laws be established for those with whom the authoritative enunciation of such laws has no longer the weight it once had, those who find no other inherent force in moral statutes than they derive as resulting from experience, and who reject as unreasonable all belief in the intuitive recognition of laws of morality.

We proceed, then, to consider the evolution of conduct in the various types of animal life, from the lowest upward to man.—*Knowledge.*

GENIUS AND HEREDITY.

By M. E. CARO,

OF THE INSTITUTE OF FRANCE.

IT has been shown by the researches of Galton, Ribot, and others, that a law of heredity exists, and is applicable to our psychological qualities. Without attempting to deny the operation of this law, it is our intention here, believing that its scope has been considerably magnified, to endeavor to determine its limits in particular directions. With this object, we shall confine our inquiry to two points : Is it according to a good philosophical method to explain by heredity alone all the most complex, most delicate, and most considerable phenomena of human life, when we can, with at least as much probability, bring in other causes which, though they have been much neglected, are very perceptible and even more directly observable ? And is it true, as is assumed, that all the exceptions to the law of heredity, even in the intellectual and moral order, are only apparent ? We shall speak first of those curious facts concerning intellectual heredity, some of which, and those the most extraordinary ones, can not be accounted for by any assignable cause. Other facts in the category can equally well, perhaps better than by heredity, be explained by reference to the medium, to education, to habit, to the moral and intellectual atmosphere in which the child lives, to the force of the influences to which it is subject, and to the examples that are set before it. We acknowledge that the medium can not afford an explanation of genius and can not create superior faculties ; but it furnishes the opportunity for their manifestation, and reveals them where they exist. How many noble and high minds have been extinguished by unfavorable cricumstances and hostile mediums! What an important part, on the other hand, may have been played in the expansion of superior minds in certain favored families, by the influence of examples of the most delicate methods of investigation in questions of the natural sciences, by habituation to rigorous methods in the exact sciences! Who could in such cases separate what, in the working of such different influences, is attributable to education and what to heredity?

We must first leave out of the consideration genius, properly so called, which can not be included in any determinate category. At this point we meet the error which has vitiated Mr. Galton's whole work, and which is curiously illustrated in the title itself of his book, "Hereditary Genius." Genius is of all things not a phenomenon of heredity. It is precisely in what is extraordinary and exceptional in it—that is, in its essential quality—that genius escapes all our formulas. It is pre-eminently the abnormal phenomenon, the one that we can not reduce to its elements, or put into a classification, an irreducible formula, the resolution of which recognizes no law within the compass of human knowledge. At this point, certainly, Mr. Galton's lists betray their poverty; and he tries in vain to connect the lines of artists and scientific men with the illustrious genius who all at once bursts out from among them. Even in the musical family of the Bachs, which was distinguished for eight generations and through two centuries, we may count up all the examples of the special musical talent which appeared again and again in each generation; we may review all those gifted persons, the organists, the choir-singers, the choir-leaders, the city musicians, whether they be ancestors, sons, or grandsons; but we can find only one Sebastian Bach. Whence came that particular impulsion, that soaring force, that carried him to the very summit of inspiration? Why is it that he alone of the whole family could compose that marvelous series of preludes, fugues, and oratorios which stand as isolated monuments in the history of the great art? Why were none of the others like him? Mr. Galton's tables do not give us the key to this mystery; they simply reveal a transmission of the musical faculty, a community of aptitudes among the members of this family. But that which was not common to him with the others, that which made Sebastian Bach, is the thing we want explained, and it is precisely this that heredity does not explain. The aptitudes were transmitted like a patrimony, but the grand phenomenon of genius was the property of only one, and was produced but once. It is, then, outside of heredity, for it is unique. The same thoughts might be applied to Beethoven, and with still more force, for the only musical examples in his line were those of his father and grandfather, chapel-masters. Similar instances are abundant. We might cite, among the painters, Raphael, whose father, and Titian, whose sons and brother, were respectable but not illustrious artists. Among great men of science what real relation can exist, in the order of skill and genius, between Aristotle and his father Nicomachus, court-physician, of whom we hardly know anything; or between Galileo and his father Vicenzo, who wrote on the theory of music; or between Leibnitz and his father, law-professor at Leipsic? In fact, only a single example can be opposed to our criticism, that of the family of the Bernouillis, which was celebrated for the number of mathematicians and physicists whom it produced through several generations. Yet here we have to take notice of the fact that only one of the family, John, was rated by his contemporaries alongside of Newton and Leibnitz on account of his brilliant mathematical discoveries. The others were very distinguished men, but that is a different thing. The genius stands apart.

Still, we can say that in these three orders of the creative art there is something hereditary—not genius, indeed, but a kind of necessary apprenticeship, or perhaps a physiological and mental aptitude tending to determine to certain vocations. In this way we can understand why we meet so many musicians, or painters, or men of science, in the same family. In the case of the painters, for example, there is something that inspiration can not do without, there are a number of primary gifts and technical properties in design or color which are easily transmitted by example and imitation in the father's studio, and are distributed as a common patrimony among the children. Only one of the family will rise to the first rank; but this initiation into his art is indispensable to him as a matter of economy of time and labor, and also to give greater freedom to his inspiration. Macaulay has well said that Homer could never have made himself known to us in the language of a savage tribe, and that Phidias could never have carved his Minerva out of a log with a fish-bone. It is necessary to take account of these favorable circumstances, which in some families help to overcome the first difficulties of the art, and furnish the future genius with convenient instrumentalities with which he can make himself familiar and skillful from his earliest childhood. So the taste for music—that is, an aptitude for measuring time and distinguishing notes—is innate with many children, and is often derived from the father, mother, or other ancestors. If both parents are musicians, all the children will generally have a correct ear; if only one of them is a musician, some of the children may have the taste, while others may not. Likewise, a facility in quickly grasping and handling numerical or algebraic values is indispensable to the operations of the mathematician, and may be remarked as a peculiar gift in certain families, among whom may some time arise one illustrious in the science. These conditions are not essentials of genius, but they are useful to it in helping it to disengage and reveal itself. They are, as it were, the alphabet of his art to the composer, mathematician, or painter; and it is not without advantage that the art has, by means of the example and traditions of the family, become a kind of instinct for the future great man. This explains how it is that great painters, mathematicians, or musicians, are so frequently produced in families in which the practice of those arts and sciences is familiar. The same aptitude may be shared by several members of the family, who will remain in the secondary rank, while a single one rises above them all. It is the aptitude, not genius, that is hereditary, while Mr. Galton has constantly confounded the two. In the other orders of invention, as in poetry and eloquence, there is nothing inconsistent with a solitary instance of genius being produced in a family that does not seem to have been prepared for it. The preparatory training, the special aptitude, are less necessary in them. It is enough if the national language has reached a degree of clearness and vigor in which it can give perfect expression. Generally, the great writer blossoms out alone. He seems to appear, an unexpected phenomenon, in a succession of modest generations, the uniform course of which he breaks at a blow. Sometimes similar aptitudes may be found among other members of the family, but the fact is without significance or consequences. Bossuet, Pascal, Molière, Voltaire, Jean Jacques Rousseau, Byron, and Goethe, however we may try to account for them, can not be explained by heredity. They are the first and the last in the families that produced them, without any visible transmission of superior gifts. Going back in history, but still keeping to modern times, are not Dante, Milton, and Shakespeare also solitary great ones, who can not be satisfactorily accounted for, either by organic evolution, the intellectual medium, or generation? All those external conditions of genius that have been so often analyzed and described may have prepared for the event and primed for the occasion. The last turn was still wanting, the supreme gift that should be decisive over all the rest, and bring it about that among so many heads in the same family or the same nation, equally predestined by the same concurrence of circumstances, one only should have been chosen, and that the light should have shone upon that elect head only; and we may keep on asking, Why on that head, and not on another? No, to this day the great gift of inspiration in science, poetry, and art has not revealed its secret. Those sovereign minds, precisely by what they possess that is incommunicable, rise high and alone above the flood of generations which precede and follow them, and by reason of this superior side of their nature they do not belong to nature. Those exalted originals in mind who tower above mankind have no fathers and leave no sons in the blood. Notwithstanding Mr. Galton, the least hereditary thing in the world is genius.

M. de Candolle* appears to us to have exactly analyzed the origin and conditions of the kind of mental heredity in a slighter degree that we might represent by the words talent, vocation, and aptitude. While he does not deny the influence of heredity in the development of vocations, especially of scientific vocations, which are the special object of his study, he does not declare it exclusive and decisive. After ma-

* "Histoire des Sciences et des Savants depuis Deux Siècles."

ture examination, he does not believe that there is any special heredity for a particular science, but only admits a transmission of the elementary faculties in a condition of harmony and vigor agreeable to a sound mind. This precious heritage may be applied in several very different ways. A person who has received from his parents a certain degree and a favorable combination of the faculties of attention, memory, judgment, and will, is not destined to be condemned by a kind of fatal heritage to any special kind of work. Generally, a reflexive choice, or the rule of circumstances, rather than a special heredity, determines the use that is made of these faculties; its particular direction is decided by the medium and the family; and the success of the effort is determined by the energetic application of the will. A reservation should doubtless be made in the case of a determined taste for a certain career imposing itself upon a young man when he enters into life; but the facts that such tastes and inclinations are often opposed to paternal habits, and that they may be very different as between brothers, are proofs that they are not hereditary; they are often the products of an active imagination called forth by certain attractions, which it has forged for itself, or of notions suggested by some conversation or some entertaining lecture. Much room, then, is left for circumstances and liberty in the employment of the faculties which one has received. "The man endowed with marked traits of perseverance, attention, and judgment, with no considerable defect in his other faculties, will become a jurist, historian, scholar, chemist, geologist, or physician, according as his will is influenced by a host of circumstances. In each of these occupations he will advance in proportion to his strength, his zeal, and the concentration of his energy upon a single specialty. I have little faith in the necessity of innate and imperious vocations for particular objects. This is not to deny the influence of heredity, but to reduce it to something very general, compatible with the liberty of the individual, and susceptible of being inclined or modified according to ulterior influences, the action of which increases as the child becomes a man." Moreover, even when mental heredity seems to have been effectual, it may be regarded as working in the line of the grand categories of faculties, rather than of special faculties. Thus, it is not uncommon to find two brothers, or father and son, celebrated, one in the natural sciences, the other in historical and social sciences: as, for instance, the two Humboldts; Oersted and his brother the jurist; Hugo de Mohl, the botanist, and his brother Jules de Mohl, the Orientalist; Madame Necker, daughter of the geologist De Saussure; Ampère, scholar and literary man, son of a physicist. If there were a special heredity guiding to a particular science, these examples would be inexplicable, while they are quite natural under the supposition of a transmission of general faculties applicable to all sciences having analogous methods.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

ENTERIC DISORDERS.

ABOUT a century before the birth of the Emperor Augustus, the most popular physician in Rome was the Grecian philosopher Asclepiades. His system seems to have resembled that of our "movement-cure" doctors. Instead of being stuffed with drugs, his patients were invited to his *palæstra*, a sort of out-door gymnasium or hygienic garden, where they were doctored with gymnastics, wholesome comestibles, and, as some writers assert, with flattery—probably courteous attention to the jeremiads of crapulent senators. At all events, his method proved eminently successful, though we need not doubt that all respectable druggists retailed *canards* about his establishment. He had devised a special course of gymnastics for every disorder of the human organism, and repeatedly declared that he would utterly renounce the claim to the title of a physician if he should ever be sick for a single day. Medicines he rejected on the ground that *they accomplish by violent means what the palæstra-method would effect in an easier way.*

Still, in certain cases, a short, sharp remedy might be preferable to an easy-going one, but unfortunately there is a more serious objection to the use of drugs, viz., the danger of complicating instead of curing the disease. For—1. The diagnosis may fail to establish the true cause of the disorder. No watch-maker would undertake to explain the irregularities of a timepiece by merely listening to a description of the symptoms, and before he can trace the effect to its cause he must minutely inspect the interior mechanism. But a physician is not only generally obliged to content himself with the evidence of the external symptoms, but he has to deal with an apparatus so infinitely more complex than the most intricate chronometer, that, even under normal circumstances, the process of its plainest functions has never been fully explained.*

2. We risk to mistake the suppression of the symptoms for the suppression of the disease. We would try in vain to subdue a conflagration by demolishing the fire-bells, but on exactly the same principle the mediæval drug-mongers attempted to restore the health of their

* "Every organic process is a miracle, that is, in every essential sense an unexplained phenomenon."—LORENZ OKEN.

"He obstinately refused to take medicine. "Doctor," said he, "no physicking. Do not counteract the living principle. Let it alone; leave it the liberty of defending itself; it will do better than your drugs. The watch-maker can not open it, and must, in handling it, grope his way blindfold and at random. For once that he assists and relieves, by dint of torturing it with crooked instruments, he injures it ten times, and at last destroys it."—(Scott's "Life of Napoleon," p. 368.)

patients by attacking the outward symptoms of the disorder. Habitual overeating produced a sick-headache: they applied a blister to the head. Impure blood covered the neck with ulcers: they applied a salve to the neck. The alcohol-vice resulted in a rheumatic affection of the knee-joint: they covered the knee-pan with leeches. They suppressed the alarm-signals of the disease, but, before the patient could really recover, his constitution had to overcome both the malady and the medicine.

3. We risk to confound an appeal for rest with an appeal for active interference, and thus to turn a transient and necessary suspension of an organic function into an actual disease. Numerous *enteric disorders*, or bowel-complaints, are thus artificially developed. The marvelous self-regulating principle of the human organism now and then limits the activity of special organic functions, in order to defray an unusual expenditure of vital energy. The after-dinner lassitude can thus be explained: the process of digestion engrosses the energies of the system. Mental labor retards digestion; a strenuous muscular effort often suspends it entirely for hours together. Fevers, wounds, etc., have an astringent tendency: the potential resources of the organism are engaged in a process of reconstruction. Perspiration is Nature's effort to counteract the influence of an excessive degree of heat, and, when the effect of sun-heat is aggravated by calorific food and superfluous clothing, the work of reducing the temperature of the blood almost monopolizes the energies of the system, while at the same time the diminished demand for animal caloric lessens the influence of a chief stimulus of organic activity. Warm weather, therefore, indisposes to active exercise, and produces a (temporary) tendency to costiveness. That tendency is neither abnormal nor morbid, and to counteract it by dint of drastic drugs means to create, instead of curing, a disease. If a foot-messenger stops at the wayside to tie his shoe-strings, the time thus employed is not wasted. The sudden application of a horsewhip would force him to take as suddenly to his heels, but during his flight he might lose his way, and perhaps his shoes.

With a few exceptions, which we shall presently notice, *chronic constipation* results from the abuse of aperient medicines. A spell of dry, warm weather, sedentary work in an overheated room, a change from summer to winter diet—perhaps a mere temporary abstinence from a wonted dish of aperient food—has diminished the stools of an otherwise healthy child. The simultaneous want of appetite yields to a short fast, but the stringency of the bowels continues, and on the third day the parents administer a laxative. That for the next twenty-four hours the patient feels considerably worse than before does not shake their faith in the value of the drug; the main purpose has been attained—the "bowels move." Properly speaking, that movement is an abnormal convulsion, a reaction against the obtrusion of a drastic poison, which has "cured" the stringency of the bowels as a shower-bath of vitriol would cure the drowsiness of a tired man. An imaginary evil has yielded to a real evil, and, what is worse, becomes itself soon real enough to confirm the opinion of the drug-worshipers that the patient must be "put under a course of corrective tonics." For very soon the unnatural irritation is followed by an abnormal lassitude, a digestive torpor, attended with symptoms of distress that plainly distinguish it from the original remissness of the bowels. In the eyes of the drug-dupes, however, it is nothing but a relapse of the former complaint, and must be combated with more effective remedies. "Treacle and brimstone, thrice a day," was the verdict of the mediæval Æsculap. "The timely use of our incomparable invigorant will regulate the action of the bowels and impart a generous and speedy impulse to the organic functions of the whole body," says the inventor of the new patent "liver-regulator"—a new combination of "valuable herbs" with the usual basis of alcohol. "A wineglassful every morning." The herbs prove their value by enabling the vender to accommodate his customers on Sunday morning, when common dram-shops are closed, and with an equal disregard of times and seasons the alcoholic principle opens the bowels. The incomparable stimulant admits no such excuses as fatigue or warm weather; the charm works; the regular attacks of a life-endangering poison have to be as regularly repelled. Other symptoms, such as troubled dreams, fretfulness, heart-burn and irregular pulse, seem, indeed, to indicate the approach of a new disease, but that will be met by other drugs, and in the mean while the liver-cure is continued. After the lapse of a few months the patient gets possibly a chance to escape his doom; out-door exercise, the excitement of a pleasant journey, a new residence, a change of diet, encourage the hope that the bowels may be left to their own resources, and the "tonic" is provisionally discontinued. An exceptionally strong constitution may really be able to overcome the after-effects of the drug-disease (for from beginning to end it has been nothing but that), but in a great plurality of cases the event proves that the stimulant has fastened upon the system: constipation, in an aggravated form, returns, and can now be relieved only by the wonted means—"a fact," as the orthodox drug-doctor would not fail to observe, "which should convince idealists that now and then Nature can really not dispense with a little assistance." *

* Two generations ago the abuse of purgative drugs was carried to a degree which undoubtedly shortened the average longevity of many families. Thousands of parents made it a rule (which still has its advocates) to dose their children at the end of every month; and Wieland's practical philosopher not only prescribes a laxative for every fit of ill humor, but answers the sentimental tirades of his wife by sentencing her to a prompt enema:

"Brummt mein Engel wie ein Bär,
'Lise,' sprech ich, 'musst purgiren,'
Rufe dann den Bader her,
Lasse sie recht durch-klystiren."

That assistance has made the fortune of numerous nostrum-mongers and helped our made-dishes to wreck the health of many millions. For, without the interference of a positive poison, dietetic abuses have to be carried to a monstrous excess before they will result in chronic constipation. A slight stringency of the bowels is often simply a transient lassitude of the system, and may be safely left to the remedial resources of Nature. After the third day, however, the disorder demands a change of regimen. A chief objection to our system of cookery is the hygienic tendency of the *essence-mania*, the concentration of nutritive elements. Ours is an age of extracts. We have moral extracts in the form of Bible-House pamphlets ; language-extracts in the form of compendious grammars ; exercise-extracts under the name of gymnastic curriculums ; air-extracts in the shape of oxygen-bladders, and a vast deal of such food-concentrations as Liebig's soup, fruit-jellies, condensed milk, flavoring extracts, and branless flour. But, somehow or other, the old plan seems, after all, the best. In the homes of our forefathers morals were taught by example, and with very respectable results. Six years of grammar-drill in a dead language do not further a student as much as six months of conversation in a living tongue—the concrete beats the abstract. Boat-racing, wood-chopping, and mountain-climbing, are healthier, as well as more pleasant, than gymnastic crank-work ; the diverting incidents of out-door sports which the movement-cure doctor tries to eliminate are the very things that give interest and life to exercise. And, for some reasons (not easy to define without the help of such analogies), concentrated nourishment does not agree with the nature of the human organism. The lungs find it easier to derive their oxygen from woodland air than from a ready-made extract, and the stomach, on the whole, prefers to get its nourishment in the form for which its organism was originally adapted. *Want of bulk* makes our food so indigestible. In fruits and berries—probably the staple diet of our instinct-taught ancestors—the percentage of nutritive elements is rather small, but the residue should not be called worthless, since it serves to make the whole more digestible. A large, ripe watermelon contains about three ounces of saccharine elements, which in that combination have a mildly aperient effect, while in the form of glucose-candy they would produce constipation, heartburn, and flatulence. The coarsest bran-bread is the most digestible, and to the palate of an unprejudiced child also far more attractive than the smooth but chalky and insipid starch preparations called baker's bread. Graham-bread and milk, whortleberries, rice-pudding, and stewed prunes, once or twice a week, generally keep the bowels in tolerable order, provided that the general mode of life does not prevent the influence of the natural peptic stimulants. But even in a case of obstinate costiveness few people would resort to drugs after trying the effects of a *legumen-diet*. Beans do not agree with some persons (though the Pythagorean interdict has no hygienic significance), but one of the three legumens—*beans*, *peas*, and *lentils*—is pretty sure to suit every constitution, and as bowel-regulators their value can hardly be overrated. Taken like medicine at regular intervals of eight hours, and in doses of about a pint and a half, the third or fourth meal of pea-soup (boiled in soft water and flavored with butter and a pinch of chopped onions) will prove as effective as a moderate medicinal aperient; but, while the effect even of a mild cathartic is followed by an astringent reaction, the relief obtained by an aperient regimen is permanent, unless that effect is persistently counteracted by the original cause of the disorder. Fruit, fresh or stewed, ripe grapes, or tamarind-jelly, and frequent draughts of pure cold water, will insure the efficacy of the remedy.

Besides an astringent diet, the chief predisposing causes of constipation are: *warm weather*, *overheated rooms*, *want of exercise*, *sedentary occupations*, *tight garments*, the after-effects of *drastic drugs*, of *malarial fevers*, and sometimes of *self-abuse*. *Parturition* is frequently followed by a protracted period of close stools. In the most obstinate cases of constipation *clysters* are preferable to cathartics, for the reason that the former reach the special seat of the disease, viz., the lower part of the rectum, while the latter begin their work by convulsing the stomach, and, by irritating its sensitive membrane, disqualify it for the proper performance of its function. But injections, even of the simplest kind, should be used only as the last resort, after all the following remedies have proved ineffective:

Mastication.—Thoroughly masticate and insalivate each morsel of solid food. Eat slowly; do not soak your bread, etc., to facilitate deglutition, but let the saliva perform that business. The stomach of bilious dyspeptics often rejects a stirabout of bread and milk, but accepts the ingredients in a separate form.

Passive Exercise.—Kneading the abdomen, or riding on horseback or in a jolting cart, often affords relief by dislodging the obdurated obstructions of the lower intestines.

Cold sponge-baths excite a peristaltic movement of the colon, and often induce a direct evacuation.

Air-baths have an analogous effect, and in summer the bed should be removed to the airiest room in the house. After the stools have become more regular, exhausting fatigues (in warm weather especially) should be carefully avoided. The advent of winter greatly lessens the danger of a relapse. Frost is a peptic stimulant, and after October the cold ablutions can be gradually discontinued. Fresh air, an occasional sleigh-ride, or an excursion on a rumbling freight-train, will do the rest; and the cure is complete if, during the next warm season, the digestive organs perform their proper functions without the aid of artificial stimulants. The remedies for bilious constipation have been mentioned in the chapter on "Dyspepsia," but I will here repeat the chief rule for the cure of chronic indigestion: "Never eat till you have leisure to digest." Avoid after-dinner work ; break through every rule of conventional customs, and postpone the principal meal to the end of the day, rather than let the marasmus of the digestive organs reach a degree that calls for a change of climate and occupation, as the only alternative of a total collapse. Open your bedroom-windows, take a liberal dose of fresh spring-water with the last meal, and an air-bath before going to bed, and the result will convince you that night is *not* an unpropitious time for digestion.

Unlike constipation, *diarrhœa,* even in its transient phases, is always a morbid symptom, and a proof that either the quality or the excessive quantity of the ingested food calls for abnormal means of evacuation. For the incipient stages of the disorder the great specific is *fasting.* Denutrition, or the temporary deprivation of food, exercises an astringent influence, as part of its general *conservative* effect. The organism, stinted in the supply of its vital resources, soon begins to curtail its current expenditure. The movements of the respiratory process decrease ; the temperature of the body sinks, the secretion of bile and uric acid is diminished, and before long the retrenchments of the assimilative process react on the functions of the intestinal organs ; the colon contracts, and the smaller intestines retain all but the most irritating ingesta.*

When that remedy fails, the presumption is that either some virulent substance resists the eliminative efforts of Nature, or else that, in spite of the diminished sources of supply, the accumulated alimentary material still exceeds the needs of the organism. In the latter case, unless a continuation of the fast should seem preferable, the waste can be stopped by *active exercise.* After a hard day's work a man can assimilate a quantum of food that would afflict an idler with grievous crapulence. The Kamtchatka savage has earned the right to digest the flesh of the brute which he has slain in a rough-and-tumble combat. The stomach of the negro does not reject the fruit which he has plucked from the top branches of a tall forest-tree. Loose bowels become retentive if Epicurus has chopped his own wood and fetched his own cooking-water. But the best of all astringent exercises is a *pedestrian excursion.* A liberal supply of green fruit has a laxative tendency. A campaign in an orchard country costs the invaders a good deal of laudanum ; in midsummer some forty per cent of the rank and file are generally on the sick-list with diarrhœa. But the first forced march stops such symptoms. Laxatives and pedestrianism are what lecturers on materia medica call "incompatibles." By a combination of foot-journeys and abstinence even a malignant case of chronic diar-

* A persistent *hunger-cure* will eliminate even an active virus by a gradual molecular catalysis and displacement of the inorganic elements. The Arabs cure syphilis by quarantines *à la Tanner ;* and Dr. C. E. Page mentions the case of a far-gone consumptive who starved the tubercles out of his system. Aneurisms (internal tumors) have been cured by similar means.

rhœa can soon be brought under control, though the debility of the patient should limit his first excursions to the precincts of his bedroom. Care should, however, be taken not to abuse the partially restored vigor of the digestive organs, especially *during the period of deficient appetite* that often follows a colliquative condition of the bowels. Progressive doses of out-door exercise will gradually overcome that apathy, and, when the stomach volunteers to announce the need of nourishment, it can be relied upon to find ways and means to utilize it.

But the problem of a complete cure becomes more complicated if the bowels have been tortured with astringent drugs. Diarrhœa itself is an asthenic condition, indicating a deficiency of vital strength, yet nearly every health-exhausting poison of the vegetable and mineral kingdom has been employed to paralyze the activity and, as it were, silence the protest of the rebellious organs. Bismuth, arsenic, calomel, opium, mercury, nux vomica, zinc salts, acetate of lead, and nitrate of silver, are among the gentle "aids to Nature" that have been employed to control the revolt of the mutinous bowels. An attempt to control a fit of vomiting by choking the neck of the patient would be an analogous mistake. The prescription operates as long as the vitality of the bowels is absolutely paralyzed by the virulence of the drug, but the first return of functional energy will be used to eject the poison. That new protest is silenced by the same argument; for a while the exhaustion of the whole system is mistaken for a sign of submission, till a fresh revolt calls for a repetition of the coercive measures. In the mean time the organism suffers under a compound system of starvation; the humors are surcharged with virulent matter, the whole digestive apparatus withdraws its aid from the needs of the vital economy, and the flame of life feeds on the store of tissue; the patient wastes more rapidly than an un-poisoned person would on an air-and-water diet. In garrets, where the last piece of furniture had been sold to defray the costs of a direful nostrum, I have more than once seen victims of astringent poisons in a state of misery which human beings can reach by no other road: worn out, corpse-colored, emaciated wretches, with that look of listless despair which the eyes of a dying beast sometimes assume on the brink of Nirvana. The first condition of recovery is the peremptory *abolition of the poison-outrage.* For the first three days prescribe nothing but *sweetened rice-water*, and only tablespoonful doses of that; give the stomach a sorely-needed chance of rest. On the fourth and fifth day add a few drops of *milk*, and toward the end of the week inspissate the broth to the consistency of gruel. There are persons with whom milk disagrees in all its forms; for such prepare a surrogate of *whipped eggs* with sugar and warm water—a tablespoonful every half-hour. Do not hope that the stomach of a far-gone drug-martyr will at once tolerate even such feather-weight burdens; it will not repel them with the spasmodic violence that characterized its reactions against a virulent nostrum, but it will often protest its disability to retain the whole quantum. A small but increasing percentage will be assimilated, and, if the corresponding enlargement of the rations is not overdone, the patient, at the end of the third or fourth week, may be rewarded by the return of something like positive appetite, i. e., a craving for more solid food. Try a slice of rice-pudding and fruit-jelly, or a homœopathic dose of blanc-mange. Try a soft-boiled egg or a baked apple. Eschew cordials. Avoid food-extracts, even strong beef-tea, which for a person in such circumstances is a stimulant rather than a nourishment. In the mean time watch the weather, and on the first clear day screen the lower windows, open the upper sashes, and treat the patient to a *sun-bath.* Sunlight, applied for half an hour to the bare skin, is a better tonic than cold water, which invigorates a healthy man, but exhausts an asthenic invalid. In the form of *tepid sponge-baths,* however, water should be applied as soon as the patient can bear the fatigue of keeping on his legs for a couple of minutes. The first decided gain in strength employ in the preparatory exercises of *pedestrianism.* Carpet the room, clear a track for a circular walk, provide supports at proper intervals, a small table in one corner, a chair or a curtain-strap in the other. Interest the patient in his progressive achievements, keep a record-book, procure a boxful of chips and tally off each round. Three miles a day mark the time when the sanitarium can be transferred to the out-door world. In a vineyard country devote the vintage season to a three weeks' *grape-cure.* The cure consists in dining on bucketfuls of ripe grapes and transparent slices of wheat bread. Grape-breakfasts, grape-luncheons, and grape-suppers, *ad libitum,* but no bread, nor anything else that could interfere with the system-renovating effect of the sweet abstersive, that has been tried with signal success in the treatment of bilious dyspepsia, gout, and cutaneous diseases.* Extreme caution in the use of animal food, acids, and fermented beverages, for the first six months at least, is as necessary as after an attack of *dysentery,* which should be similarly treated, except that a more rapid recovery of strength will permit a speedier return to out-door and active exercise.

Colic can generally be traced to the presence of fermenting fluids, and is the penalty of excessive indulgence in such beverages as mush, new beer, fresh cider, together with sour milk and watery vegetables, but may in rarer cases indicate the agency of more dangerous substances,

* The grape-cures of Thionville, Staremberg, Meran, Lintz, and the Bergstrasse, near Mannheim, are yearly visited by thousands. In the United States the best facilities might be found at Hammondsport, Flushing, and Iona Island, New York; Salem, Massachusetts; Hagerstown, Maryland; Lebanon, Columbia, and Eagleville, Pennsylvania; Golconda, Illinois; Hermann, Missouri; Cincinnati, Delaware, and Kelly's Island, Ohio. All Southern California is now studded with vineyards, and the *Trauben-kur* of Meran hardly excels the grapes of San Gabriel and Annaheim. Five cents a pound for the ripest bunches is the average price on Kelly's Island; in California from two to three cents a pound; in larger quantities perhaps even less.

drastic mineral acids, putrefactive and zymotic poisons, noxious gases, etc. Rest and warm bandages are the best remedies. The antidotes of *corrosive poisons* will be named in a separate chapter. The pains of *gastric spasms*, as a consequence of dietetic sins, may be alleviated by manipulation and friction with a moist piece of flannel; in extreme cases, indicating the presence of virulent acids, by means of a stomach-pump. Generally a semi-horizontal position, reclining on the left side, with the upper part of the body slightly raised, together with local friction, will considerably ease the distressed organ, though intermittent griping pangs may continue till the alchemy of the physiological workshop has neutralized the irritating substance. From a kindred affection colic can be distinguished by a simple test: if pressure against the upper part of the groin increases the pain, the complaint is an inflammation of the peritonæum, but otherwise due to the presence cf acid fluids or expansive gases. *Painter's colic* may be recognized by the discoloration of the gums and lips, and can be cured only by the removal of the cause. A napkin, sprinkled with aromatic vinegar, and tied loosely across the nostrils, will, however, lessen the effect of the noxious effluvia; and the Italians recommend the internal use of olive-oil (cotton-seed oil would probably serve the same purpose) and wine. For a few days after a severe attack of colic, pure water should be the only drink.

Flatulence tends to obviate the proximate cause of intestinal cramps. As a concomitant of dyspepsia, it indicates the accumulation of undigested food and the necessity of greater abstemiousness. Burnt magnesia absorbs gastric acids, but at the same time impairs the functional vigor of the stomach too often to be, on the whole, a lesser evil. It is, however, one of the very few chemical remedies which act, temporarily at least, by a direct removal of the proximate cause. Its permanent removal can be effected only by a change of regimen.

In the treatment of *hæmorrhoids*, too, we have to distinguish between palliatives and radical remedies. If the statistics of the complaint could be tabulated, I believe it would be found that its centers of distribution coincide with a prevalence of sedentary occupations, combined with the use of narcotic drinks, especially coffee. Monkeys have posterior callosities, and their habits prove that an occasional sitting posture is normal to the primates of the animal kingdom. But, in a state of nature at least, our arboreal relatives are too restless to avail themselves of their sitting facilities oftener than five or six times a day—for about a minute at a time. In menageries they become sedate enough for ten-minutes sessions. But a German chancery-clerk has to sit fifteen hours a day, awaiting promotion and the supper-hour, for he is often required to eat his dinner *in situ*. If his dinner-basket is sent from a cheap boarding-house, it is sure to contain a selection of highly astringent comestibles—tough beef, leathery potato-chips, allspice, ginger-cakes, and pickles. The accompanying flask contains coffee. If the man of sessions stoops, he damages his lungs; if he leans against the edge of the table, he may endanger his stomach; but, as sure as he sits, he compresses the region of the *vena portæ.* Obstructions of that vein are favored by two circumstances: it has to pass a double system of capillaries, and, before it can reach the liver, it has to pump its heavy blood *upward.* Sooner or later the incessant pressure results in varicose enlargements, actual obstruction occurs, the vein-bags become engorged and at last inflamed, and their rupture discharges the blood, which mingles with the secretions of the rectum, and causes that incessant pricking and burning that make hæmorrhoids (emerods, piles) as troublesome as a combination of itch and gout. An astringent diet aggravates the evil by inspissating the blood and retarding the process of circulation. The stricken Philistines obtained relief by sacrificing golden *fac-similes* of the afflicted parts, and cauterizations temporarily free the obstructed passages; but the days of miracles are past, and, as long as the cause continues to operate, it would not avail the patient to sacrifice his entire stock of emerods. *Inunctions of warm tallow* will palliate the itch. Common mutton-tallow serves that purpose as well as any patent ointment, for itch and its cognate complaints are not amenable to the influence of the faith-cure. The radical remedies are *gymnastics* and an *aperient diet.* The gymnastic specifics are the exercises that promote deep and full respiration, and at the same time react on the abdominal cavity, as spear-throwing, swinging by the arms, and dumb-bell practice. The diet should be digestible, and as fluid as possible; while exercise stimulates the circulation, the diluents will attenuate the blood, and thus obviate the proximate cause of the disorder. If the patient has to stick to his office, he should procure a combination-desk (which any carpenter can construct without infringement of patents), and stand and sit by turns.

The ancients kept slaves who had to work all day, sitting before a primitive grist-mill, and it is possible that hæmorrhoids are really a very antique complaint. But during the age of gymnastics and unfrequent meals it is not probable that people suffered much from *maw-worms.* Parasites are marvelous colonizers. Wherever the ground is prepared for their reception, the seed is sure to make its appearance. There are about sixty different kinds of mildew, a special variety for nearly every special kind of fruit or vegetable; and, if a decaying berry of the rarest sort is exposed to the open air, it will soon be covered with its specific kind of mold. A piece of putrid flesh will attract blow-flies, even where flies of that sort have never been seen before. The germs of numberless parasites fill the air, and each species, after its kind, will promptly fasten upon every sort of decaying or stagnant organic matter, even in the interior of the body. But in the living organism of the human system such stagnations are wholly abnormal. In the economy of the digestive organs peptic disintegration should precede putrefactive decay; the chyle should never stagnate, the stream of the organic functions should move with an uninterrupted current. There are rivers that become so low in summer that pools of water can be found only in the deeper cavities of the river-bed, and such pools are sure to swarm with "wrigglers," or incipient gnats. But, as soon as the current of the rising river drains those pools, the wrigglers speedily vanish.

The maw-worm plague is caused and should be cured on the same principle. Most people eat too often. Before the stomach can dispose of the first meal, it receives a second consignment, and soon after a third, of comestibles elaborately contrived to retard digestion; afternoon work monopolizes the energies of the system; the *mêlange* in the small intestines becomes unmanageable, stagnates, and at last ferments. Babies are gorged with milk till the contents of the little vessel literally spill at the muzzle; they are swaddled and bandaged, kept in horizontal confinement, and anxiously prevented from every motion that might ease the labor of the sorely overtaxed bowels. Fresh air, the next best peptic stimulant, is likewise carefully excluded. Nature fights the enemy for a week or two, but at last succumbs to odds: fermentation sets in; parasites fasten upon their well-prepared pabulum, and soon the tortures of the mummified little martyr are aggravated by the wriggling of hundreds of ascarides. Nervous children can thus be worried into epileptic fits, and even delirium and brain-fever. Locally the worm-plague produces constipation, hæmorrhages (often resembling the symptoms of true hæmorrhoids), and burning stools.

If the evil has reached proportions that defy dietetic specifics, the removal of the cause (as in prurigo, scabies, and syphilis) requires the application of artificial remedies. Injections of warm water with an infusion of *quassia*, or *carbolic acid*, will expel pin-worm; *oil of chenopodium* (worm-seed) in minute doses, administered with a teaspoonful of castor-oil, is an effective prescription for the expulsion of the "round-worm."

Among the remedies against *tæniæ*, or tape-worms, the following vegetable specifics are not less effective and much safer than the *calomel* preparations which were formerly prescribed for that purpose: Pomegranate-bark (*Granati fructus cortex*); male fern (*Filix mascula*); but especially *pounded pumpkin-seed*. Three ounces of the fresh seed, mixed with a pint of water and pounded into an emulsion, taken after a twenty-four hours' fast, rarely fail to evict the tenant within three hours.

But the germs of the parasites remain behind, and the same predisposing conditions may at any time effect their redevelopment. Dietetic remedies must complete the cure. Children should be restricted to three meals a day. Let them earn their recovery by exercise—running, tumbling, dangling at the end of a grapple-swing. Adults should limit themselves to a lunch and a good dinner, drink a liberal quantum of fresh, cold spring-water, but no fermented beverage, and strictly abstain from indigestible food, especially cheese, sour rye-bread, sauer-kraut, archaic sausages, pickles, and hard-boiled eggs. Light bread, cream, and grapes (or baked apples), should constitute the staple of the diet. A two-weeks grape-cure can do harm. An occasional fast-day will insure the elimination of undigested food-deposits. Pin-worms that have escaped the day of wrath may now and then betray their presence, but they have ceased to multiply, and, after the current of the organic circulation has once been fairly re-established, intestinal parasites will disappear like the wrigglers of a drained river-pool.

LAND-BIRDS IN MID-OCEAN.

By GEORGE W. GRIM.

THE appearance of some of the smaller varieties of migratory birds, such as sparrows, swallows, doves, etc., several hundred miles away from the nearest land is by no means an unusual occurrence on the ocean. About these little erratic visitors there are some curious and interesting facts. Their appearance is almost always one at a time, though I have known a considerable number, representing, perhaps, as many different varieties, to accumulate in the course of a day. It is usually, though not always, in stormy or unsettled weather.

The first curious fact about these birds is, that they never appear to be tired out; whereas birds are often met with near the land with their strength quite exhausted. A second curious fact about them is their preternatural tameness where there is no cat or dog on board, and the crew show no disposition to molest them, as exhibited by their apparently seeking rather than avoiding the presence of man.

Another curious fact about them is the recovery of all their native wildness and their instinctive avoidance of man's presence on approaching the land. The first time I noticed this fact was with a pair of olive-colored ring-doves, which, from their remarkable tameness and familiarity, I was led to believe had been bred in a domestic state and perhaps on shipboard. I kept them in the skylight in the cabin, where they seemed to be quite contented; but on approaching the land they became the wildest of the wild. One of them escaped and flew away. I succeeded in taking the other into port, where I gave it its liberty. Now, I am certain that these birds could not have been apprised of the approach to the land through the medium of any of their ordinary senses. This curious circumstance led me to notice more particularly the conduct of other varieties of these little wanderers upon the ocean so far from their native habitat, and I find that they nearly all exhibit to a greater or less extent the same curious characteristics. Here the observant mariner with a smattering of science may find something to cogitate upon.

Light, heat, sound, etc., are said to be effects produced upon the living organism through the medium of appropriately developed organs by as many different modes of motion, whereby the animal is brought into conscious connection with surrounding objects, the effect diminishing in a progressive ratio as the distance of the object increases. Of these special organs there are said to be five in number which are essential to the well-being of all perfectly developed animals. But may there not be other analogous modes of motion, producing analogous effects upon the living organism, whereby the animal is brought into conscious connection with surrounding objects, and by or through which it has a sense of the locality or direction of such objects as are essential to its well-being to seek or avoid? Admitting this, suppose a flock of birds have started on one of their migratory excursions, guided mainly by this sense of direction, in pursuit of some distant object. Then let us suppose that in their flight they pass obliquely, but unwittingly, into another higher stratum or current of air moving with great velocity in some other direction, but toward the ocean. The flock would necessarily become very much scattered, and in the confusion a portion of them would be carried unconsciously out to sea, beyond the range of their sense of direction—having lost which, they fly at random and at ease, exerting just sufficient effort to sustain themselves in the air; while another portion of the flock, keeping within the limit of their sense of direction, will exhaust all their strength vainly endeavoring to reach their object against a violent wind.

So intimately associated with this sense of direction is their instinct of self-preservation in avoiding the presence of man, that while the one is in abeyance, the other, in the absence of anything to arouse it, remains dormant. This, I believe, is the true meaning of the preternatural tameness exhibited by the birds on the Galapagos Islands mentioned by Darwin.

From the peculiar properties of air in its relation to heat, the atmosphere has a tendency to form itself into heterogeneous strata, more or less inclined to the horizon; each stratum having a horizontal motion independent of the others—a fact the significance of which, I think, is frequently lost sight of by meteorologists, more especially by cyclonologists. That some of the higher strata of the atmosphere have an independent horizontal motion, the velocity of which is often incomparably greater than anything we experience in the lower stratum, is evident not only from the appearance in mid-ocean of birds, but of insects hundreds of miles from land, and apparently as lively as if they were in their own native haunts. I have seen grasshoppers at least a thousand miles,* and dragon-flies certainly two hundred miles from land.† During a recent voyage from New Zealand to New South Wales, and thence to Japan, frequently, for several days in succession, moths and butterflies were visible in the air nearly every hour in the day.

THE ILLUSION OF CHANCE.

By WILLIAM A. EDDY.

STUDY of the movements of events reveals dynamical, necessary sequences, and contemplation of the laws of probability, treated mathematically, generally involves a mental attitude at variance with theories of luck and premonition. It is believed that a rational treatment of the question will help to dispel superstitious ideas by disclosing the chain of continuity in all known actions. First, we will consider events mathematically, or as illustrating the laws of probability; and, second, as related to the practical question of success in life. The subject includes indirectly the question of ethics. Wrong or injurious action seems to disappear into a vast labyrinth. As we judge superficially or by immediate effects, we are easily misled into a belief that fraud may result in permanent gain, or that oppression will cure some political evils. It is important, for instance, that we have right ideas regarding the tendency in affairs whereby continued injustice or abuse of power comes to retribution. The jarring of the just relations of things leads to complications too subtile to be controlled, as the tyrants of history found by terrible experience, and the fact that our control is partial, as noticed definitely further on, should cause fear of the improper use of power. These truths well justify an examination of the subject.

Before considering the more complicated question of partial control in its relation to success, we will first glance at the simple or direct relations between familiar events, as seen in the calculable uniformity in the average results of great numbers of so-called games of chance. The numerical results of card-playing and dice-throwing, as examined by Professor Venn, have reaffirmed what is generally known

* "December 13, 1876, latitude 17° 24′ north, longitude 44° 12′ west. While taking the sun at noon, noticed a number of grasshoppers about the vessel. Made several unsuccessful attempts to capture one of them. The nearest point of land is the Island of Montserrat, latitude 16° 48′ north, longitude 62° 12′ west, distant 1,023 miles."—(Extract from a private log.)

† In the vicinity of the river La Plata, violent westerly gales, called *pamperos*, are of frequent occurrence. One of the surest precursors of these gales is the appearance of numerous dragon-flies in the air. I have seen these insects collecting about the ship fully two hundred miles from land, off the entrance of the river, while the wind was still blowing a gale from the eastward.

—that resulting special aggregates, differing widely in number, show a narrow margin of difference when combined into an average of many such aggregates. "Let us suppose," he says, "that we toss up a penny a great many times; the results of the successive throws may be said to form a series. The separate throws of this series seem to occur in utter disorder. . . . But when we consider the result of a long succession we find a marked distinction; a kind of order begins gradually to emerge, and at last assumes a distinct and striking aspect." *

It is claimed that at one time about two hundred persons committed suicide annually in London, but it is possible that the increase of prosperity or the extension of moral influence might lessen the number. Human actions, when compared with games in which no skill is applied, thus disclose a marked difference in the fact that the average of many games shows a very small margin of departure from calculated uniformity, while during long periods human actions arising from like causes differ widely, owing to the evolution of intelligence, which gradually establishes extensive differences. Many natural phenomena go through long periods of growth and decline. But this method in nature may be far more difficult to trace than that in a game of cards. It is completely beyond our power to arrange the star systems in even a theoretical way that would seem in the slightest degree complete. In phenomena repeated at conceivable intervals, however, we may find the average as steadily maintained as that of great numbers of games. This is seen in the slight variations in the average of rainfall during a decade. If we extend the problem beyond the range of our short lives, we again find that apparently fixed averages slowly change. It would, therefore, require inconceivable lapses of time to discern the uniformity of average in these gradual changes during many centuries. As an illustration of this, there are good reasons for believing that the temperatures of the north and south temperate zones vary so greatly in ten thousand five hundred years that large portions of the globe now under cultivation will be covered by glaciers. Mr. H. B. Norton, in a lecture delivered before the Kansas Academy of Science,† makes a careful mathematical calculation based on the precession of the equinoxes. He thus estimates that the greatest variation in length between winters of the northern and southern hemispheres occurs at recurring periods of twenty thousand nine hundred and thirty-seven years. These great lapses of time are, he claims, accompanied by alternate deep submergence of the poles in accordance with the gradual change of the earth's axial inclination. He says:

"It thus appears probable that there have been many glacial periods in each hemisphere, and that the ocean, like a mighty pendulum, vibrates from pole to pole."

* "The Logic of Chance," by John Venn, M. A., p. 5.

† Published in "The Popular Science Monthly," October, 1879.

Herbert Spencer points out similar truths in that part of his philosophy concerning the rhythm of motion: * "Every planet, during a certain long period, presents more of its northern than of its southern hemisphere to the sun at the time of its nearest approach to him; and then, again, during a like period, presents more of its southern hemisphere than of its northern—a recurring coincidence which, though causing in some planets no sensible alterations of climate, involves in the case of the earth an epoch of twenty-one thousand years, during which each hemisphere goes through a cycle of temperate seasons, and seasons that are extreme in their heat and cold. Nor is this all. There is even a variation of this variation. For the summers and winters of the whole earth become more or less strongly contrasted, as the eccentricity of its orbit increases and decreases. . . . So that in the quantity of light and heat which any portion of the earth receives from the sun, there goes on a quadruple rhythm, that of day and night; that of summer and winter; that due to the changing position of the axis at perihelion and aphelion, taking twenty-one thousand years to complete; and that involved by the variation of the orbit's eccentricity, gone through in millions of years."

These phenomena illustrate the regularity of averages on an immense scale. The differences in temperature between unusually hot or cold seasons in a given year all offset one another when reduced to an average of a decade or of a century, just as we assume that the great differences between glacial and tropical temperatures manifest approximate uniformity in the long period above considered. It is thus clear that circumstances or the motions of events lead to sustained average results in spite of seeming irregularities. The slowness with which some great changes take place is equivalent to the establishment of permanent conditions as far as the short duration of our individual consciousness is concerned. The glacial period, whether due to the precession of the equinoxes or some other cause, involves a lapse of time far longer than is covered by the historical record of the earliest races, along down the line of mingled civilization and barbarity to the present time.

In deference to those who are too cautious to accept any doctrine of averages in nature, it is well to give full weight to an opinion in a letter from Professor C. H. Hitchcock, regarding the glacial period. He thinks that every agency must be considered, including "obliquity of orbit, precession of the equinoxes, axial variation, and elevated planes at the north." He adds, "If you can prove that in an ice age at the north the climate about the south pole was ameliorated, then the fact that it is somewhat colder there now may be of service." Beside the variation in ocean-level, we may consider it probable that, when the earth cooled from its primeval molten state, it was left with

* "First Principles," pp. 256, 257.

slight excess of elevated surface at points either north or south of the equator, and that in time this resulted in difference of temperature, in ice accumulation, in axial variation due to unequal attraction. Professor Hitchcock's suggestion of many causes is valuable because it calls attention to the possibility or probability of a vast and connected ring of variations, each related to the other, so that ultimately we can only understand the facts as illustrating the instability of the homogeneous as taught by Herbert Spencer. But the oscillation is manifested in so many other ways that, even when it fails as applied to a special series of geological facts, we are still justified in believing it as an underlying truth not demonstrated in this case, owing to our want of definite knowledge concerning the glacial period.

Having thus glanced at mathematical considerations, we now pass to the identity pervading widely different phenomena. In addition to this law by which exceptional events are found to accord with a certain average, we further find identity in various kinds of action. When the ice on the river is rent with a sound like the booming of cannon, we detect some resemblance to the rumbling of an earthquake. Hence the theory may be that the subterranean sound involves the cracking of rocky strata. The motion of a small whirlpool, of a tornado, of the solar system, and hypothetically of great extents of nebulous matter, discloses an undercurrent of identity indicating that we should not value the event in itself, but the wide play of phenomena so represented. We may further conclude that the material universe, as far as known, is of value as standing for something beside optical appearances and mechanism. Aside from this representative value, concerning sidereal systems, men of genius may discern direct practical power in small things, as in the following instances: Watt applies to a wider use the lifting power of steam, as seen in the upward motion of a tea-kettle cover,* and Edison applies the lessened friction between electrified metal and rough paper to the general purpose of reducing the friction of machinery—at present this principle is used to increase the sounding power of the telephone. Many things appear trifling because we fail to see in them the wonderful analogies awaiting disclosure and the possibilities of development, so that lack of perception or combining power is the main condition of our helplessness in the presence of many forms of material action or phenomena.

In direct opposition to the idea of mastery through knowledge and continuous effort, we find the belief in luck, the central idea of which is that a bias in our favor may pervade events. The notion of natural order in events, followed regardless of persons, substitutes for the illusion of luck the truth of a mere coincidence between what we like and what results. Such favorable coincidences when not read aright have wrecked the lives of some men who might otherwise have developed useful powers. A careful study of such a fortunate turn of events

* The story has been discredited, but the truth is applicable.

reveals some unpleasant but irresistible facts—that a sustained favorable coincidence is very rare and likely to be of doubtful permanent value, because there is not a proper development of personal quality whereby no injury will result from prosperity. The fortunate person tries to swim in a sea of new conditions which he has not reached by a natural process of growth. The phrase "always lucky" is open to two objections not easily set aside, owing to the profound complexity of events: that the person may have skill, tact, agreeableness; and that there may be error, owing to the special or restricted view of the person judging. Belief in luck is directly and practically objectionable, because it leads to submission in matters requiring action.

Another singular but essentially superstitious idea at times gains credence. A connection between two events is affirmed strongly in proportion to lack of evidence, or it is assumed that an event has necessary relation to personal welfare. This was well illustrated by an occurrence in the central part of Illinois during the presidential contest between Lincoln and Douglas. Two flag-staffs, about two hundred feet high, had been put up in the Court-House Square of the town. Just before the election the staff in honor of Douglas fell, owing to a defect in the timber. It was at once thought that this foreshadowed the defeat of Douglas, and when the result seemed to verify this prophecy the superstitious impression became stronger than ever.

Our tendency to fill the unknown with imposing possibilities is a natural and perhaps justifiable effect of the profound mysteries of life and being which stimulate our curiosity and imagination, but there is absurdity in postulating connections between special events which are much better explained by means of the usual physical factors and the reason. With some persons the supposed relation between death and thirteen at table seems impressive, because it is assumed that there is interference owing to unknown laws of action or association. It may seem incredible that any well-educated person should hold this belief seriously, yet beyond the shadow of a doubt it has influenced many who were able in action, if not in dealing with questions of causation. As death and thirteen at table are both quite common, it follows that the concentration of attention upon this or any usual number must result in the observation of many coincidences. An absence of the coincidence is easily overlooked, because the allowance of one year for the death to occur causes the prophecy to be forgotten. The disclosure of this or any other causal connection at once deprives the superstitious idea of its assumed value. This is evident in a like instance if we maintain that spilling salt has relation to calamity because it indicates carelessness and nervousness. Nature never overlooks carelessness, and nervousness may arise from consciousness of impending trouble; hence statistics might show (if we could eliminate other influences) that persons who spill salt or upset things are more liable to disaster than others. The rejection of a natural cause is unfortunate, because it is one form of the belief that an imagined relation is objective. It is assuming that an event will necessarily conform to a prophecy made entirely without reasonable data. George Eliot pointed out this absence of reason by saying, in effect, that some people are surprised at the presence of an evil which they have done everything to produce, and at the absence of a wished-for result which they have done nothing to attain.

FEMALE EDUCATION FROM A MEDICAL POINT OF VIEW.*

By T. S. CLOUSTON, M. D.

THERE are a good many reasons why physicians should have opinions about the education of youth rather different from those held by most of the public and of the professional educators. Their whole art is founded on the study of the human being—his beginning, his development, his course, his decay, and his death. All his structures and all his functions are carefully inquired into. A doctor must nowadays be a physiologist, and a physiologist includes the mental as well as the bodily functions of man in his range of inquiry. In fact, it is one of the peculiarities of the physiological mode of studying human nature that man is looked on as a whole—body and mind together—a unity, in which they can not be studied apart from each other. Then the practical aims of modern medicine, founded on this enlarged study of man, are getting to be more and more concentrated on measures for the prevention of diseases, and not merely for their cure. To prevent disease one must control the conditions of life. Especially in youth, when the human being is most amenable to influences for good and evil that affect the whole future life, must one regulate the conditions of life, if health is to be preserved. The doctor finds that health means far more than a good digestion. It means a conscious sense of well-being all over, contentment, power of work, capacity to resist evil influences, and, to some extent, good morality. It means a sound mind in a sound body. The process and the method of education undoubtedly influence health strongly. If the educator has damaged the health, the doctor is expected to put it right. An important part of the physician's duty is to study the sum-total of a man's hereditary tendencies, and his bodily weak or strong points, what is commonly called his constitution. He finds that education in many of its modern forms may be either a most helpful or a most dangerous process to many constitutions. In fact, the modern physician is rather

* Lecture delivered at the Philosophical Institution of Edinburgh, November, 1882.

disposed to set up as the skilled engineer of the human machine, and the authoritative exponent of its proper treatment in all its departments, both when it is working rightly as well as when it goes wrong.

A careful study of the qualities and capacities of one's material is the very first thing to be done before determining the wear and tear to which it is to be subjected, or arranging the work it is to do. This is a comparatively easy matter, when an ordinary machine is to be made, however complicated. The iron and the steel of the locomotive can be most accurately tested. Yet all prudent engineers allow an enormous margin for casualties. The actual strain put on is not half of what the machinery could really bear. Who would subject the plates of a boiler to a pressure just up to their bursting-point? Nature in her mechanics usually makes much more allowance than engineers do. The heart of an animal could send five times the amount of blood that it has to propel at twice the rate of the normal blood-current. The arterial pipes that contain and conduct the blood to the extremities are of sufficient thickness and strength to resist five times the pressure put on them day by day. The stomach in a healthy man has usually the power of digesting twice or thrice the amount of food really needed for nourishing the body. Woe betide the diners-out, if it stopped short just at the point when enough for Nature's wants had been digested! This principle of having a reserve of spare power beyond the ordinary daily needs, only to be called into operation on rare and special occasions, is Nature's principle throughout the whole region of life. She scatters seeds by the million where thousands only can grow.

There is a law of Nature, too, that lies at the very root of the principles I am going to advocate to-night. It is this, that every living being has from its birth a limit of growth and development in all directions beyond which it can not possibly go by any amount of forcing. Man can not add one cubit to his stature. The blacksmith's arm can not grow beyond a certain limit. The cricketer's quickness can not be increased beyond this inexorable point. The thinker's effort can not extend further than this fixed limit of brain-power in each man. This limit is fixed at different points in each man in regard to his various powers, but there is a limit beyond which you can not go in any direction in each faculty and organ.

The capacity for being educated or developed in youth, the receptive capacity of each brain, is definitely fixed as to each brain of each young man and woman.

Then the important laws of hereditary transmission of weaknesses and peculiarities and strong points must be studied and kept in mind, so far as we know them, by the educator of youth. To hear some persons talk, you would imagine that every youth and maid had a constitution as free from faults and weak points, and as little liable to go wrong, as a forty-shilling watch. Nothing is more certain than that every man and woman is like their progenitors in the main. It takes generations for new conditions of life to eradicate hereditary peculiarities, and then they are always tending to come back. These hereditary peculiarities in youth are mostly not seen as actualities that can be pointed out and proved to exist by any outward signs. They exist as potentialities only, and come out as actual measurable and ascertainable facts at certain ages, or under certain conditions. A young man who inherits gout strongly may for the first five-and-twenty years of his life be absolutely free from any trace of the disease. Yet we are warranted in inferring that something is there which must be taken into account in the diet and conditions of life, if we wish to contract and eradicate the tendency. Many nervous diseases and conditions are the most hereditary of all, and we have good reason to think that, in those subject to them, the conditions of life, and the treatment to which the brain and the rest of the nervous system are subjected during the period of the building of the constitution—that is, during adolescence from thirteen to twenty-five—are of the highest importance in hastening and accentuating, or retarding and lessening, those nervous peculiarities. The problems of the hereditary transmission of qualities and tendencies to disease are some of the most wonderful in nature, and they are as yet by no means clearly elucidated. Many of them, as yet, can not be brought under any law. In our present state of physiological knowledge, it is, for instance, a quite inconceivable thing what takes place when we have two generations of perfectly healthy persons intervening between an insane great-grandmother and an insane great-grandchild. The grandparent and the parent carried something in their constitutions which was never appreciable to us at all. Yet it was there just as certainly as if it had broken out as a disease. It is one of the future problems of physiology and medicine to deduce the exact laws of heredity in living beings, and to counteract the evil hereditary tendencies through conditions of life. To do the latter we shall undoubtedly have to begin early in life, and we shall have to control the education especially, and make it conformable to Nature's indications, laws, and conditions.

Another law of living beings to be kept in mind is this: There is a certain general energy in the organism which may be used in many directions, and may take different forms, such as for growth, nutrition, muscular force, thinking, feeling, or acquiring knowledge, according as it is called out or needed. But its total amount is strictly limited, and if it is used to do one thing, then it is not available for another. If you use the force of your steam-engine for generating electricity, you can not have it for sawing your wood. If you have the vital energy doing the work of building the bones and muscles and brain during the year that a girl grows two inches in height, and gains a stone in weight, you can not have it that year for the acquisition of knowledge and for study. If by undue pressure you do call up and use for education the energy that ought to go toward growth and strengthening the body, you produce a small and unhealthy specimen of humanity, just like those plants which have had their flowers unduly forced, and are deficient in bulk and hardiness, and will not produce seed. Nature disposes of her energies in a human being in due proportion to the wants of each organ and faculty. There is a natural and harmonious relation which each bears to the other. This relation is different in different persons, and at different periods of life. The plowman takes up most of his energy in muscular effort and in the repair of waste muscle, and he has little left for thinking. The student uses his up in the mental effort of his brain, and has little left for heavy muscular work. No doubt Nature is sometimes prodigal of energy, and provides enough for the high-pressure working of both the brain and the muscles in some cases. But this is not the rule, and should not be assumed as applicable to many persons. At the different periods of life Nature uses up her available energy in different ways. She allocates it in babyhood chiefly to body-growth, in early girlhood partly to growth and partly to brain development ; in adolescence, the period of which I am to speak chiefly to-night, her effort is evidently to complete the building up of the structures everywhere, to bring to full development the various functions, to strengthen and harmonize the whole body and the brain, so that they shall be able to produce, and do in the succeeding years of full maturity all that they are capable of. It is certainly not a period of production, but of acquisition. If the original constitution derived from ancestry has been good, if the conditions of life in childhood have been favorable, if the education has been of the right kind, developing the whole being in all her faculties equally and harmoniously after Nature's plan, and if the period of adolescence has crowned and completed every organ and every faculty, no faculty being unduly called on to the impoverishment of the others, then we expect, and indeed must have, a woman in health, which means happiness, with the full capacity for work, for production, and for resisting hurtful influences, and for living her allotted time. But this can only result from a harmonious and healthy *development*, which we may take as the physician's word to denote education in his sense. It can only result from regarding the woman as a unit, body and mind inseparable ; it can only result from the educator's efforts being on the lines of Nature's facts, and Nature's harmonies, and Nature's laws.

Another fact in regard to the vital energies and forces of the human body is this : That you may use up by an undue push and pressure at one time of life the power that ought to have been spread out over long periods. We see this daily in men who have had trying or or excited lives and occupations. Some of them wear out soon, and grow old soon, and are old men with no energy or vitality left at fifty.

What you put into one period of life you want at another. If with ten tons of coal in the tender you keep your locomotive running at sixty miles an hour for the first two hours, you do not expect it to do this for long. Each period of life has its peculiar forces and energies in which it is specially rich. In adolescence the strong points, mental and bodily, are very marked. I shall specially allude to them by-and-by. It is sufficient to say here that they are not thinking or intense repression of all the general energies so as to concentrate them in mental work. This may be done, but the question is, Is it well to do it? Does it make life more complete and happy to do so, looking at life as a whole? A physician, like a philosopher, must look on life from the cradle to the grave, not on one portion of it only, as the educationalist is perforce obliged to do, having nothing to do with it afterward. Like many architects and contractors building our houses for us, they turn out an article finished up to the standard of the time, and then hand it over to you. They never see it again. Its future does not concern them much. I have often proposed that your architect and contractor should be bound to come and look at your house every five years for the first twenty, and should get certain deferred payments at these periods according as the work is standing, and no defects developing. So I would have the educator's reputation depend, not on what he has turned out at twenty-one, but on the result at forty or fifty or sixty. Education is a preparation for the work of life, not a thing that is good in itself. If it has helped life to be healthy, happy, successful, and long, then it has been good; if in any degree it has caused disease, unhappiness, non-success, then it has been bad.

There is another vital fact in the constitution of human nature that needs to be taken into account—at least I for one believe it to be a fact. It is this, that one generation may, by living at high pressure, or under specially unfavorable conditions, exhaust and use up more than its share of energy. That is, it may draw a bill on posterity, and transmit to the next generation not enough to pay it. I believe many of us are now having the benefit of the calm, unexciting, lazy lives of our forefathers of the last generation. They stored up energy for us; now we are using it. The question is, Can we begin at adolescence, work at high pressure, keep this up during our lives (which in that case will be on an average rather short), and yet transmit to our posterity enough vital energy for their needs? How often it has happened, in the history of the world, that people who for generations have exhibited no special energy, blaze out in tremendous bursts of national greatness for a time, and then almost die out! The Tartars under Genghis Khan, the Turks when they overawed Europe, the Arabs when they conquered Spain, are examples. We must take care that this does not happen to us. How often we see a quiet country family, that has for generations led quiet, humdrum lives, suddenly produce one or two great men, and then relapse into greater obscurity than before, or become degenerate and die out altogether!

Another fact in the body and mind history of human beings is this, that there are certain physiological eras or periods in life, each of which has a certain meaning. The chief of such eras are childhood, puberty, adolescence, maturity, the climacteric, and senility. We have to ascertain, What does Nature mean by these eras? What does it strive to attain to in each period? What are the ideal conditions of each? No one of these periods can be studied from a bodily point of view alone, or from a mental point of view alone. They must be regarded from the point of view of the whole living being, with all its powers and faculties, bodily and mental. Not only so, but in most cases the inherited weaknesses must be taken into account too. Those eras of life can not be fully understood looked at with reference to the individual. Their meaning is only seen when the social life, the ancestral life, and the life of the future race, are all taken into account. And this is what makes some proper attention to those eras so very important from the social as well as the physician's point of view. If they are not understood, and so are mismanaged, not only the individual suffers, but society and the race of the future. Particularly the era of adolescence is important, for it is the summer ripening time in the vital history. If the grain is poorly matured, it is not good for either eating or sowing.

Such is the physician's, or perhaps I should rather say the physiologist's, way of regarding a woman, her development, and her education. It is because we do not think the average parent and the professional educator in the technical sense always take this wide view, but that the professional enthusiasm of the latter takes account of, and tries to cultivate, one set of faculties only, viz., the mental; because we think the public mind is getting to regard as all-important in female education what we think is not so important, and so to take little account of what we regard as of supreme importance to the individual and to the race—viz., the constitution and the health—that I think that the physiological view of female education should be brought forward and presented to the public mind more frequently than is the case; while the bad results in after-life of disregarding Nature's laws, as these results come under the notice of the physician, should be strongly and clearly brought before the general mass of parents and educators. It is not a matter that concerns the physician and his immediate patient only. It concerns the whole of the people.

I shall now enter more into detail in illustration of the general principles I have mentioned, as applied to that period of the life of a young woman when the chief part of her education is going on. I am not going to speak much of the period of childhood, or up to the age of thirteen or so. Before that time it is no doubt important that education should be conducted on physiological principles, with due regard to the growth of the whole organism, and therefore without too many hours of mental work, with plenty of play and rest, and in well-ventilated school-rooms. During the period of childhood few girls will overwork themselves. If it is done, it is by outside pressure, and any bad effects are usually temporary, and easily got over by a little rest, and a good holiday in the country.

The era of adolescence is one of the greatest importance from a bodily and mental point of view in young men and women, but especially in the latter. Bodily, the child eats, sleeps, grows, plays, and does what she is told. Life has no seriousness. Everything in the body and mind is inchoate and unformed. Nothing indicates permanence. There are great and constant muscular energy, noise, sound sleep, quick digestion. The delights of life consist in sweets and games, the imagination is shallow, the affections are instinctive, "character" is nascent; there is no morality in any correct sense, and no real religious sentiment. There is little liability to nervous diseases except those affecting the muscular system; there are no neuralgias, no liability to mental diseases, and most other diseases are sharp and soon over. It is very different with the girl when adolescence commences. Then bodily energies of a new kind begin to arise, vast tracts of brain quite unused before are brought into active exercise. The growth assumes a different direction and type, awkwardness of movement becomes possible, and on the other hand a grace never before attainable can be acquired. The bones begin to cohere and solidify at their ends, and the soft cartilage joinings to get firmer. The tastes for food and drink often change. Bread and butter and sweets no longer satisfy entirely. Stronger and more stimulating foods are craved. The carriage and walk change. The lines of beauty begin to develop. But the mental changes are even more striking. All that is specially characteristic of woman begins to appear; childish things are put away; dolls no longer give pleasure. For the first time distinct individual mental peculiarities show themselves. The effective portion of the mental nature begins to assume altogether new forms, and to acquire a new power. Literature and poetry begin to be understood in a vague way, and the latter often becomes a passion. The imagination becomes strengthened, and is directed into different channels from before. The sense of right and wrong and of duty becomes then more active. Morality in a real sense is possible. A sense of the seriousness and responsibility of life may be said then to awaken for the first time. The knowledge of good and evil is acquired. The religious instinct arises then for the first time in any power. Modesty and diffidence in certain circumstances are for the first time seen. The emotional nature acquires depth, and tenderness appears. The real events and possibilities of the future are reflected in vague and dream-like emotions and longings that have much bliss in them, but not a little too of seriousness and difficulty. The adolescent feels instinctively that she has now entered a new country, the face of which she does not know, but which may be full of good and happiness to her. The reasoning faculty acquires more backbone, but is as yet the slave of the instincts and the emotions. A conception of an ideal in anything is then attainable, and the ideal is very apt to take the place of the real. The relations and feelings toward the other sex utterly change, and the change makes its subject liable to tremendous emotional cataclysms, that may utterly overmaster the rest of the mental life. There is a subjective egoism, and often selfishness, tending toward objective dualism. There is resolute action from instinct, and there is a tendency to set at defiance calculation and reason. All those changes go hand in hand with bodily changes and bodily development. There is a direct action and interaction between body and mind, all through. Accompanying all these there are, when health is present, a constant ebullition of animal spirits, a joyous feeling, a pleasure in life for its own sake, and there is a craving for light and beauty in something. There should not only be enough energy in the body and mind to do work, but there should be some to spare for fun and frolic, which is just Nature's pleasant way of expending vital force that is not needed at the time for anything else.

For the origination, for the gradual evolution of all these mental changes into perfect womanhood, there are needed corresponding bodily developments. Without these we should have none of those marvelous mental and emotional phenomena properly evolved and developed. If the health is weak, the nutrition poor, the bodily functions disordered and imperfect, and the nervous force impaired, we are liable to have the whole feminine mental development arrested or distorted. If undue calls are made on the nervous force, or the mental power, or the bodily energies, the perfection of nature can not be attained, and womanhood is reached without the characteristic womanly qualities of mind or body. The fair ideal is distorted. The girl student who has concentrated all her force on cramming book knowledge, neglecting her bodily requirements; the girl betrothed who has been allowed to fall in love before her emotional nature was largely enough developed; and the girl drudge who has been exhausted with physical labor—all alike are apt to suffer the effects of an inharmonious, and therefore an unhealthy, mental and bodily constitution. The body and the mind go in absolute unison, just as the blush on the maiden's cheek comes and goes with emotion, as the brightness and mobility of her features go with mental vivacity and happiness.

All those mental and bodily changes are not sudden, nor fully completed and brought to perfection at once; it takes on an average from ten to twelve years before they are fully completed. All that time they are going on, and during that time there is an immense strain on the constitution. All that time the whole organic nature is in a state of what we call instability: that is, it is liable to be upset in its working by slight causes. The calls on the inherent vital energy to carry on and to bring to the harmonious perfection of full womanhood all these combined bodily and mental qualities I have referred to, during these ten or twelve years, is very great indeed.

We physicians maintain that this period is one of momentous importance, and we have good reason to know this, for we are often called on to treat diseases that arise then, and, having originated then, have been fully matured afterward. The risks and the dangers to body and mind are then very great indeed. We count it a fearful risk to run, not merely that actual disease should be brought on, but that a girl capable of being developed into a healthy and happy woman, with a rounded feminine constitution after Nature's type—the only type that secures happiness and satisfaction to a woman—should by bad management, misdirected education, or bad conditions of life, grow into a distorted, unnatural, and therefore unhappy woman, who can not get out of the life that she has only to live once all that it is capable of yielding her. Like all the other physiological eras of life, that of adolescence only comes once. If the developing process, which is its chief characteristic, is not completed, then it is missed for life. Whatever is done then is final; whatever is left undone is also final. If a woman is not formed at twenty-five, the chances are she will never be so; if she is not healthy then, she probably will not be so. Who in his senses can deny that it is far better for nineteen women out of twenty to be healthy than to be intellectually well educated? No acquirements of knowledge can possibly make up for health in after-life. There is an organic happiness that goes only with good health and a harmoniously constituted body and mind. Without that organic happiness life is not worth having. Cheerfulness is one of the best outward signs of this perfect health, and what woman has not missed her vocation in the world who is not cheerful? A general sense of well-being is the best conscious proof of perfect health. It underlies all enduring happiness. It means good and harmonious development of mind and body, properly working functions, and satisfied organic needs. Any method of education that impairs this must be bad and one-sided.

Here it may be necessary to correct a too common notion that the brain only subserves mental work. To hear the common expression "brain-work," one would imagine that muscular exercise, ordinary employments, and digestion, could go on without the brain's working at all. No idea could be more mistaken. The brain is a most complicated organ in structure and function, that regulates the working of every portion of the body, that has certain portions of it devoted to motion and feeling, and passion, and digestion, and body-growth, and nutrition, etc. It is the one organ that dominates all the others, regulating and harmonizing all their functions. If one side of it is injured during growth, the opposite side of the body is left stunted and partially paralyzed, as well as the mental power weakened. If undue calls are made on one part, the other portions suffer. Now this wondrous and as yet only partially known organ has grown most of its growth, in so far as mere bulk is concerned, by the time adolescence begins. But its higher qualities—its force, its power of producing varied energies—are then only nascent. They develop during this period. It is then that the brain needs plenty of rest in sleep, fresh air, pure blood, good, nourishing, non-stimulating food, and work that develops but does not exhaust. The mental portion of the brain is no doubt the highest, and undue calls on that portion exhaust more than any other part. As I said, only a certain amount of energy or work is possible by any amount of stimulation. The brain has most diversified functions, but it has also a solidarity of action. No part is sick without all the other parts suffering. No function is overtaxed without all the other functions being weakened. Overtaxing of the mental function is specially weakening. In mature life, after the body is fully developed, such an overtaxing can be repaired by rest. The injury is merely temporary. If a man overworks his brain in business or study, and gives himself too little sleep, and gets an attack of indigestion, it means that he has taken up the brain-energy that ought to have gone toward digestion in mental work. But he stops work, goes to the country, and his recuperated brain soon acquires force enough to stimulate the stomach to secrete its juices and do its work. But if in adolescence, before the bones are knit, and the growth completed, and the feminine nature far advanced toward perfection, if the brain that is in the process of doing all these things is year by year called on to exert its yet imperfect forces chiefly in acquiring book-knowledge by long hours of study, and in consequence the growth is stopped, the blood is thinned, the cheeks are pallid, the fat destroyed, the wondrous forces and faculties that I have spoken of are arrested before they attain completion, then, when the period of growth and development ceases, the damage is irreparable. There is no time or place of organic repentance provided by Nature for the sins of the schoolmaster. Life has to be faced with an imperfect organism, its work and duties done with impaired forces, and its chances of accidents met without a stock of reserve power. This is a poor lookout for the individual; but when motherhood comes, and sound minds in sound bodies have to be transmitted to posterity, how is it to be then with the future race? This aspect of the question of female education during the period of adolescence is of absolutely primary importance to the world. Yet it is wholly ignored in many systems of education. What is the use of culture, if it is all to end with the present generation? What a responsibility to transmit to future generations weak bodies and over-sensitive brains, liable to all sorts of nervous disease! Nothing can be more certain than that the qualities, good and bad, acquired in one generation are sent on to the next. The world may be all the better of a generation of healthy, ignorant, and happy mothers, who can produce stalwart, forceful sons and daughters (not that I wish this lecture to be an apology for health and ignorance), but the world must be worse for a system of stopping full and harmonious development in the mothers of the next generation. My plea is, that as Nature is harmonious in mental and bodily development, we should follow on her lines, and not set up an educational standard for ourselves that is one-sided, because it takes no proper account of the constitution of the body and brain at all, only considering one brain-function—the mental.

Along with these developments of mind and emotion during adolescence there are, unfortunately, too apt to develop hereditary weaknesses, especially of the nervous kind. Physicians then meet with hysteria, neuralgia, nervous exhaustion, insanity, etc., for the first time. As normal individualities of bodily form and mental character then arise, so abnormal developments arise too where they are inherited or brought on by unfavorable treatment. This law is found to prevail in human constitutions: if you give Nature a good chance by specially favorable conditions, and by counteractive measures early in life, she tends to eradicate evil hereditary tendencies, and to return to a healthy type, if the evil has not gone too far in the ancestry or in the individual. Unfortunately, there are very few families indeed, nowadays, free from tendencies to some hereditary disease or other. Our modern life tends to develop the brain and nervous system, and undue development means risk of disease always. What the profession of medicine specially desires to guard our population now against, is our becoming a nervous race. We want to have body as well as mind; otherwise we think that degeneration of the race is inevitable. And, therefore, we rather would err on the safe side, and keep the mental part of the human machine back a little, while we would encourage bulk, and fat, and bone, and muscular strength. We think this gives a greater chance of health and happiness to the individual, and infinitely more chance of permanence and improvement to the race. This applies to the female sex, we think, more than to the male. Man's chief work is more related to the present (from a physiological point of view), woman's chief work to the future of the world. Why should we spoil a good mother by making an ordinary grammarian?

It will be said, as an hereditary fact, that most great men have had mothers of strong minds. I believe this to be true, but it is not a fact that many great men have had what would now be called "highly-educated" mothers. On the contrary, very few such men have had such mothers. There were usually an innate force and a good development of mind and body in the mothers of such men, who usually had led quiet, uneventful, unexciting lives. I am inclined to believe that if the mothers of such men had been in adolescence worked in learning book-knowledge for eight or ten hours a day in a sitting posture; if they had been stimulated by competition all that time, and had ended at twenty-one by being first-prize women (as probably most of them had the power of being)—if this had befallen them, then, I think, their sons would have been small and distorted men, instead of being the lights of the world.

One great argument for the "higher education" of women is that it makes them fitter companions for highly-educated men. This view should be looked at in the light of the ideal women that have been created in literature by men and women of genius. If genius has the instinct to discover the highest qualities, and to portray them for our instruction, we should get guidance here. Women have been painted by our poets, dramatists, and creative writers of fiction, by the thousand. Many persons would accept the ideals thus sketched for them as a surer guide than the labored deductions of the scientists. Men of genius ought to have known the kind of women whose companionship they liked, and whose influence on them was best. While they have had to create every kind of woman in peopling the ideal worlds they have made for us, it is certainly very remarkable that the ideal type of the very highly book-educated woman of the modern educationalist is scarcely met with at all. In "The Princess" of our poet-laureate the fancy can not be said to be a serious or imitable one. Though the sentiment of the "sweet girl-graduates with their golden hair" is this:

"Oh! lift your natures up,
Embrace our aims: work out your freedom, girls;
Knowledge is now no more a fountain sealed.
Drink deep until the habits of the slave,
The sins of emptiness, gossip, and spite,
And slander die. Better not be at all
Than not be noble"—

yet the poet paints the sweetness so as altogether to overpower the learnedness in the picture, and the Princess's ideal and purpose come to naught. And Lady Psyche's dream of likeness and equality is as far as ever from being realized:

"Everywhere
Two heads in council, two beside the hearth,
Two in the tangled business of the world,
Two in the liberal offices of life,
Two plummets dropped for one to sound the abyss
Of science and the secrets of the mind.
Musician, painter, sculptor, critic move;
And everywhere the broad and bounteous earth
Should bear a double growth of these rare souls,
Poets whose thoughts enrich the blood of the world."

Shakespeare's women are certainly not of the learned sort. Their years of adolescence were not taken up in getting book-knowledge exclusively. Their emotional nature was not dried up by the strain of intellectual work in youth. Their constitutions were not spoiled by study. They had fair faces, and womanly forms, and warm affections, and strong, impulsive passions, and mother-wit, and keen discernment, and most vigorous resolution, but nothing that we would call learning —not one of them. Portia, who acted the most learned part of all Shakespeare's women, vehemently describes herself as

"An unlessoned girl, unschooled, unpracticed."

George Eliot has created for us a whole host of young women, all real, all true to nature. Herself a woman, and a genius of the highest order; penetrating, learned, accomplished, subtile, and with a power of discriminating language unequaled in our generation; a wife and mother too—she was the best-fitted woman of the age unquestionably to draw for us a picture of young womanhood, highly educated in knowledge, up to the educationalist's ideal. Where do you find such a character in her writings? Dorothea in "Middlemarch" had exactly the makings of the successful omnivorous young female students of the present day; intellectual, conscientious, hyper-conscientious—as such young women so often are to their cost—"studious, her mind was theoretic, and yearned after some lofty conceptions of the world. . . . She was enamored of intensity and greatness." She was self-sacrificing to a fault. She was often ardent, and not in the least self-admiring. Yet Dorothea is not highly educated in the modern sense. Perhaps a modern educationalist would say that that was the reason poor Dorothea made such a mess of it, and threw herself away first on a selfish, shallow old brute, thinking he was a hero, and then on the least interesting fellow in the book.

One of the finest studies of adolescence in the female sex, from the mental side, is Gwendolen Harleth, in "Daniel Deronda." The picture is worthy of study by all persons who take an interest in human nature. Gwendolen was neither good nor studious. She was idle in learning, and she was selfish. She had a vast amount of subjective egoism, tending toward objective dualism, resolute action from instinct, a setting at defiance of calculation and reason, yet acting most reasonably toward the end in view. She was full of sentimentality, of inchoate religious instinct, of a desire for notice. Yet she was undeniably a fine young woman, and is a type of a large mass of the young women whom our modern educationalists would like to set to work for eight hours a day, from the age of thirteen to twenty, acquiring book-learning. I confess I more agree with Hannah More's notion of education for such a girl: "I call education not that which smothers a woman with accomplishments, but that which tends to consolidate a firm and regular system of character, that which tends to form a friend, a companion, and a wife. I call education not that which is made up of shreds and patches, of useless arts, but that which inculcates principles, polishes taste, regulates temper, cultivates reason, subdues the passions, directs the feelings, habituates to reflection, and trains to self-denial—that which refers all actions, feelings, sentiments, tastes, and passions to the love and fear of God." If to this we add that which hardens the muscles, adds to the fat, quickens and makes graceful the movements, hardens the bones, softens the skin, enriches the blood, promotes but does not over-stimulate the bodily functions, quickens and makes accurate the observation, increases the sense of real beauty of all kinds, promotes the cheerfulness, and develops a sense of universal well-being, we should have, in my opinion, the principles on which an educational system should be founded.

George Eliot's Romola was in a sense a learned woman, brought up in the midst of books, and in the atmosphere of culture. Yet she took to love-making, marriage, self-denial, charity, and religion, and deserted her books the moment her duty in them was done. She had no innate love of book-learning ; most of what she had acquired seemed to do her little good in her after-life. It was no guide to her in her difficulties, it was no solace to her in disappointments, it was no resource to her when everything else had failed. It had not taken hold of her nature, because it was not on the great lines on which her nature was constituted. She and her father were as much alike as a man and woman can be. Yet to him his books were an occupation and a delight which he loved, to her their study had been a self-denial all through.

We all know what Thackeray's women were, and yet he stands very high as a faithful student and expounder of human nature, as it exists.

When we look at the sort of women again that these great masters of the study of human character made their heroes fall down and worship, we certainly do not find that the schoolmaster had had much to do with the creation of their attractiveness. Hamlet and Ophelia, Adam Bede and Hetty, Deronda and Gwendolen, Lydgate and Rosamond, are the common types of men above the common mold taking to women of the unlearned if not quite uneducated type. The thoughtful and scientific Lydgate said about pretty, shallow Rosamond : "She is grace itself ; she is perfectly lovely and accomplished ; that is what a woman ought to be : she ought to produce the effect of exquisite music"; while he said about the stately, thoughtful Dorothea, "The society of such women was about as relaxing as going from your work to teach the second form, instead of reclining in a paradise, with sweet laughs for bird-notes and blue eyes for a heaven."

But it may be said all this was wrong, the result of yielding to unaided, unlearned Nature's lowest affinities, and that it turned out badly for those men. If they had mated suitably, the world would have been better, and they themselves would have been happier. But the physiologist will not readily believe that Nature's mental affinities can be wrong, any more than he can believe that the appetite is not on the whole the best guide as to the kind and amount of food that is good for us. When he finds in nature a marked masculine and feminine type of being, of body and of mind, marked enough from birth, but diverging widely from the beginning of the physiological era of adolescence, each type tending toward a different ideal, and attaining this at the end of that period ; and, recognizing these facts of nature, he finds it most difficult to admit that the same type of education should prevail in this momentous era, or that the same standard and ideal of a completed education should be striven after for the two sexes. And, when he finds that the great geniuses of literature have created these types of young women as different from the masculine type as the Apollo Belvedere is unlike the Venus de' Medici, he can not but become strongly persuaded that his deductions from physiological facts are true, and that they have been always instinctively recognized by the wisest of mankind. If it can be shown that the present tendency to over-educate the female sex in book-learning during adolescence, and the mental work, confinement, etc., that this implies tend to impair perfect health, to interfere with Nature's lines of feminine development, to exhaust energy that is needed for other purposes, and to diminish the chances of the permanence of the race, then it is time that the physiological view in regard to education were put in a plain way to the professional educator and to the parent.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XVIII.

I FIND that Sir Henry Thompson, in a lecture delivered at the Fisheries Exhibition, and now reprinted, has invaded my subject, and has done this so well that I shall retaliate by annexing his suggestion, which is that fish should be *roasted*. He says that this mode of cooking fish should be general, since it is applicable to all varieties. I fully agree with him, but go a little further in the same direction by including, not only roasting in a Dutch or American oven *before* the fire, but also in the side-ovens of kitcheners and in gas-ovens, which, when used as I have explained, are roasters, i. e., they cook by radiation, without any of the drying anticipated by Sir Henry.

The practical housewife will probably say that this is not new, seeing that people who know what is good have long been in the habit of enjoying mackerel and haddocks (especially Dublin Bay haddocks) stuffed and baked, and cods' heads similarly treated. The Jews do something of the kind with halibut's head, which they prize as the greatest of all piscine delicacies. The John Dory is commonly stuffed and cooked in an oven by those who understand his merits.

The excellence of Sir Henry Thompson's idea consists in its breadth as applicable to *all fish*, on the basis of that fundamental principle of scientific cookery on which I have so continually and variously insisted, viz., the retention of the natural juices of the viands.

He recommends the placing of the fish entire, if of moderate size, in a tin or plated copper dish adapted to the form and size of the fish, but a little deeper than its thickness, so as to retain all the juices, which by exposure to the heat will flow out ; the surface to be lightly spread with butter and a morsel or two added, and the dish placed before the fire in a Dutch or American oven, or the special apparatus made by Burton, of Oxford Street, which was exhibited at the lecture.

To this I may add that, if a closed oven be used, Rumford's device of a false bottom, shown in Fig. 3, of No. 11 of this series, should be adopted, which may be easily done by simply standing the above-described fish-dish, with any kind of support to raise it a little, in a larger tin tray or baking-dish, containing some water. The evaporation of the water will prevent the drying up of the fish or of its natural gravy ; and, if the oven ventilation is treated with the contempt I have recommended, the fish, if thick, will be better cooked and more juicy than in an open-faced oven in front of the fire.

This reminds me of a method of cooking fish which, in the course of my pedestrian travels in Italy, I have seen practiced in the rudest of *osterias*, where my fellow-guests were *carbonari* (charcoal-burners) wagoners, road-making navvies, etc. Their staple *magro*, or fast-day material, is split and dried codfish imported from Norway, which in appearance resembles the hides that are imported to the Bermondsey tanneries. A piece is hacked out from one these, soaked for a while in water, and carefully rolled in a piece of paper saturated with olive-oil. A hole is then made in the white embers of the charcoal fire, the paper parcel of fish inserted and carefully buried in ashes of selected temperature. It comes out wonderfully well cooked, considering the nature of the raw material. Luxurious cookery *en papillote* is conducted on the same principle, and especially applied to red mullets, the paper being buttered and the sauce enveloped with the fish. In all these cases the retention of the natural juices is the primary object.

I should say that Sir Henry Thompson directs, as a matter of course, that the roasted fish should be served in the dish wherein it was cooked. He suggests that " portions of fish, such as fillets, may be treated as well as entire fish ; garnishes of all kinds, as shell-fish, etc., may be added, flavoring also with fine herbs and condiments according to taste." " Fillets of plaice or skate, with a slice or two of bacon—the dish to be filled or garnished with some previously-boiled haricots "—is wisely recommended as a savory meal for a poor man, and one that is highly nutritious. A chemical analysis of sixpennyworth of such a combination would prove its nutritive value to be equal to fully eighteenpennyworth of beefsteak.

Some people may be inclined to smile at what I am about to say, viz., that such savory dishes, serving to vary the monotony of the poor hard-working man's ordinary fare, afford considerable moral as well as physical advantage.

An instructive experience of my own will illustrate this. When wandering alone through Norway in 1856, I lost the track in crossing the Kyolen fjeld, struggled on for twenty-three hours without food or rest, and arrived in sorry plight at Lom, a very wild region. After a few hours' rest I pushed on to a still wilder region and still rougher quarters, and continued thus to the great Jostedal table-land, an unbroken glacier of five hundred square miles; then descended the Jostedal itself to its opening on the Sogne fjord—five days of extreme hardship, with no other food than flatbrod (very coarse oatcake), and bilberries gathered on the way, varied on one occasion with the luxury of two raw turnips. Then I reached a comparatively luxurious station (Ronnei), where ham and eggs and claret were obtainable. The first glass of claret produced an effect that alarmed me—a craving for more and for stronger drink, that was almost irresistible. I finished a bottle of St. Julien, and nothing but a violent effort of will prevented me from then ordering brandy.

I attribute this to the exhaustion consequent upon the excessive work and insufficient unsavory food of the previous five days; have made many subsequent observations on the victims of alcohol, and have no doubt that overwork and scanty, tasteless food are the primary source of the craving for strong drink that so largely prevails with such deplorable results among the class that is the most exposed to such privation. I do not say that this is the only source of such depraved appetite. It may also be engendered by the opposite extreme of excessive luxurious pandering to general sensuality.

The practical inference suggested by this experience and these observations is, that speech-making, pledge-signing, and blue-ribbon missions can only effect temporary results, unless supplemented by satisfying the natural appetite of hungry people by supplies of food that is not only nutritious, but savory and *varied*. Such food need be no more expensive than that which is commonly eaten by the poorest of Englishmen, but it must be far better cooked.

Comparing the domestic economy of the poorer classes of our countrymen with that of the corresponding classes in France and Italy (with both of which I am well acquainted), I find that the raw material of the dietary of the French and Italians is inferior to that of the English, but a far better result is obtained by better cookery. The Italian peasantry are better fed than the French. In the poor *osterias* above referred to, not only the Friday salt fish, but all the other viands, were incomparably better cooked than in corresponding places in England, and the variety was greater than is common in many middle-class houses. The ordinary supper of the "roughs" above named was of three courses: first a *minestra*, i. e., a soup of some kind, continually varied, or a savory dish of macaroni; then a ragout or savory stew of vegetables and meat, followed by an excellent salad; the beverage a flask of thin but genuine wine. When I come to the subject of cheese, I will describe their mode of cooking and using it.

My first walk through Italy extended from the Alps to Naples, and from Messina to Syracuse. I thus spent nearly a year in Italy, during a season of great abundance, and never saw a drunken Italian. A few years after this I walked through a part of Lombardy, and found the little *osterias* as bad as English beer-shops or low public-houses. It was a period of scarcity and trouble; "the three plagues," as they called them—the potato-disease, the silk-worm fungus, and the grape-disease—had brought about general privation. There was no wine at all; potato-spirit and coarse beer had taken its place. Monotonous *polenta*, a sort of paste or porridge made from Indian-corn meal, to which they give the contemptuous name of *miserabile*, was then the general food, and much drunkenness was the natural consequence.

XIX.

Referring to No. 17 of this series (November "Monthly"), a correspondent who has just returned from Norway, where he followed the route of my last trip there, reminds me of the marvelous congregation of sea-birds that assembles on some of the headlands of the Arctic Ocean, and suggests that egg-oil might be obtained in large quantities there. He quotes from the work of P. L. Simmonds on "Waste Products" the following: "In the Exhibition of 1862 the Russian Commission showed egg-oil in large quantities and of various qualities, the best so fine as to far excel olive-oil for cooking purposes"; but it was not sufficiently cheap for general use.

Among the places indicated by Mr. Grimwood Taylor, the most remarkable is Sverholt Klubben, a grand headland between the North Cape and Nord Kyn, rising precipitously from the sea to a height of above one thousand feet. The face of the rock weathers perpendicularly, forming a number of ledges about two or three feet above each other, and extending laterally for more than a mile. On the two occasions when I passed it, the whole of this amphitheatre was occupied by a species of gull, the "kittiwake," perched on the ledges, their white breasts showing like the shirt-fronts of an audience of a million or two of male pygmies in evening dress. On blowing the steam-whistle, the rock appeared to advance, and presently the sky was darkened by a living cloud, and every other sound was extinguished by a roar of wings and the harsh, wailing screams of a number of birds that

I dare not estimate. The celebrated bird colony on the Bass Rock is but a covey compared with this.

The inhabitants of the little human settlement in the Bay of Sverholt derive much of their subsistence from the eggs of these birds; but whether they could gather a few millions for oil-making, without repeating the story of the goose and the golden eggs, is questionable. The eider-ducks that inhabit some of the low mossy islands thereabout, are guarded by strict legislative regulations during their incubation period, lest they should emigrate, and the down-harvest be sacrificed.

I now come to the subject of *stewing*, more especially the stewing of flesh food. Some of my readers may think that I ought to have treated this in connection with the boiling of meat, as boiling and stewing are commonly regarded as mere modifications of the same process. According to my mode of regarding the subject, i. e., with reference to the object to be attained, these are opposite processes.

The object in the so-called "boiling" of, say, a leg of mutton is to raise the temperature of the meat throughout just up to the cooking temperature (see Nos. 3 and 4) in such a manner that it shall as nearly as possible retain all its juices; the hot water merely operating as a vehicle or medium for conveying the heat.

In stewing nearly all this is reversed. The juices are to be extracted more or less completely, and the water is required to act as a solvent as well as a heat-conveyer. Instead of the meat itself surrounding and enveloping the juices as it should when boiled, roasted, grilled, or fried, we demand in a stew that the juices shall surround or envelop the meat. In some cases the separation of the juices is the sole object, as in the preparation of certain soups and gravies, of which "beef-tea" may be taken as a typical example. *Extractum Carnis*, or "Liebig's Extract of Meat," is beef-tea (or mutton-tea) concentrated by evaporation.

The juices of lean meat may be extracted very completely without cooking the meat at all, merely by mincing it and then placing it in cold water. *Maceration* is the proper name for this treatment. The philosophy of this is interesting, and so little understood in the kitchen that I must explain its rudiments.

If two liquids capable of mixing together, but of different densities, be placed in the same vessel, the denser at the bottom, they will mix together in defiance of gravitation, the heavy liquid rising and spreading itself throughout the lighter, and the lighter descending and diffusing itself through the heavier.

Thus, concentrated sulphuric acid (oil of vitriol), which has nearly double the density of water, may be placed under water by pouring water into a tall glass jar, and then carefully pouring the acid down a funnel with a long tube, the bottom end of which touches the bottom of the jar. At first the heavy liquid pushes up the lighter, and its upper surface may be distinctly seen with that of the lighter resting upon it. This is better shown if the water be colored by a blue tincture of litmus, which is reddened by the acid. A red stratum indicates the boundaries of the two liquids. Gradually the reddening proceeds upward and downward, the whole of the water changes from blue to red, and the acid becomes tinged.

Graham worked for many years upon the determination of the laws of this diffusion and the rates at which different liquids diffused into each other. His method was to fill small jars of uniform size and shape (about four ounces capacity) with the saline or other dense solution, place upon the ground mouth of the jar a plate-glass cover, then immerse it, when filled, in a cylindrical glass vessel containing about twenty ounces of distilled water. The cover being very carefully removed, diffusion was allowed to proceed for a given time, and then by analysis the amount of transfer into the distilled water was determined.

I must resist the temptation to expound the very interesting results of these researches, merely stating that they prove this diffusion to be no mere accidental mixing, but an action that proceeds with a regularity reducible to simple mathematical laws. One curious fact I must mention, viz., that, on comparing the solutions of a number of different salts, those which crystallize in the same forms have similar rates of diffusion. The law that bears the most directly upon cookery is that "the quantity of any substance diffused from a solution of uniform strength increases as the temperature rises." The application of this will be seen presently.

It may be supposed that, if the jar used in Graham's diffusion experiments were tied over with a mechanically air-tight and water-tight membrane, brine or other saline solution thus confined in the jar could not diffuse itself into the pure water above and around it; people who are satisfied with anything that "stands to reason" would be quite sure that a bladder which resists the passage of water, even when the water is pressed up to the bursting-point, can not be permeable to a most gentle and spontaneous flow of the same water. The true philosopher, however, never trusts to any reasoning, not even mathematical demonstration, until its conclusions are verified by observations and experiment. In this case all rational preconceptions or mathematical calculations based upon the amount of attractive force exerted between the particles of the different liquids are outraged by the facts.

If a stout, well-tied bladder that would burst rather than allow a drop of water to be squeezed mechanically through it be partially filled with a solution of common washing-soda, and then immersed in distilled water, the soda will make its way out of the bladder by passing through its walls, and the pure water will go in at the same time; for if, after some time is allowed, the outer water be tested by dipping into it a strip of red litmus-paper, it will be turned blue, showing the presence of the alkali therein, and, if the contents of the bladder be weighed or measured, they will be found to have increased by the inflow of fresh water. This inflow is called *endosmosis*, and the outflow of the solution is called *exosmosis*. If an India-rubber bottle be filled with water and immersed in alcohol or ether, the endosmosis of the spirit will be so powerfully exerted as to distend the bottle considerably. If the bottle be filled with alcohol or ether and surrounded by water, it will nearly empty itself.

The force exerted by this action is displayed by the rising of the sap from the rootlets of a forest giant to the cells of its topmost leaves. Not only plants, but animals also, are complex osmotic machines. There is scarcely any vital function—if any at all—in which this osmosis does not play an important part. I have no doubt that the mental effort I am at this moment exerting is largely dependent upon the endosmosis and exosmosis that is proceeding through the delicate membranes of some of the many miles of blood-vessels that ramify throughout the gray matter of my brain. But I must wander no further beyond the kitchen, having already said enough to indicate that exosmosis is fundamental to the philosophy of beef-tea extraction, and reserve further particulars for my next paper.

Postscript.—I feel bound to step aside from the proper subject of these papers to make public acknowledgment of an act of honorable generosity, especially as many hard things have been said concerning American plagiarism of the work of British authors. As everybody knows, we have no legal rights in America, and any publisher there may appropriate as much of our work as he chooses. American *legislators* are responsible for this. Nevertheless, I received, a short time since, a letter from Mr. E. L. Youmans, of New York, inclosing a check for £20, as an *honorarium*, in consideration of the fact that these papers are being reprinted in "The Popular Science Monthly." Shortly before this, a similar remittance was sent from another publishing firm (Messrs. Funk & Wagnalls), who have reprinted "Science in Short Chapters." These facts indicate that some American publishers have larger organs of conscientiousness than the present majority of American legislators.

I am told that another American publisher has issued another reprint of "Chemistry of Cookery" without making any remittance; but, as Mr. Proctor would say, "this is a detail."—*Knowledge.*

VINOUS SUPERSTITIONS.

By Dr. TH. BODIN.

ALTHOUGH the world no longer believes in the gods, demi-gods, and heroes with which the ancients and our pagan ancestors animated nearly every object, old-country people still retain a considerable relic of heathenism in the shape of myths of a host of spirits of nature which are all the time at work to produce prosperity and success or destruction.

In Alsace, the eye of the traveler is gladdened by the view of the picturesque vine-lands which stretch in almost unbroken succession along the slopes of the Vosges and Jura Mountains, heavy with handsome clusters of grapes. We can hardly wonder that the country people, feeling a similar delight, but one modified according to their different habit of thought, should attribute the prosperity of their vine-crops to higher powers; and it is easily explainable that in their childish fancies they, half in earnest, half in humor, allow these genii of old to continue to live and do their beneficent work. Especially characteristic of these children of Bacchus, to which a variety of most pleasant legends are attached, are prophecies respecting the success or failure of the next vintage, predictions that make themselves known by visible or audible signs.

Thus, in the spring, when the air is scented with the fragrance of the blossoms, and everything points to an abundant vintage, the people believe they can hear in the hill at Brunstatt the "Wigigerle" fiddling lustily to the accompaniment of ringing glasses and dancing. If, however, the vintner's prospects for the year are dull, the smell of the blossoms is only faint, and the attentive listener can only occasionally hear the sound of the strings, while the hill seems empty and desolate.

A pendant to the jolly "Wigigerle" (wine-fiddler) is the "White Lady of Paulinus Castle" who haunts the region of Weissenburg. She is believed to wander at night through the vines, and occasionally to make her appearance in the day-time. In case the year is to be unprosperous, she shows herself rarely, closely veiled, bearing a bunch of hidden keys, wearing a sad face, and weeping much; but, if the vintage is to be rich, she greets the vine-dressers cheerily, and rattles her keys gayly as she passes through the gardens.

The Alsatians also regard as an infallible wine-oracle the cellar of Arnsberg Castle, which belongs to the family of the Fesslers, a race of sturdy drinkers who became extinct in the seventeenth century, and is popularly called the Devil's Castle. The immense stocks of wine supposed to lie in the deep and spacious caverns have not been touched for centuries; for the most industrious search has failed to discover a door or any way by which an entrance to them can be forced. In good seasons, a sweet odor of wine arises from the ground at the time of the blooming of the vines, and diffuses itself around.

St. Hunna, formerly one of the richest ladies of Alsace, is honored as the patron of the poor, thirsty topers of the town of Hunnasweihen, in bad years. This pious woman, who was a friend and comforter of the poor in the seventh century, sometimes condescended so far as to wash the clothes of her maids, whence she got the name of the saintly laundress. A copious spring, flowing through four outlets, has been consecrated to her memory, and is known far and wide as the Hunna Spring. It occasionally happens in years when wine is scarce, so the story runs, that, when the people go to the spring of mornings and evenings to water their horses and cattle, wine flows out of all the outlets; and those who can boast that they have enjoyed this wine say that it is better than any other.

A St. Morand is honored as the patron of the vintners of a district near Worms, in consequence of a legend that the commune was once blessed, in answer to his prayers, with an unusually abundant harvest. Two portraits of him may be seen in the church at Steinbach, in one of which he is represented as holding a bunch of grapes and pressing out the juice with his hand.

The property is attributed to several springs in Alsace, of flowing only when the harvests are to be abundant.

According to the superstition in another region, if one will go to the Geisbrunn of Freiburg, in Breisgau, at midnight on New Year's, he will find a little man there, who in silence will give some very significant tokens. If the year is to be a good one, he will bear three ears of corn in one hand and three bunches of grapes in the other, and will make friendly gestures. If the year is going to be bad, he will have a sour face and empty hands.

The vineyard is surrounded, in Germany and other countries, by numerous poetic superstitions. The Swabians say that the grapes will receive a fine flavor if the vines are shaken on St. John's day. The Bavarians have a proverb that, if one would have good wine, he must write on his cask, "O taste and see that the Lord is good" (Psalm xxxiv, 8); and the South-Germans have a proverb, "If one would make good vinegar from wine, he must throw the names of three witches into it."

In Switzerland, the country people freshen up their stale wine by laying dead toads on the bung-holes of the casks. The ancient Germans were mindful of their gods at their feasts, when they strove to distinguish themselves as great drinkers; and the pious custom of drinking to the health of their divinities was binding among them. The North-Germans were accustomed at certain feasts to empty a cup to Bragi, and by that act to assume a promise to emulate the bold deeds of that god. Such promises were irrevocable. Bargains were therefore bound by a kind of drink-offering in order to obtain the favor of the gods. At the heir's-feast bumpers were drunk to the memory of the departing one; and on other occasions glasses were emptied in honor of those who were absent. These customs, from which our toasts appear to be derived, were not abolished in Christian times: only the saints succeeded to the rights of the gods. St. Martin, it is said, at his own desire, took the place of Donar; St. Gertrude received the honors that had been paid to Freya; and Njörd and Frey appear to have surrendered their functions to the first martyr of the

Church, St. Stephen. At Freiburg the Johannites were accustomed to hang a stone, representing one of those thrown at Stephen, to a silver chain. Wine was poured upon the stone and then given to the faithful to drink. Memorial drinks to St. Michael and St. John the Evangelist were also very common. Departing guests and travelers were accustomed to drink "John's blessing" as well as in memory of St. Gertrude; and a number of mythical stories are associated with these draughts.

St. Gertrude is said to have drunk a St. John's draught with a knight who had entered into a pact with the devil, and thereby to have delivered him. Since St. Gertrude was the patron of sailors, and her chapel at Bonn, near the Rhine, was much visited by seafaring people, it is easy to explain why the draughts to her honor were drunk in a glass shaped like a ship. It is still customary in some Roman Catholic churches to bless a cup of wine on St. John the Evangelist's day (the 27th of December), and commend to the people the memory of the beloved disciple. These customs are not observed outside of Germany. In Catholic Germany it is usual to celebrate a first festival at the house with the wine (generally red wine) which has been blessed at the church, and to give to the whole family to drink out of the same cup; a few drops are even poured out for the baby in the cradle. Part of what is left is preserved, and part is poured into the cask, to impart its blessing to what is there and turn all evil spells from it. Speculative Swabian hosts often consecrate large quantities of wine for the entertainment of their guests and neighbors; and the popular fancy prevails that, if such of this wine as has been kept over the whole year is drunk on the annivesary of the day of its consecration, it will bring recovery to the sick, and protection and strength to those who are about to start on a journey. Engaged couples taste this wine at their betrothals, when it is offered to them by the priest after having blessed it. If one drinks it on the day it is consecrated, he is secured for the whole year against poisoning, witchery, and lightning. It is an old Bavarian custom for the father to drink a "John's blessing" before departing on a journey, and then, swinging the cup backward over his head, to cast a few drops on the ground. The "John's blessing" on St. John the Baptist's day, June 24th, which the South-German Protestants observe socially, without making a church festival of it, is doubtless related to the Catholic custom.

The John's blessings have been referred to the cup drunk by the disciples, or perhaps to the wedding at Cana of Galilee; but we think we have shown that they are derived from the old heathen thank-offerings, and the sacramental wine has probably been also brought within the scope of the usage by popular fancy. Many healing powers are attached to this wine in some places, and it is sometimes called in as the last and surest remedy in extreme cases. That industrious investigator of folk-lore, M. Töppen, says on this subject in his work on the superstitions of the Masures, that "consecrated communion-wine is used in all diseases as the most sovereign and last resort. The Masures often ask their pastors for it. If they will not give it to them, they go to the Catholic priests, who grant their requests without hesitation. They frequently have the wine blessed at the Catholic confessionals; and some of them think that communion-wine from Catholic churches is more efficacious than that from evangelical churches. Nevertheless, Catholics sometimes go to evangelical pastors to get their communion-wine." Herr C. G. Hintz, another writer on folk-lore, mentions it as a time-honored custom in old Prussia to put a bottle of wine on the altar, so that it may be blessed at the sacramental service.

The beliefs on this subject are in some cases contradictory: thus, while the Lauenburg peasant regards the communion-wine as a sovereign cure, and calls in the priest when he finds the doctor too dear, or that his remedies fail, the people of Oldenburg and East Prussia put off the taking of the sick-bed communion as long as possible, for fear that it will be followed by a speedy death.—*Translated for the Popular Science Monthly from Die Natur.*

MALARIA AND THE PROGRESS OF MEDICINE.*

THE attempt to estimate the successes of medicine on the grand scale is met at the outset by a source of fallacy which can not well be eliminated. Medicine has certainly a share, and it may be a very large share, in the general lengthening of life, in the decrease of pain and suffering, and in the increase of working-power; but other influences, besides the thought and endeavor of the medical profession, have helped to bring about those results. A brief consideration of malarial fever (including simple ague and the more deadly tropical forms), of the causes that have made it less common at home, and more amenable to treatment everywhere, and of the views entertained about it, will serve to show how various are the forces that make for improved well-being, and how checkered the medical record has been. No single cause of premature death, of life-long misery, and of loss of working-power, has ever equaled malaria. There is some reason to think that it was from personal experience of the ague, and the hepatic derangements consequent on it, that Descartes got his profound conviction of ill-health being the greatest of all hindrances to the wisdom and capability of the individual. There can, at least, be hardly any question that malaria is, and always has been, the

* Abstracted from an article entitled "The Progress of Medicine," in the "Quarterly Review" for July, 1883.

largest single element in the miseries of mankind. Fortunately, malarial fever has almost disappeared from Great Britain, and it has hardly existed in some of our colonies, particularly the Australasian; it has decreased considerably in many parts of Northern Europe and the United States. Again, there is a drug, cinchona-bark, with its products, which has a great power over the course of the fever. The cultivation of the cinchona-tree is now a great industry both in the Eastern and Western Hemispheres, and whatever quinine or other products of the bark can do for malarious sickness will be, at no distant time, a benefit that may be shared by all but the very poorest and the races least accessible to civilization. Lastly, the symptoms, course, and complications of the intermittent and remittent fevers which malaria causes are known with all the precision that can be wished. What share, then, has medicine had in dealing with this destroyer of human happiness in the past, and what is the attitude of medicine toward malaria at present?

The almost total extinction of malaria at home and its decrease abroad have been brought about in the ordinary course of draining and cultivating the soil, and by a wise attention to the planting or conservation of trees. There is a characteristic passage at the end of Kingsley's novel "Hereward," in which he commemorates his hero as the first of the new English "who, by the inspiration of God, began to drain the fens." The draining of the fens and all such achievements throughout the world have brought better health with them, but neither the doctors nor even the sanitarians have been the primary moving forces. Again, the medicinal uses of cinchona-bark were known first to the indigenous inhabitants of the Peruvian Andes, where the trees are native and where the ague is common; and it was the Jesuits who introduced it widely into Europe (1630) and the East. The story of the reception of this remedy by the medical profession has its unpleasant side. The arch-stupidities of the Paris faculty, who still live for the amusement of the world in Molière's comedies, opposed it with their united weight. Court physicians in other European capitals than Paris assailed it with abuse, and no one wrote more nonsense about it than Gideon Harvey, the physician of Charles II. The new remedy, apart from its merits, fell in with the views of the Paracelsists, and disagreed with the views of the Galenists, and was recommended or condemned accordingly. Even the great Stahl, nearly a century after cinchona was first brought to Spain, would have none of it, and, in his servitude to his theories, he even went so far as to make use of Gideon Harvey's ignorant tirade against the drug by reprinting it in German. As late as 1729, an excellent physician of Breslau, Kanold, whose writings on epidemics are still valuable for their comprehensive grasp, declared in his last illness (a "pernicious quartan") that he would sooner die than make use of a remedy which went so direct against his principles! The world, of course, gave little heed to these inane disputations; the value of cinchona was beyond the power of the faculty either to discover or to obscure. But, on behalf of the faculty, it remains to add that cinchona found powerful advocates within it from the first; and it will not surprise any one to be told that these were generally the men whom medical history, on other grounds as well, has extolled or at any rate saved from oblivion. Such were Sydenham and Morton in London, Albertini in Bologna, Peyer in Schaffhausen, and Werlhof in Hanover. The therapeutic position of cinchona was firmly established by Torti's treatise on the treatment of periodical fevers, published at Modena in 1709.

The next step in the relief of malarious sickness on the grand scale was the extraction of the alkaloid quinine from the cinchona-bark. The powdered bark was not only very unpalatable, but it was cumbrous to carry and dispense, and, although the principle of the remedy remained the same, it has proved of infinitely greater service in the form of quinine, and in the form of the cheap alkaloidal mixture known in Bengal as "quinetum." The first extraction of an alkaloid was in the case of morphia, from opium, in 1805; the discoverer was an apothecary of Hameln, who was rewarded rather better than the celebrated piper of that town, for the French Academy of Sciences voted him two thousand francs. Quinine was discovered in 1820 by the French chemists Pelletier and Caventou. The sciences and arts of botany and practical forestry, of chemistry and practical pharmacy, are now all concerned in the production of this most invaluable of remedies. The commerce of the world has taken cinchona in hand, and there are now plantations of the trees not unworthy to be named beside those of coffee and tea. The value of the crude bark imported into England alone in 1882 was nearly two millions sterling. The original and native cinchona region on the damp eastern slopes of the Andes in Peru is still a source of wealth, and a still greater source of wealth are the new plantations on the Andes in Bolivia. The Indian Government has successfully cultivated the bark on a large scale in the Nilghiri Hills in Madras, and more recently at Darjiling in the Himalayas; while a crowd of private planters have followed in the same enterprise in Coorg, Travancore, and Ceylon. The Dutch Government, who were the pioneers of cinchona cultivation, have found the climate and soil of Java well adapted for the species and varieties of trees most rich in quinine. Jamaica is the latest field to which this new and ever-increasing industry has extended.

How does quinine control, modify, or cut short an attack of ague? This is a question with which the commerce of the world can not grapple, but only the medical profession; and the truth requires it to be said, that the medical profession knows little of the *modus operandi* of quinine in ague. Sydenham, two hundred years ago, laid down the two great rules for the administration of bark: to give it after the first paroxysm and in the subsequent intervals, and to continue its use as a precaution against the recurrence of the fever. Little remained to be added to these practical indications; they were empirical, indeed—and they are empirical still. The profession is not even sure whether quinine acts by breaking the recurrent habit of ague (as an anti-periodic), or otherwise. There are also the most conflicting statements as to whether the taking of quinine will ward off the attack of ague in passing through a malarious locality; there are a good many reasons for believing that quinine has no preventive or anticipatory action against the first onset of a remittent or intermittent fever, but the professional advice will probably be that quinine taken as a preventive can at least do no harm.

But it is when we leave the sphere of empirical experience, and enter the physiological and pathological workshops of the profession, that we realize most acutely how great is the disproportion, in this matter of malaria, between the opportunities of medicine and its achievements. Take, for example, the following sufficiently eclectic statement on the physiological actions of quinine:

> Quinia, $C_{20}H_{24}N_2O_2$, one of the alkaloids of cinchona, in small doses accelerates the heart's action in the warm-blooded animal; in moderate doses it slows it; and in large doses it may arrest it, and cause convulsions and death. Research shows that its action is essentially upon the central nervous system. It destroys all microscopic animal organisms, apparently killing vibrios, bacteria, and amœbæ; but it seems to be without action on humble organisms belonging to the vegetable kingdom. It arrests the movements of all kinds of protoplasm, including those of the colorless corpuscles of the blood. It arrests fermentive processes which depend on the presence of animal or vegetable organisms, but it does not interfere with the action of digestive fluids.—(Quain's "Dictionary of Medicine," p. 35.)

There is here something for everybody; and, if we now go to the pathological workshop, we shall discover the beautiful adaptation of these varied actions of quinine to the various opinions that are entertained of the malarious fevers over which the drug has so powerful an influence. Is malarial fever a fermentive process, depending on the presence of animal or vegetable organisms? then quinine arrests such processes. Is malarial fever caused by a profound disturbance of the nervous mechanism which regulates the animal heat? then the action of quinine is "essentially upon the central nervous system." Nothing could be more accommodating, and nothing more unsatisfactory.

The theoretical notions about malaria form an instructive page of medical history. Until about 1823 it was always thought to be associated with marshes and swamps, but in that year Dr. William Fergusson brought to England numerous proofs that it occurred abundantly in elevated and rocky regions. Such evidences have gone on accumulating, and it is now well known that malaria has no necessary connection with the marsh. But the profession is still profoundly impressed with the belief that malaria is an actual or material poisonous substance. To Homer it was the arrows of Apollo in anger, to the mediæval folk-lore it was the mischief of elves and sprites; and, if scientific medicine does not now permit us to personify the malaria, it teaches us at least to materialize it. Although the fevers which malaria produces are quite unlike the fevers that are contagious or communicable, the present scientific guides of the profession are resolved to find a material virus or poison as the cause of them. The malarial poison was sought for, in the early days of chemistry, among the various gases of the marsh, but the chemical search proved fruitless. When the microscope came in, the miasm was diligently looked for in the soil of malarious localities and in the vapors overhanging them. From 1849 to the present year, some twenty different vegetable organisms or their spores, of very various degrees of complexity, have been described each in its turn as the malarious miasm and as the specific cause of remittent and intermittent fevers; and the quest for a material substance assumed to be the cause of malarial fever is regarded with much favor in the best scientific circles. Meanwhile a body of opinion, which takes due account of all the manifold associated circumstances of malaria throughout the world, has been forming, and yearly growing in volume, that there is no malarious miasm at all; that "malaria," indeed, is a profound disorganization of the nervous mechanism that presides over the temperature of the body; and that this upsetting of the heat-regulating center is likely to happen when the body has been exposed during the day to extreme solar heat and to fatigue, and exposed at sundown and in the night to the tropical or sub-tropical chill, which will be severe in proportion to the rapid cooling of the ground and the amount of vapor condensed in the lowest stratum of the air. There is no more beautiful mechanism in nature than that which keeps man's internal heat always about 98° day and night, summer and winter, in the Arctic regions or in the tropics; but even that most wonderful of all self-adapting pieces of mechanism, if it be taxed too much, as by extremes of day and night temperature, will get out of gear; and a fever, still retaining something of the diurnal periodicity, will be the result. No one can read the powerful criticism * of Surgeon-Major Oldham, of the Indian Medical Service, without discovering this rational explanation of malaria to have the best of the facts and the best of the logic on its side.

The decision of this point of theory one way or another has the most momentous issues, not so much for the treatment of malarious fever as for its prevention. It is, in short, a question, on the one hand, of common prudence in warm countries, more often moist than arid, and more often level than mountainous, against exposure of the body to the direct action of the sun's rays and to the nightly chill

* "What is Malaria? and why is it most intense in Hot Climates?" London, 1871, 8vo, pp. 186.

that follows; or, on the other hand, of a fatalist doctrine of vegetable spores or organisms of the lowest grade making ceaseless war upon mankind. The world has a way of finding out the truth by its experiences on the large scale. It settled the inane theoretical objections to the value of cinchona-bark, and it will probably form its own opinion on the relative merits of the vegetable-spore theory of malaria and the theory of exposure and climatic vicissitudes. It will be a regrettable circumstance if in this matter the profession has to follow public opinion instead of leading it.

THE LOESS-DEPOSITS OF NORTHERN CHINA.

By FREDERICK W. WILLIAMS.

SCIENTISTS as well as economists and statesmen are turning with a scrutiny, renewed as each year advances, toward the great region of middle Asia—a territory which, if it supplies society with immigrants much too thrifty for the tastes of our broader-minded Celtic brethren, bids fair in many ways to furnish materials for scientific research that can be compared in interest to no other portion of the world's surface. Without delaying to mention here the recent travelers who are rapidly lessening the bounds of that tract, still confessed to be the least known area of the globe, it is our purpose to direct attention to a geological phenomenon among the most important as well as peculiar of any hitherto brought to light in this field of investigation: we mean the loess-beds covering a great portion of Northern China.

The term *loess*, now generally accepted, has been used to designate a tertiary deposit appearing in the Rhine Valley, along the Danube, and in several isolated sections of Europe. Its formation has heretofore been ascribed to glaciers, but its enormous extent and thickness in China demand some other origin. The substance is a brownish-colored earth, extremely porous, and, when dry, easily powdered between the fingers, when it becomes an impalpable dust that may be rubbed into the pores of the skin. Its particles are somewhat angular in shape, the lumps varying from the size of a peanut to a foot in length, whose appearance warrants the peculiarly appropriate Chinese name meaning "ginger-stones." After washing, the stuff is readily disintegrated, and spread far and wide by rivers during their times of flood. Mr. Kingsmill, in the "Journal of the Geological Society" (London), states that a number of specimens, which crumbled in the moist air of a Shanghai summer, rearranged themselves afterward in the bottom of a drawer in which they had been placed. Every atom of loess is perforated by small tubes, usually very minute, circulating after the manner of root-fibers, and lined with a thin coating of carbonate of lime. The direction of these canals being always from above downward, cleavage in the loess mass, irrespective of size, is invariably vertical, while, from the same cause, water in falling upon a deposit of this material never collects in the form of puddles or lakes on its surface, but sinks at once to the local water-level.

The loess territory of China begins, at its eastern limit, with the foot-hills of the great alluvial plain—roughly speaking, upon the line drawn from Peking to Kaifung in Honan. From this rises a terrace of from ninety to two hundred and fifty feet in height, consisting entirely of loess; and westward of it, in a nearly north and south line, stretches the Tai-hang Shan, or dividing range between the alluvial land and the hill-districts of Shansi. An almost uninterrupted loess-covered country extends west of this line to Lake Koko-nor and head-waters of the Yellow River. On the north the formation can be traced from the vicinity of Kalgan, along the water-shed of the Mongolian steppes, and into the desert beyond the Ala Shan range. Toward the south its limits are less sharply defined; though covering all the country of the Wei basin (in Shensi), none is found in Sz'chuen, due south of this valley, but it appears in parts of Honan and Eastern Shantung. Excepting occasional spurs and isolated spots, loess may be considered as ending everywhere on the north side of the Yangtse Valley, and, to convey a general notion, as covering the parallelogram between longitudes 99° and 115° east, and latitudes 33° and 41° north. The district within China Proper represents a territory half as large again as that of the German Empire, while outside of the provinces there is reason to believe that loess spreads far to the east and north, possibly in varying thicknesses quite across the desert. Baron von Richthofen observed this deposit in Shansi to a height of 7,200 feet above the sea, and supposes that it may occur at higher levels.

One of the most striking as well as important phenomena of this formation is the perpendicular splitting of its mass—already referred to—into sudden and multitudinous clefts that cut up the country in every direction, and render observation as well as travel often exceedingly difficult. The cliffs, caused by erosion, vary from cracks measured by inches to cañons half a mile wide and hundreds of feet deep; they branch out in every direction, ramifying through the country after the manner of tree-roots in the soil—from each root a rootlet, and from these other small fibers—until the system of passages develops into a labyrinth of far-reaching and intermingling lanes. Were the loess throughout of the uniform structure seen in single clefts, such a region would indeed be absolutely impassable, the vertical banks becoming precipices of often more than a thousand feet. The fact, however, that loess exhibits in every locality a terrace formation, renders its surface not only habitable, but highly convenient for agricultural purposes; it has given rise, moreover, to the theory advanced by Kingsmill and some others, of its stratification, and from this a proof of its origin as a marine deposit.

But, since attention was first directed to this formation by Mr. Pumpelly, in 1864, its structure has been more carefully examined by other geologists, whose hypotheses are pretty generally discarded for that of Baron von Richthofen. This gentleman, who may be considered *facile princeps* among foreign geologists who have visited China, argues that these apparent layers of loess are due to external conditions, as of rocks and *débris* sliding from surrounding hill-sides upon the loess-dust as it sifted into the basin or valley, thus interrupting the homogeneity of the gradually rising deposit. In the sides of gorges near the mountains are seen layers of coarse *débris* which, in going toward the valley-bottom, become finer, while the layers themselves are thinner and separated by an increasing vertical distance; along these rubble-beds are numerous calcareous concretions which stand upright. These are, then, the terrace-forming layers which, by their resistance to the action of water, cause the broken chasms and step-like contour of the loess regions. Each bank does, indeed, cleave vertically, sometimes—since the erosion works from below—leaving an overhanging bank; but, meeting with this horizontal layer of marl-stones, the abrasion is interrupted, and a ledge is made. Falling clods upon such spaces are gradually spread over their surfaces by natural action, converting them into rich fields. When seen from a height in good seasons, these systems of terraces present an endless succession of green fields and growing crops; viewed from the deep cut of some stream or road-bed, the traveler sees nothing but yellow walls of loam and dusty tiers of loess-ridges. As may be readily imagined, a country of this nature exhibits many landscapes of unrivaled picturesqueness, especially when lofty crags, which some variation in the water-course has left as giant guardsmen of fertile river-valleys, stand out in bold relief against the green background of neighboring hills and a fruitful alluvial bottom, or when an opening of some ascending pass allows the eye to range over leagues of sharp-cut ridges and teeming crops, the work of the careful cultivator.

The extreme ease with which loess is cut away tends at times to seriously embarrass traffic. Dust made by the cart-wheels on a highway is taken up by strong winds during the dry season and blown over the surrounding lands, much after the manner in which it was originally deposited here. This action, continued over centuries, and assisted by occasional deluges of rain, which find a ready channel in the road-bed, has hollowed the country routes into depressions of often fifty or a hundred feet, where the passenger may ride for miles without obtaining a glimpse of field or landscape. Lieutenant Kreitner, of the Szechenyi exploring expedition (whose pleasant article on Thibet appeared in "The Popular Science Monthly" for August, 1882) illustrates, by a personal experience when in Shansi, the difficulty and danger of departing from the highway when in one of these deep cuts; after scrambling for miles along the broken loess above the road, he only regained it when a further passage was cut off by a precipice on the one side, while a jump of some thirty feet into the beaten track was his only alternative upon the other.

Difficult as may be such a territory for roads and the purposes of trade, its advantages to a farmer are manifold. Wherever this deposit extends, there the husbandman has an assured harvest two and even three times in a year. It is easily worked, exceedingly fertile, and submits to constant tillage, with no other manure than a sprinkling of its own loam dug from the nearest bank. But loess performs still another service to its inhabitants. Caves made at the bases of its straight clefts afford homes to millions of people in the northern provinces. Choosing an escarpment where the consistency of the earth is greatest, the natives cut for themselves rooms and houses, whose partition-walls, cement, beds, and furniture are made *in toto* from the same loess. Whole villages cluster together in a series of adjoining or superimposed chambers, some of which pierce the soil to a depth of often more than two hundred feet. In costlier dwellings the terrace or succession of terraces thus perforated are faced with brick, as well as the arching of rooms within. The advantages of such habitations consist as well in imperviousness to changes of temperature without as in their durability when constructed in properly selected places—many loess dwellings outlasting six or seven generations. The capabilities of defense in a country such as this, where an invading army must inevitably become lost in the tangle of interlacing ways, and where the defenders may always remain concealed, are very suggestive.

There remains, lastly, a peculiar property of loess which is perhaps more important than all other features when measured by its man-serving efficiency. This is the manner in which it brings forth crops without the aid of manure. From a period more than two thousand years before Christ, to the present day, the province of Shansi has borne the name of "Granary of the Empire," while its fertile soil, *hwang-tu*, or "yellow earth," is the origin of the imperial color. Spite of this productiveness, which, in the fourteenth century, caused Friar Odoric to admiringly call it "the second country in the world," its present capacity for raising crops seems to be as great as ever. In the nature of this substance lies the reason for this apparently inexhaustible fecundity. Its remarkably porous structure must, indeed, cause it to absorb the gases necessary to plant-life to a much greater degree than other soils, but the stable production of those mineral substances needful to the yearly succession of crops is in the ground itself. The salts contained more or less in solution at the water-level of the region are freed by the capillary action of the loess when rain-water sinks through the spongy mass from above. Surface moisture, following the downward direction of the tiny loess-tubes, establishes a connection with the waters compressed below, when, owing to the law of diffusion, the ingredients, being released, mix with the moisture of the little canals, and are there taken from the lowest to the topmost levels, permeating the ground and furnishing nourishment to the plant-roots at the surface. It is on account of this curious action of loess that a copious rainfall is more necessary in Northern China than elsewhere, for with a dearth of rain the capillary communication from above, below, and *vice versa*, is interrupted, and vegetation loses both its moisture and manure. Drought and famine are consequently synonymous terms here.

As to the origin of loess, Baron von Richthofen's theory is substantially as follows: The uniform composition of this material over extended areas, coupled with the absence of stratification and of marine or fresh-water organic remains, renders impossible the hypothesis that it is a water-deposit. On the other hand, it contains vast quantities of land-shells and the vestiges of animals (mammalia) at every level—both in remarkably perfect condition. Concluding, also, that from the conformation of the neighboring mountain-chains and their peculiar weathering, the glacial theory is inadmissible, he advances the supposition that loess is a subaërial deposit, and that its fields are the drained analogues of the steppe-basins of Central Asia. They date from a geological era of great dryness, before the existence of the Yellow and other rivers of the northern provinces. As the rocks and hills of the highlands disintegrated, the sand was removed, not by water-courses seaward, but by the high winds ranging over a treeless desert landward, until the dust settled in the grass-covered districts of what is at present China Proper. New vegetation was at once nourished, while its roots were raised by the constantly arriving deposit; the decay of old roots produced the lime-lined canals which impart to this material its peculiar characteristics. Any one who has observed the terrible dust-storms of Northern China, when the air is filled with an impalpable yellow powder, which leaves its coating upon everything, and often extends in a fog-like cloud hundreds of miles to sea, will understand the power of this action during many thousand centuries. This deposition received the shells and bones of innumerable animals, while the dissolved solutions contained in its bulk staid therein, or saturated the water of small lakes. By the sinking of mountain-chains in the south, rain-clouds emptied themselves over this region with much greater frequency, and gradually the system became drained, the erosion working backward from the coast, slowly cutting into one basin after another. With the sinking of its salts to lower levels, unexampled richness was added to the wonderful topography of this singular formation.

Mr. Pumpelly, while accepting this ingenious theory in place of his own (that of a fresh-water lake deposit), adds that the supply of loess might have been materially increased by the vast *mers-de-glace* of High Asia and the Tien Shan, whose streams have for ages transported the products of glacial attrition into Central Asia and Northwestern China. Again, he insists that Richthofen has not given importance enough to the parting planes, wrongly considered by his predecessors in the study of Chinese geology as planes of stratification. "These," he says, "account for the marginal layers of *débris* brought down from the mountains. And the continuous and more abundant growth of grasses *at one plane* would produce a modification of the soil structurally and chemically, which superincumbent accumulations could never efface. It should seem probable that we have herein, also, the explanation of the calcareous concretions which abound along these planes; for the greater amount of carbonic acid generated by the slow decay of this vegetation would, by forming a bicarbonate, give to the lime the mobility necessary to produce the concretions."

It is hardly within the scope of this article to do more than present in brief outline an exposition of the loess-theory that has made its orginator already celebrated throughout Germany. Nor can we follow Baron von Richthofen further into the extension of his postulate, wherein one is scarcely surprised at finding a plausible and attractive application of this idea of loess-formation to the entire Europe-Asiatic Continent, to the pampas of the South and prairies of the North American world. While the three or four northwestern provinces of China exhibit undoubtedly the strangest and most picturesque features of this formation, its influence upon the climate of Central Asia, the reactionary effect of this upon the surface configuration of the steppelands, and thus on the historical and ethnographical development of the cradle of the human race, are but some of the legitimate generalizations—if not necessary results—coming from this interesting phase of nature.

THE NATURAL SETTING OF CRYSTALS.

By J. B. CHOATE.

THE study of natural history has of late years been largely directed to the observation of laws according to which the development of the individual species and genus takes place. Although the vital principle which determines the growth and the nature of the animal or plant eludes the search of shrewd and practiced observers, yet the modes in which that principle manifests itself are in many cases pretty well understood. In numberless instances we have been shown the purpose with which Nature works on unceasingly toward certain definite anticipated ends. It is this fixed intent of Nature, rationally and hopefully pursued, which reveals the thought of the universe. The processes of growth and of change are evident enough to be familiar, but it is the reason for these phenomena which so often makes them miracles of wonder to the observer. Care, intelligence and skill will everywhere be seen, but there is a marked distinction between the growth that goes on under the supervision of an intelligence wholly external to the form which is brought into being, as in the case of a crystal, and that development which is made according to instinctive or conscious tendencies implanted in the germ.

Tree, shrub and grass show evidence of effort on the part of the individual directed to quite obvious ends. The form assumed is in every instance such as to enable the plant to resist the violence to which it may be exposed. All the energies controlled by vital force are directed to supplying wants felt or anticipated. The tree in its growth develops strength where strength is needed, just as man by exercise increases his muscular power. In the formation of crystals another law predominates. It matters not whether these are safely hidden away in the caverns of the earth, or are exposed to risk of destruction upon its surface. They usually occur attached to one another, or to the faces of the rock. In the latter case, such as have unequal axes will be found so placed as to have their longest axes at right angles to the surface to which they are attached, or, if the surface be curved, this axis will be at right angles to the plane tangent to the curve at that point. This arrangement will be seen most plainly upon examination of a geode lined with quartz-crystals. It provides for the setting of the largest number of crystals upon a given surface, but puts them in the position of the least stable equilibrium quite unlike the sturdy posture assumed by a tree deeply rooted to the soil, and having its fibers most strongly interlaced in the region of its base. This setting of crystals displays them to the best advantage, but it leaves them more exposed to abrasion than would any other position, and more likely to be removed from their place. No provision has been made to guard against external violence, and in this may be found a striking point of distinction between an animate and an inanimate entity.

SURFACE CHARACTERS OF THE PLANET MARS.*

SCHIAPARELLI continued his observations of the topography of the planet Mars during its last opposition, i. e., from October 26, 1881, to the end of February, 1882, and his results were communicated in a preliminary report early in March to the Accademia dei Lincei, of Rome.

Owing to the prevailing weather, his observations were restricted

* Translated for "The Popular Science Monthly" by Marcus Benjamin, Ph. B., F. C. S.

to fifty days—from the end of December to the beginning of February. Among these, sixteen evenings were remarkably favorable, so much so that the greatest magnifying powers could be used.

It was therefore possible, notwithstanding the fact that the apparent diameter of Mars was not over 16″ (against 19″ in 1877), to obtain results which surpass all previous endeavors. Beginning with the white polar spots, Schiaparelli first mentions that the northern polar spot was always more or less visible. During the months of November and December it appeared separated into several branches or masses, as was also the case in 1879. In the latter half of January these branches began to amalgamate and form a regular, continuous, and uniform *calotte*, the diameter of which reached about 50° at the beginning of February, and then decreased in a distinctly noticeable manner; while, on the contrary, the southern polar spot remained invisible during the entire period of the observations, even in January and February, when the south pole entered the field of view 2°. From this, in connection with the experience gained in 1879 relative to the visibility of the spot, he concludes that eight months after the southern solstice it had not yet attained a diameter of 20°—a diameter which, according to the observations during the previous opposition, it generally attained to a few weeks before this solstice.

During the course of the observations, various white or whitish spots made their appearance at the southern edge of the planet, greatly resembling the polar spot, but after exact examination and measurement proved to be one or the other of the well-known southern islands of the planet, which appeared white around their edges in consideration of a property peculiar to these localities.

The dark portion (ocean?) which surrounds these islands did not seem to possess this property; and, in order to explain how the polar spot, during the southern winter on Mars, can occupy a part of this locality, it becomes necessary to make the assumption that at such times this part undergoes such changes that it is enabled to appear of a bright white color.

Similar white or whitish spots were observed at intervals at other points of the yellow surface of the planet; some of the better determined points, which had already been noticed in 1877 and 1879, were also visible on this occasion, while others remained invisible. A number of white spots were observed, which, however, were only temporary, particularly in the neighborhood of the northern polar *calotte*. Emanating from this position, there often would be noticed white inclined stripes passing toward the equator of the planet; the arrangement of these seemed to be dependent upon the rotation of Mars—other positions near the edge of the planet likewise presented a whitish appearance.

A general dimming of the white spots which hid the configuration of the planet was observed on the 18th of January, between the meridians of 40° and 120°. It extended only over the yellow portions, which are supposed to be continents, and often covered the canals, but completely avoided the darker portions, which represent the oceans and larger lakes. It was not a contiguous covering, but consisting of white or whitish spots, which were irregularly distributed.

The atmosphere of Mars appears to have been more transparent than during 1877. Not only the luminous and the opaque zone of the rim were smaller, but in some parts of the planet the contrast between the light and shade was more distinctly visible with an inclined illumination, and so it was possible to more readily distinguish objects at the edge of the planet than at the center.

During November the north pole advanced some 7° to 8° within the circle of the visible hemisphere; but the hope of being enabled to examine the surface in the vicinity of this pole was unrealized on account of the unfavorable weather. For this reason the limit of the chart of 1881–'82 does exceed 60° north latitude, and, hence, does not extend much beyond the portions explored in 1879; but the parts lying between 30° and 60° northern latitude could be more closely examined. On this occasion also the lower end of the chart is limited by a series of dark stripes which appear to be connected with the northern ocean. The peculiar character of the surface of Mars can not, however, be well explained until after the next opposition. It was impossible to explore the southern ocean with exactness beyond 50° south, although all of the islands which had previously been recognized were observed as white spots similar to the polar snow. All of the smaller seas which branch off from the equator were very distinct in their configuration. The continents and the interior lakes between the bright equatorial zone and the south ocean could be drawn with the greatest accuracy. A few changes in the appearance of particular portions as compared with their shape in 1879 were noticed, and as hundreds of thousands of square kilometres of surface, which were formerly light, had in the mean while become dark, so on the other hand many of the sections which previously were dark now became luminous. These changes prove that the darkening principle which produces them is due to something which is movable and extends over the surface of the planet (for instance, water or some other liquid), or perhaps something capable of being transmitted from place to place (such as vegetation).

Not one of the old dark lines which have been called "canals" was missing, and causes which in all probability were due to the sun produced numerous phenomena, which in former oppositions were only suspected. That brilliant, light-red color mixed with white, which in 1877 occupied the whole of the equatorial zone and a large part of it in 1879, was found in 1882 to be entirely absent. Undefined shadows began to form in this luminous veil surrounded by stains of an orange-yellow color; these shadows become darker by degrees, concentrate themselves and absorb bodies by changing into groups of more or less black lines; at the same time the orange color extends, and finally, with but little exception, covers the whole of the so-called continental zone.

The large areas of the so-called "Alcionia" ocean and gulf, which in 1879 appeared to belong to the "ocean," resolved themselves into complicated bunches of definite lines. Finally, one could see what we have every reason to believe is the true aspect of the planet. Besides this, we noticed the peculiar and unexpected phenomena of the *doubling* of the canals, which will probably tend to considerably alter the present views of the physical characters of the planet. This doubling is clearly not an optical effect, dependent upon the increased optic power, as is the case in the double stars; nor is it produced by the longitudinal division of a canal. It takes place under the following circumstances: To the right or left of an existing line, without any change in its direction or position, another parallel line is produced which differs from the first in appearance and direction only in exceptional cases. Between the lines so produced, the distance varied from 12° to 6° (350 to 700 kilometres). Among certain of the lines doubling could only be suspected, but not observable at the small distance (5°) separating them. Sometimes a line was darker or broader at two or more points, and the accompanying line would also show this peculiar feature. The length of each pair may differ considerably, and vary from 15° to 80°. Some were of a reddish-brown color, somewhat darker than the ground from which they could be distinguished; others, generally the finer ones, were very dark. The broader ones formed true bands, the sides of which were perfectly parallel. They followed (as far as could be judged without exact measurements) the direction of the large circles of the planet, and only in a few cases were they bent off toward the side. No irregularities could be observed among them with the magnifying (417) power used. Certain of them show such great regularity that they might be designated as a series of parallel lines drawn by the aid of a ruler. In some cases, several pairs would combine, one behind the other, and form a double polygonal line; with very definitely marked angles such a series would occupy a great extent. This phenomenon of doubling appears to be connected with certain epochs—and it takes place almost simultaneously over the entire surface of the planet, covered by the bright portions (continents ?). Not a trace of these was observed in 1877 during the weeks which followed the southern solstice of the planet. A single isolated instance was noticed in 1879 on the 26th of December. The appearance of this doubling was the more surprising, as a careful examination on December 23d and 24th gave no cause for suspecting any such change. During the last opposition, a reappearance of this phenomenon was impatiently looked for, but it did not show itself for two months, and then later than was expected ; at first indistinct and dim, but becoming more distinct on the following day. This was one month after the autumnal equinox of Mars. The doubling continued to be visible until after the end of February. On the 11th of January another doubling had already made its appearance, but was not further noticed because the canals which doubled were very irregular. Great, therefore, was our surprise to find that, on the 19th of January, a canal which passed through the center showed two straight parallel lines, which, on repeated examination, were found to be true phenomena. From this date the number of canals appearing doubled increased ; even on the 24th of February when the apparent diameter of Mars had been reduced to less than 10°, the doubling of the canals could be distinguished. In an aggregate (exclusive of a few cases which could not be configured on account of the insufficient power of the telescope to define such delicate cases), some twenty cases of doubling were noticed, seventeen of which occurred in the course of one month, i. e., from January 19th to February 19th—the mean of the time corresponding to about the end of the second month after the autumnal equinox of the planet. In addition to these there were probably others which made their appearance ; but, unfortunately, the unfavorable weather and the increasing distance of the planet prevented a successful following up of the further development of these highly important phenomena. In a few cases it was possible to determine some premonitory signs of the doubling.

On January 13th a very light and indefinite shadow began to spread itself parallel to the canal known as "Ganges" ; on the 18th and 19th these portions were covered with white spots, on the 20th the Ganges appeared to be composed of two lines, but the phenomenon was still doubtful ; on the 21st the doubling was distinct and remained so until February 23d. Similar observations were made on other lines.

Everything leads to the conclusion that we have here a periodical phenomenon, which is probably connected with the seasons of Mars. If this be the case, we may hope to extend these observations during the next opposition, when we shall be able to see the seasons of the planet advanced about eighty days. This opposition will take place January 1, 1884. The position of Mars on this date will be identical with that on the 13th of February, 1882, and the apparent diameter will be about 12·9″, that is, pretty near the mean diameter which the planet had during the finding of the above-described doublings. Therefore there is reason to hope that these phenomena may again be determined and confirmed by other observers. The desire to obtain such information has been the main object of the foregoing communication.

THE NEW PROFESSION.

By HENRY GREER.

IT is but a few years since the practical student of electrical science was limited to the single branch of telegraphy. His choice lay between becoming a telegraph operator and a manufacturer of telegraph instruments. The telegraph operators form a numerous and intelligent body of men; sharp competition exists among them, and for a long time they had scarcely any chance of improving their position, because until recently no other branch of electrical engineering was open to them. But, during the last dozen years, great progress has been made in various and new applications of electricity. Skilled electrical engineers are few; and any one, who has acquired a practical knowledge of several branches of electricity, will find no difficulty in keeping himself profitably employed.

Until lately, the young electrician's great desire was to qualify himself for submarine telegraphy. The work of *testing* and localizing faults in cables is of a more scientific and interesting character than work in other departments of telegraph engineering. The manufacture of cables is also a subject for particular study, and a fair knowledge of mechanical engineering may be gained by practice in it. Two of the many different departments of electrical engineering, telephony and electric lighting, are becoming especially important, and yet there is great difficulty in finding competent electricians to accomplish the work.

During a recent sojourn in Europe, I learned that not only young men, but educated women also, were studying electrical engineering, and that large fortunes have been made in it. The enormous extension of the telegraphic system, and the wonderful advances made in electricity, electric lighting, telephony, electrical cables, and railways, and in the transmission of power, offer great advantages to persons seeking profitable employment. Telegraph engineering or electrical engineering is a new profession. More than this, it is one which is not yet overcrowded, and it is, therefore, undoubtedly an occupation which many of our college graduates will adopt.

The ultimate value of the advances which have recently been made in electrical science can not now be estimated. The great electrician, Professor Clerk Maxwell, was asked shortly before his death, by a distinguished scientist, "What is the greatest scientific discovery of the last quarter of a century?" His reply was, "The discovery that the Gramme machine is reversible." The ordinary electrician would have called the telephone, the Faure accumulator, or the Edison electric light, the greatest discovery, but Professor Maxwell's deep and philosophic mind perceived that in the fact he named, which to so many of us might seem little more than a curious experiment, lay the principle which, if rightly developed, would make practicable the transmission of power.

If, now, we could call back this great electrical engineer, and ask him what recent discovery came next in importance to this, what would he reply? His answer would be the discovery that "a voltaic battery is reversible." The Gramme machine has given us means of transmitting power of electricity. The later discovery enables us to store up electrical energy as distinguished from electricity.

Electrical engineering, which embraces a knowledge of cables, telegraphy, electric lighting, electrical measurement, transmission of power, storage-batteries, and how to localize faults in cables, land lines, and telephone lines, has thus become a subject of the first practical importance.

A prominent department of the electrical engineer's work is the localizing of faults in ocean-cables, which may be of five different kinds: 1. Where the copper conductor makes a "perfect earth." 2. Where the copper conductor is broken, and yet the insulation remains unbroken. 3. Where an "imperfect earth" is made. 4. Faults arising from a hole in the gutta-percha sheath, making a connection between the conductor and the sea. 5. From the establishment of a connection between the iron sheathing and the copper core, by a nail or wire driven in.

The first kind of fault is easily located, because we know the resistance of the cable when it is in perfect working order. If, for instance, it has 10,000 *ohms*, or units of resistance, a fault making a perfect earth midway in the cable would give us 5,000 ohms resistance. Or, we know how many ohms of resistance there are to a mile of cable when it is in perfect working order, and, by the use of delicate instruments and by mathematical calculations, we can easily locate the fault.

The location of the second class of faults, i. e., a complete breakage of the conductor, naturally followed by a total cessation of all communications between the two ends of the cable, may be detected in several ways. The charge which the cable will contain is first measured; and, when the charge per mile is known, the amount actually observed will directly give the location of the faults; and the exactness with which the position of the break can be determined is limited only by the accuracy with which the relative charges can be compared. Suppose, for instance, the discharge from a mile of the cable with a given battery, and reflecting galvanometer, is represented by a deflection of ten divisions, and the discharge from a cable containing a broken copper conductor is one hundred divisions, we know the fault is about ten miles from the shore.

A fault of the fourth kind is located very readily. There is a great fall in the insulation resistance, and a slight fall in the apparent resistance of the copper conductor, between the two stations; but messages can be still transmitted, as a part only of the whole current, inversely proportional to the resistance of the fault, escapes into the ocean. If one office insulates the cable, and the other measures the resistance, the fault acts like a fault that is caused by the fracture of both the copper wire and the gutta-percha, but little of the copper core being exposed.

The fifth kind of fault corresponds almost exactly in behavior to a fault caused by fracture of the copper conductor and gutta-percha, in which a considerable portion of the length of copper wire remains exposed to the water. The resistance will vary still less; and there will be a total absence of the feeble currents which result when the copper and iron of a cable are broken and separated by salt water.

Submarine or ocean telegraphy holds a very prominent place in electrical engineering, and the instruments used in it are interesting. In instructing pupils a very curious apparatus is used. It is the artificial or dummy cable, consisting of a number of "resistance-coils," and condensers so arranged as to reproduce all the phenomena and all the practical difficulties that are presented by a real ocean-cable. With a good instructor, this piece of apparatus is of very great service, inasmuch as all kinds of imperfections can be readily and correctly imitated in any part of the circuit.

Still greater interest, perhaps, attaches to the apparatus for showing the retardation that a current experiences in traversing a long cable. This apparatus consists of a series of "resistance-coils," "rheostats," and condensers, having small receiving instruments at a dozen different points in the circuit, representing as many different offices on the line. The receiving instruments are similar to the mirror portion of Sir William Thomson's mirror galvanometer. In this a ray of light falls upon a very small mirror attached to a small magnet; and this rotates around a vertical axis when acted upon by a current that circulates in a coil of wire. These magnets, with the mirrors attached, moving one after the other, indicate the time taken in charging the whole length of the circuit.

I. The Storage of Electricity.—Another principal branch of electrical engineering, promising much in the near future, is the great French discovery of the storage of electrical energy. It is among the most important inventions of the last thirty years. The electrical storage of energy must not be confounded with the storage of electricity. An electrical storage-battery is an apparatus for transforming electricity; in it electrical energy is no longer produced directly, but changes its properties. A given source furnishes a certain volume or quantity of electricity, at a certain pressure or tension. In certain instances, it may be important to increase one of these properties at the expense of another, as in mechanics it is often required to transform speed into force or force into speed by means of fly-wheels or driving-wheels. The apparatus which produces this charge is called the electrical transformer. These machines can be divided into two large classes: 1. As regards tension; and, 2. As regards quantity. The storage-batteries of Thomson, Planté, d'Arsonval, and Varley, belong to the quantity class. All these batteries have a common use. They store electrical energy and give it out transformed. Secondary couples are electrical accumulators, as well as transformers.

II. The Electric Light.—It is clear that this wonderful application of electricity is thus far only in its infancy, and that it must either supplement or supplant gas-lighting in the near future. In it educated persons of either sex may, after a thorough course of training, easily find very remunerative employment in a fast-developing branch of the new profession. With all the older professions overcrowded, an electrical engineer's prospects are, to-day, undoubtedly bright, especially if he has some knowledge of mechanics, though this is not absolutely necessary. Very great impetus has, also, been given to electrical industries by the invention of the telephone, electrical storage-batteries, fire-alarm telegraphs, district telegraphs, and the introduction of the electric light into the domain of our domestic economy. In all these branches there are more places than qualified persons to fill them.

III. Training for the New Profession.—The person who is educated simply as a mechanical engineer, or simply as a telegraph engineer, can not at once make himself useful in the wider range of the new profession which has created itself. The requisites for an electrical engineer are, theoretical and practical knowledge of physics, including mechanics and mathematics. The first questions to be asked a parent, who desires his son to be an electrician, are: "Has your son been studying physics at the ordinary school? Has he ever made any experiments himself, or does he see experiments made by the lecturer?" Let this son commence his technical education at once, for he can learn more of real science in the interval of rest, during his technical education, than he will ever acquire if he devotes himself to books. By a technical college we mean one in which a general education in the application of science to industries is given to all the students, and a special education in the applications of science to individual students.

Electrical engineering has thus a deeper interest for the parents of America than they know. A knowledge of mechanical drawing and designing is essential; and new designs of instruments should be put before the students for use and study, as it is important to cultivate in them the powers of original thought and combination. Next to machine designing and drawing, in the education of an electrical engineer, is a practical knowledge of electricity. And by this I mean far more than an ordinary acquaintance with the effects of glass electrical machines, sealing-wax experiments, etc., etc. The knowledge must be experimental, and it must be quantitative, not merely qualitative. No person ever learned electricity from a book. If one wants to know why a particular *dynamo* is more efficient than another, he must enter on a course of professional education, like that of studying medicine or reading law. Night after night, in England, many young men come thirty miles to learn how the efficiency of an electric lamp, storage-battery, or a dynamo-machine, is actually measured—how to obtain experimentally the characteristic curves of dynamo-machines of different speeds, calibrating galvanometers, testing magnets, etc.

It would not have been extremely difficult to give lectures on electrical engineering twenty years ago, but the development of the science now is so great that it would be an exceedingly laborious matter to prepare a course on the subject without efficient apparatus. Of the importance of such lectures there can be no doubt, and the time will come when the principles, at least, of electrical engineering will be taught in our schools. The new developments of the science and art can hardly be exaggerated ; and while at one time scientific men were of the opinion that the popular mind erred in supposing that electricity would supersede steam as a motive power, engines are now employed to produce power, while electricity affords us the very best means yet discovered of distributing that power.

Electricity does not yet take the place of steam, but it takes the place of cogs, wheels, belting, etc.

A word as to the time necessary to become an electrical engineer. It is claimed by some that six months' study suffices to make a good electrician ; but experience teaches us that a year and a half of assiduous work would not be by any means too much.

In conclusion, I may say that this is a profession suitable for women of a scientific, studious, or inventive turn of mind. It is not a profession requiring physical force, but rather keen abilities, good mathematical and scientific training, and the special education of the telegraph engineer.

I can not suggest a brighter prospect for young men, or for intelligent and energetic young women, who wish to learn a profession, than this art, which year by year is steadily assuming more and more importance.

CONCENTRIC RINGS OF TREES.

By A. L. CHILD, M. D.

IN the December number (1882) of the "Monthly," you published an article prepared by me, on the "Annual Growth of Trees," which has been somewhat largely commented upon, in the periodicals and press of the day, as also by the "American Congress of Forestry" at St. Paul. I am glad to note this interest in the subject, as it will cause more accurate observation of the facts in the case. As many of my critics have apparently read only extracts from the article, and have accordingly drawn very incorrect inferences as to my views, I wish to restate some of the more important points, and the evidence sustaining them.

In June of 1871 I planted a quantity of seed as it ripened and fell from some red-maple trees. In 1873 I transplanted some of the trees from these seeds, placing them on my city lots in Plattsmouth, Nebraska. In August, 1882, finding them too much crowded, I cut some out, and, the concentric rings being very plain and distinct, I counted them. From the day of planting the seed to the day of cutting the trees was two months over eleven years.

On one, more distinctly marked (although there was but little difference between them), I counted on one side of the heart forty rings. Other sides were not so distinct; but in no part were there fewer than thirty-five. There was no guess-work about the age of this tree. A daily record of meteorological events for the Smithsonian Institution and Signal-Office for over twenty years, and a life-long habit of daily record of all important events, had led to much care and caution in such matters. Hence, from my own record, I *knew* the tree had but twelve years of growth; and yet, as counted by myself and many others, it had forty clear concentric rings.

Here permit me to quote a few lines from the original article, which, so far as I have seen, have been entirely ignored or overlooked by all commentators: "I could select twelve more distinct ones (rings) between which fainter and narrower, or sub-rings, appeared. Nine of these apparently annual rings on one section were peculiarly distinct; much more than the sub-rings. But, of the remaining, it was difficult to decide which were annual and which were not." When first cut, and while the wood was green and the cells filled with sap, these rings were very clear and plain; but, as the water evaporated and the wood contracted, they showed less plainly. I have a section of it now before me, and I can not make out clearly over twenty-four, where, when green, forty were clearly visible. This section was not at first so distinctly marked as a section forwarded to Professor Cleveland

Abbe, of the Signal-Office, at his request; although that, when forwarded, showed the rings much less conspicuously than when fresh and green.

Mr. P. C. Smith, in the August (1883) "Monthly," supporting the commonly received reliability of the rings, as an index to the age of the tree, refers to certain disputed corners and lines marked by hacks on trees, and the agreement of the number of the subsequent rings with the record of the surveyor. This indicates an uncertainty in the matter which is hardly receivable as scientific proof. If the record was reliable, why question the hack? If only for confirmatory evidence, how identify the one hack among the many which on old lines invariably accumulate in the vicinity of disputed lines by many resurveys? Is it not a mere assumption that the rings do indicate a like number of years; and that, as the record agreed with these rings, therefore, that hack was *the one?* Mr. Smith says, "It will be very difficult to convince an old surveyor, or an old lawyer, who has tried many of these land cases, that each concentric ring on an oak-tree, at least, does not indicate a year's growth only of such tree." Well, I am an old surveyor, having followed the business more or less for upward of fifty years, and the evidence before me admits of but the one possible conclusion; and, had Mr. Smith or any other intelligent man the same evidence, I am sure there could be no disagreement between us on the subject.

The Hon. James J. Wilson, of Bethel, Vermont, an "old lawyer" and late Senator in the State Legislature, writes me, under date of August 15th, that at a trial in the District Court at Woodstock, Vermont, on a disputed line based upon a cut on a hemlock-tree, a section of the tree embracing the cut was produced in court, and the rings outside the cut counted up from forty to fifty, while those on the opposite side were only nine or ten! The verdict of the court was, that "the rings were not a sure indication of the age of the tree."

Hon. Robert W. Furness, late Governor of Nebraska, so well known as a practical forester, has kindly furnished me with several sections of trees of known age, from which I select the following: A pig-hickory eleven years old, with sixteen distinct rings; a green-ash eight years old, with eleven very plain rings; a Kentucky coffee-tree ten years old, with fourteen very distinct rings, and, in addition to these, twenty-one sub-rings; a burr-oak ten years old, with twenty-four equally distinct rings; a black-walnut five years old, with twelve rings. Governor Furness adds that he has a chestnut of four years, with seven rings; a peach of eight years, with six rings; and a chestnut-oak of twenty-four years, with eighteen rings. He attended the recent meeting of the American Association for the Advancement of Science, at Minneapolis, Minnesota, and presented this question and his specimens to the section on forestry. He reports that Professor Budd, of the Iowa Agricultural College, presented also a specimen spruce from Puget's Sound, of known age, or nearly fifteen years old. The section was twelve inches in length, and on one end had eighteen rings and on the other end had only twelve. Commissioner Loring expresses the opinion that "this settled the question, that rings at all times could not be relied upon as an index of the age of trees."

Hon. J. T. Allan, of Omaha, superintendent of tree-planting for the Union Pacific Railroad Company, in a recent letter says: "Any intelligent man, who has given any attention to this matter of yearly tree-growth, knows that the rings are no index of a tree's age. H. P. Child, superintendent of the Kansas City stock-yards, shows me a section of pine eight years old, with nineteen rings, and a soft maple of nearly fourteen years, with sixteen very distinct rings, in addition to which there are forty-seven less distinct sub-rings."

In conclusion, that the more distinct concentric rings of a tree approximate, or in some cases exactly agree, in number with the years of the tree, no one, I presume, will deny; but that in most and probably nearly all trees, intermediate rings or sub-rings, generally less conspicuous, yet often more distinct than the annual rings, exist, is equally certain: and I think the foregoing evidence is sufficient to induce those who prefer truth to error to examine the facts of the case.

These sub-rings or additional rings are easily accounted for by sudden and more or less frequent changes of weather and requisite conditions of growth—each check tending to solidify the newly-deposited cambium, or forming layer; and, as long intervals occur of extreme drought or cold, or other unfavorable cause, the condensation produces a more pronounced and distinct ring than the annual one. Query: Has a tree grown in a conservatory, or place of unchanged conditions of heat and moisture, any concentric rings?

CORRESPONDENCE.

HUMAN FOOT-PRINTS IN STRATIFIED ROCK.

Messrs. Editors:

NEAR the mouth of the Little Cheyenne River, in Dakota Territory, there is a rock on which are some curious indentations. The rock lies on the north slope of a bowlder-covered hill, and is itself an erratic. It is about twelve feet long by seven or eight feet wide, and rises above the surface of the ground about eighteen inches. Its edges are angular, its surface flat, and it shows but little, if any, effect of ice-action. It appears to be magnesian limestone, and its size and whiteness make it a conspicuous object.

On the surface, near the southeast corner of it, is a perfect foot-print as though made by the left, moccasined foot of a woman, or boy of, say, fourteen years. The toes are toward the north. The indentation is about half an inch deep. About four and a half feet in front of it and in line with it, near the middle of the rock, is a deeper indentation made with the *right* foot, the heel being deeper than the rest of the foot. And again, about five and a half feet in front of this, and in line with both the others, is a third foot-print, this time with the *left* foot.

The three foot-prints are of the same size, and are such as would apparently be made by a person running rapidly. The foot-print of the right foot is an inch deep at the heel, and three quarters of an inch at the ball. The third foot-print is about three quarters of an inch in depth. In all three the arch of the instep is well defined, and the toes faintly indicated. The rock is hard, and not of uniform texture, having vein-like markings about a quarter of an inch wide running through it, which, weathering harder than the body of the rock, present slightly raised surfaces. *This difference in the weathering of the rock is the same in the bottom of the foot-prints as on the surface of the rock.*

From Mr. Le Beau, a "squaw-man," who has lived in that region for twenty-six years, I learned that it is known to the Indians as a "medicine"-rock, and that they worship it. He says that none of the present Indians know anything of the origin of the foot-prints. A town has been recently started within half a mile of it, called Waneta, and white children playing about it have found numerous beads and other trinkets, probably placed there as offerings.

I had heard of the rock several weeks previous to my visit, and expected to find either the work of nature with only a fancied resemblance, or the rude sculpturing of the Indians. The uniformity in size and direction discredits the former view, as the difference between the foot-prints seems to make the latter doubtful; and the *possibility* of the foot-prints having been made when the material of which the rock is composed was in a soft state presents itself as the best solution of the problem.

I trust that this communication may lead to its investigation by those competent to decide the matter.

Very truly yours,
HERBERT P. HUBBELL.

WINONA, MINNESOTA, *September* 10, 1883.

ASTHMA AND ITS TREATMENT.

Messrs. Editors:

YOUR "Monthly" for September contains an article by Felix L. Oswald, M. D., on "Asthma." For many years I was a martyr to that distressing complaint, and know its character and symptoms from personal experience. Naturally, I have also gathered, from others who were similarly afflicted, results of their experience, to say nothing of what I have read in medical works on the subject. My own experience, and that of all whom I have known, is so different from what Dr. Oswald writes, that I am impelled, for the sake of many who may receive great injury, and perhaps even lose their lives by following his extreme doctrine, to write to you in criticism of what he has written.

There are many errors of statement in his article. He says "the most frequent proximate cause is violent mental emotion—fear, anxiety, and especially suppressed anger." I do not dispute that any one of these may cause asthma, but among the proximate causes that are far more frequent are an ordinary cold, a damp pillow, an ill-ventilated, stuffy room or berth, a severe attack of indigestion. Indeed, as an asthmatic attack generally comes on in the early morning, the patient waking in a semi-nightmare to find the attack already begun, it is after a period of rest rather than passion or mental excitement that it supervenes.

"Asthma," he says, "is a *warm-weather* disease." Perhaps it may be with some. There is a great variety in asthmatic cases. Some are better in cities, some in the country. There are no two cases alike in all their features. So far from asthma being a warm-weather disease, and "*June* being *par excellence* the asthma-month of the year," my experience goes to show that the worst months are those in which the vegetation is decaying—September, October, and November.

Now, as to the remedy which our author recommends—cold water. I would like to apply his own language on a previous page of his article to this, where he says: "Horseback-riding is an approved cure for epilepsy, but during the progress of the fit the application of the specific might lead to strange consequences. Yacht-sailing in a storm would be a bad way of curing seasickness, though it diminishes the danger of future attacks."

So it is with cold water as a cure for asthma. "A plunge-bath into a pond or tub of water" would indeed be a terrible remedy for a person afflicted with a severe asthmatic spasm. No person of adult years in such a condition would think of such a remedy, for its consequences might be fatal. The shock of such treatment would infallibly increase the spasm and greatly intensify the suffering. The patient instinctively feels this, and knows that he can endure only the most soothing and gentle treatment. Therefore there is no danger to any *adult* asthmatic in reading such advice. But parents or unskilled medical men might be misled by this authoritative statement as to the cold-water remedy, and might subject children to it with a refinement of brutality which they happily would be ignorant of, but which Dr. Oswald certainly ought to know better than to recommend.

Imagine the poor sufferer, propped in a chair, livid and gasping for each imperfect breath, unable to speak, fearful of the slightest motion, a terrible strain pressing on heart, brain, and nerves, and think of a plunge cold bath in such a case. Yet our Doctor says "it is the most reliable remedy." Certainly he, for one, has not been an asthmatic.

If this criticism has only the effect of making parents or physicians hesitate before adopting such cruel remedies with children (there is no fear of adults permitting it), my main purpose in writing it will be fulfilled.

Our author also condemns the use of the ordinary alleviations in asthmatic attacks. There is some truth, doubtless, in what he says on this subject. Still, they are of the greatest value. A traveler, for instance, who is free from asthma at home, stops at a close country inn, and contracts an attack of asthma. Then the remedies which are usually prescribed—perhaps stramonium, perhaps coffee, or perhaps niter-paper fumes—relieve rapidly, and enable the traveler to proceed, whereas without them the spasm might last for days. These remedies act as helps, and the system has a surplus of strength sufficient to repair the slight damage caused by them. They help in the time of need. They act as brandy does to a frozen mountaineer; and, if a mistaken medical philosophy is going to deprive the suffering asthmatic of these invaluable aids and reliefs, it ought to be combated and exposed. As well say that surgical operations should be conducted without chloroform or ether, because the effect of those anæsthetics is harmful, as to say that the blessed relief which nature's herbs provide should not be used in case of an asthmatic emergency.

Whatever may be Dr. Oswald's merits as a physician, his paper on asthma, judged from the standpoint of a campaigner in that complaint, is not sufficiently correct or judicious to be a safe guide for the physician or the sufferer. W. B. Crosby.

New York, *September* 15, 1883.

Messrs. Editors:

From the symptoms described by Mr. W. B. Crosby, I suspect that his affliction is not chronic asthma, but the *dyspnœa* which sometimes accompanies a latent tubercular diathesis, and which, in its spasmodic form, is generally aggravated by catarrh. Asthma, like hay-fever, is chiefly a warm-weather disease; still, if Mr. Crosby's trouble is not *confined* to the end of the year, I believe I can reconcile his experience with my observation on the secondary causes of the disorder, viz., that the symptoms often ascribed to the effect of a vegetable pollen "are probably a consequence of the relaxing influence of the first warm weather, for in midwinter a single warm day, following upon a protracted frost, may produce symptoms exactly resembling those of a hay-catarrh" ("Popular Science Monthly," p. 606). Your correspondent suspects a morbific agency in the decay of the autumnal vegetation, and, in America at least, the October frosts, when the falling leaves expose a vast area of woodland-soil, are almost yearly followed by a return of warm weather. I make no doubt but annual asthmas are often supplemented by Indian-summer attacks. What Mr. Crosby says about the causal connection of asthma and *indigestion* was mentioned in other words on p. 610 ("Popular Science Monthly"): "There is a curious correlation between asthma and *close stools;* they come and go together."

Mr. Crosby is probably not less correct in his statement that his asthmatic spasms "generally come on in the early mornings, the patient waking in a semi-nightmare to find the attack already begun," and his description does not materially differ from mine, that, "after rolling and tossing about till relieved by that form of sleep which the Germans call 'Ein-dämmern'—the patient is almost sure to start up with a feeling of strangulation" ("Popular Science Monthly," p. 611). But even in such cases the proximate cause can generally be traced to some occurrence of the preceding day; indeed, most sufferers from chronic asthma know from the experience of their waking hours what the next night may be expected to have in store for them.

I do not suppose that your correspondent, whose letters bespeak him an intelligent observer, can be a dupe of the vulgar fallacy which mistakes a low temperature for the cause of "colds" and catarrhs; still, it is evident that he overrates the danger of its employment as a "remedial agent." For one life lost by the abuse of cold water, a million have been lost by the abuse of drugs. Dr. Carl Bock, whose manual of health, "Das Buch vom gesunden und kranken Menschen," is a standard (though entirely *non-systemic*) work on practical hygiene, recommends a sponge or shower-bath among the safest antispasmodics (c. "Angor pectoris, or Asthma," p. 502). It is well known that the paroxysms of yellow fever and cognate diseases decrease the intoxicating effects of alcoholic stimulants, and hydropathists have repeatedly called attention to the fact that under similar circumstances the dreaded nervous shock of a cold douche is partly neutralized by the conditions of the disease itself, and acts only as a tonic in the best sense of the word; and, since Dr. Koch's discovery, no modification of accepted medical theories has excited more attention than the successful application of cold baths to the treatment of typhoid fever. For a practical illustration of their efficacy in severe cases of spasmodic asthma, I can refer Mr. Crosby to the experience of two of my correspondents, Mr. Otto Schreiner, of Jacksonville, Florida, and Dr. H. D. Warner, of Reliance, Polk County, Tennessee. After stating his personal experience, Dr. Warner adds, "Priessnitz," the founder of hydropathy, "would become the patron-saint of asthma-patients, if they could rid themselves of the superstitious dread of cold water and give the plan a fair trial."

Stramonium (*vide Datura* in "American Cyclopædia," or any medical or pharmaceutical compend) is one of the strongest narcotic poisons, and in its physiological action resembles belladonna and henbane, producing "dryness of the throat, active delirium, dilatation of the pupils, and a rapid pulse. Death may occur with coma and convulsions." And such remedies Mr. Crosby proposes to apply to patients who "can endure only the most soothing and gentle treatment"! It is true that the action of the drug is somewhat modified by the abnormal condition of the system; still, its after-effects are perceptible for days; while those of cold water are limited to the *dread* of direful consequences, and one or two test-experiments will rarely fail to remove that objection, which is, after all, only a specialized form of the same traditional fallacy which in winter ascribes fatal consequences to an open window, but risks the sickening effluvium of an unventilated bedroom; which in warm weather dreads a draught of cold water, but trusts its life to the tender mercies of the liquor-mixer. Besides, the asthenia of an asthma-spasm is an eclipse, a temporary paralysis, rather than an exhaustion of the vital energies; and the shiver of a cold douche, instead of complicating the afflictions of the patient, relieves them by breaking the spell of the obstruction. Of course, neither stramonium nor cold water alone can reach the cause of the disease, which must be removed by an invigorating regimen—out-door life, wholesome food, and persistent continence; cold water, however, is at least an adjuvant means to that end, while the repeated use of narcotic drugs never fails to impair the tone of the nervous system, and thus directly tends to perpetuate an asthenic diathesis.*

But I fully agree with your correspondent that asthma is the most capricious disorder of the human organism, and that its study can never be exhausted. Most of his observations can be readily reconciled with the doctrine of my treatise; but, even in as far as they may represent the record of an exceptional experience, I consider them, on the whole, a valuable contribution to the pathology of the disease.

F. L. Oswald.

ANIMAL FRIENDSHIPS.

Messrs. Editors:

An article on animal friendships, which appeared not long since in "The Popular Science Monthly," reminded me of a remarkable instance that came under my own observation a short time ago.

While on a visit to a farmer in a neighboring county, I was surprised to see a magnificent, full-grown wild-turkey wandering around with the fowls in his barnyard. On watching the turkey, I was still more surprised to notice that she followed particularly a large rooster; the two seemed to be on excellent terms, and frequently strayed off from the main flock together. Inquiring of the owner, I learned the following facts: Two of his children found a few wild-turkeys' eggs in the forest and brought them home, placing them under a domestic turkey, with other eggs, to hatch. Three of the wild-turkey eggs hatched, and two of the chicks lived to grow up, but soon

* "China tobacco" and niter are hardly less objectionable. Only three weeks ago Charles H. Codman, the well-known liberal and political economist, died from the effects of inhaling niter-fumes. (*Vide* p. 148 in Boston "Index" of September 27, 1883.)

betrayed an evident dislike for the domestic turkeys, the one before mentioned showing a warm regard for the rooster, which was evidently reciprocated. When this one became fully grown, the children traded it off to a neighboring boy who resided about three miles distant in the woods, but on the following day the turkey appeared at its old home and immediately sought out its friend the rooster. It was returned to the neighbor, who finally found it impossible to keep his new possession, and so the bargain had to be annulled, and rooster and turkey were allowed to peacefully enjoy each other's companionship. E. M. S.

SPRINGFIELD, MISSOURI, *October* 22, 1883.

EDITOR'S TABLE.

DEAD-LANGUAGE STUDIES NECESSARILY A FAILURE.

WE last month cited conclusive testimony that, *as a matter of fact*, classical studies are a general and notorious failure; we now propose to look a little into the *causes* of that failure. The partisans of the system have a ready reason for so much of it as they have not the assurance to deny. They admit that the dead languages may partially fail because they are poorly taught.

It is significant that this complaint of bad classical teaching has been made for hundreds of years. The indictments of the system on this score by eminent men would fill a big book. But why, then, have not the sorely-needed reforms been carried out? The subject is surely important enough, and has been prominent enough to enforce attention to it. It has occupied the scholarly talent of generations; yet, where the system has been tried longest, the best minds have still cried out against the unbroken experience of failure, notwithstanding all attempts to reform the bad practices. Two hundred years ago, the mode of studying the dead languages was sharply condemned by John Milton, who thus wrote: "We do amiss to spend seven or eight years in scraping together so much miserable Greek and Latin as might be learned otherwise easily and delightfully in one year." Milton believed in reform, and had the most sanguine hope from a better system, which would do more even for dunces than the prevailing method could do for brighter minds, and he gives to his expectation the following quaint and vigorous expression: "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 hale 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 and entertainment of their tenderest and most docible age." And, after a couple of centuries of progress, what is the outcome? We still hear everywhere that the dead languages fail, because they are taught by obsolete and irrational methods, and it is stoutly claimed that all we need is their reformation.

But what mystery is there about these languages that their study should prove the great chronic scandalous failure of higher education, age after age? There can be no reason in their constitution or peculiarities that should necessitate any such result. There has been a thousand times more practice in teaching them than in teaching any other languages; the work of learning them is of the same kind as that of learning other languages, and they are said, moreover, to be the most perfect forms of speech, and in that respect would seem to have advantages over other languages. There is nothing exceptional in the processes of their study. The meanings and relations of words have simply to be acquired, so that they can be used for the expression of thought.

Dictionaries, grammars, literary models abound, and experienced teachers superabound. And yet, with all these facilities, the study of dead languages has been the one pre-eminent and historic failure of the so-called liberal education. There is more repulsiveness in it and more hatred of it than any other kind of study—mathematics not excepted. There have been more flogging, bullying, and bribery resorted to as incentives to classical study than to all other studies whatever. Both in England and in Germany the system has long maintained an exclusive ascendency by a barbaric discipline on the one hand, and on the other by all kinds of prizes, honors, and emoluments that could stimulate selfish ambition, and which have been jealously withheld from modern studies. With all these factitious stimulants to classical study, its failure has been so notorious that we can not attribute it to any accidental defects in the modes of its teaching. Nor can these defects be so readily repaired, for no possible reform in the modes of studying the dead languages can alter their relations to modern thought. It is here that we find the open secret of their failure.

Professor Cooke struck the key-note of this discussion when he remarked, in his article on "The Greek Question," in the last "Monthly": "A half-century has wholly changed the relations of human knowledge," and "the natural sciences have become the chief factors of our modern civilization." This change in the relations of knowledge, by which the sciences have become the great intellectual factors of civilization, has necessarily brought with it a corresponding revolution in education. For the new knowledge did not originate by the old methods of study; it came by new exercises of the mind, as much contrasted with previous habits as the greatness of its results is contrasted with the barrenness of the traditional scholarship. The old method occupied itself mainly with the study of language; the new method passed beyond language to the study of the actual phenomena of nature. The old method has for its end lingual accomplishments; the new method, a real knowledge of the characters and relations of natural things. The old method trains the verbal memory, and the reason, so far as it is exercised in transposing thought from one form of expression to another. The new method cultivates the powers of observation and the faculty of reasoning upon the objects of experience so as to educate the judgment in dealing with the problems of life. The old method left uncultivated whole tracts of the mind that are of supreme importance in gaining a knowledge of the actual properties and principles of things which are fundamental in our progressive civilization; the new method begins with the systematic cultivation of these neglected mental powers. The old method has yielded to the world long ago all that it is capable of giving; the new method has already accomplished much, but it has as yet yielded but comparatively little of what it is capable of giving when it becomes organized into a perfected system of education. It is this new scientific method, based in nature, fortified in the noblest conquests of the human mind, and full of promise in its future development that has become the rival in these days of the old system of dead-language studies. They have failed because they can not hold their ground against the new competitor.

The classics are constantly defended because of their boasted discipline, yet they have declined because of the growing sense of the weakness and inferiority of the mental cultivation they impart. They are accomplishments for show, rather than solid acquisitions for use. The study of words, the chief scholarly occupation, is mentally debilitating, because it leaves unexercised, or exercises but very imperfectly, the most important faculties of the mind—those which can only be aroused to vigorous action by direct application to the facts of the phenomenal world. That classical studies fail here has been long conceded. Dr. Whewell declares that "mere classical reading is a narrow and enfeebling education," and Sydney Smith speaks of "the safe and elegant imbecilities of classical culture." A system characterized by feebleness and imbecility in its mental reactions is no preparation for dealing with the stern problems of modern life. More and more it is felt to be out of place, and is consequently neglected. No kind of culture degenerates so readily into stupid mechanical routine as that of language. Professor Halford Vaughn thus characterizes the effects upon the mind of our excessive addition to lingual pursuits: "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." Very properly may it be said that our inordinate study of language is an idolatry of which the blind devotion to Greek is but the fetichistic form. The cause of the failure of the classics is, therefore, not because a thousand years of experience with them has failed to give us good methods of study, but because, in the competition with modern sciences, as Canon Farrar remarks, "they have been weighed in the balance and found wanting."

We have, therefore, to regard the educational failure of the dead languages as a result of the progress of the human mind, and therefore as a normal and inevitable thing. They hold their position against the advancing knowledge of the age through the power of tradition, through the blind veneration of things ancient, because they represent a conventional culture, and are conserved by old and wealthy institutions. There is, besides, a good deal of money in the classics, which is not to be overlooked when we wish to account for the tenacity with which they are maintained. Professor Gildersleeve, in a recent article "On Classics in Colleges," in the "Princeton Review," takes a very hopeful view of their continued ascendency because, among other reasons, "the vested interests of classical study are, even from a mercantile point of view, enormous. Not only teachers, but bookmakers, have a heavy stake in the fortunes of the classics, and the capital involved in them reminds us of the pecuniary hold of paganism in the early Christian centuries." Through the operation of such causes, the classics will undoubtedly linger long in the universities, but that they must yield to the pressure of modern knowledge is inevitable; and the indications that they are yielding are apparent on every hand.

But if the failure of dead-language studies be thus necessary for the causes assigned, can they then be said to succeed, even if the student accomplishes everything proposed? Is it so entirely clear that he who faithfully masters them is not worse off than he who slurs and neglects them? The presidents of our colleges tell us that the students of Latin and Greek actually succeed, even when they seem to fail; but may it not be said with more truth that they fail even when they seem most to succeed, so that it is hardly a paradox to say the greater the success the greater the failure? If classical studies are behind the age and out of place, then the greater the proficiency the worse the displacement. The hope is on the idlers at the tails of their classes, as they stand a chance of learning something else, while the poor victim of classical infatuation, with his cultivated contempt of everything useful, comes out the most pitiable of all failures. Happily we see in this country but very few of the blooming specimens of what the system can do, because our classical standards in the colleges are not high, and because the pressure of other subjects is not to be entirely resisted. But observation gives abundant assurance that no man is so disqualified for any desirable use, so irremediably helpless in the struggles of actual life, as he who has attained to the high classical ideal, and made himself at home in the literatures of Greece and Rome. The following sketch of a successful university product appeared a few years ago in the London "Times":

"Common things are quite as much neglected and despised in the education of the rich as in that of the poor. It is wonderful how little a young gentleman may know when he has taken his university degrees, *especially if he has been industrious, and has stuck to his studies.* He may really spend a long time in looking for somebody more ignorant than himself. If he talks with the driver of the stage-coach, that lands him at his father's door, he finds he knows nothing of horses. If he falls into conversation with a gardener, he knows nothing of plants or flowers. If he walks into the fields, he does not know the difference between barley, rye, and wheat; between rape and turnips; between lucern and sainfoin; between natural and artificial grass. If he goes into a carpenter's yard, he does not know one wood from another. If he comes across an attorney, he has no idea of the difference between common and statute law, and is wholly in the dark as to those securities of personal and political liberty on which we pride ourselves. If he talks with a county magistrate, he finds his only idea of the office is, that the gentleman is a sort of English sheik, as the mayor of the neighboring borough is a sort of cadi. If he strolls into any workshop, or place of manufacture, it is always to find his level, and that a level far below the present company. If he dines out, and as a youth of proved talents, and perhaps university honors, is expected to be literary, his literature is confined to a few popular novels—the novels of the last century, or even of the last generation—history and poetry having been almost studiously omitted in his education. The girl who has never stirred from home, and whose education has been economized, not to say neglected, in order to send her own brother to college, knows vastly more of those things than he does. The same exposure awaits him wherever he goes, and whenever he has the audacity to open his mouth. At sea he is a landlubber, in the country a cockney, in town a greenhorn, in science an ignoramus, in business a simpleton, in pleasure a milksop—everywhere out of his element, everywhere at sea, in the clouds, adrift, or by whatever word utter ignorance and incapacity are to be described. In society and in the work of life he finds himself beaten by the youth whom at college he despised as frivolous or abhorred as profligate. He is ordained, and takes charge of a parish, only to be laughed at by the farmers, the tradespeople, and even the old women, for he can hardly talk of religion without betraying a want of common sense."

Have we not here delineated the natural outcome of a method of instruction which, despising utility and disparaging modern knowledge, would, if strictly carried out, multiply incapables on every hand? Classical studies are theoretically predominant in most of our higher institutions of education. Could they be "successful," as it is maintained they may be and ought to be—that is, could they be pursued with the thoroughness necessary to gain the advantages claimed for them—what other effect would follow than to fill the community with weaklings, imbeciles, and good-for-nothings, of which the "Times" has portrayed for us a typical example? Such a "success" of the classics would stop the progress of knowledge, and arrest the advance of civilization. The failure of dead-language studies is therefore a salutary result in the course of nature—a necessity, a blessing, and an occasion of thankfulness, rather than of regret and lamentation.

QUEER DEFENSES OF THE CLASSICS.

They played it rather rough on Lord Coleridge the other day in calling him out on the classical question at Yale College. To be sure, it was a great temptation to exploit so illustrious a man in behalf of a declining cause, especially just now when it is understood that they are somewhat sore at that venerable seat of learning at being pilloried as fetich-worshipers, on account of their devotion to dead languages. It looked a little like a put-up job, as President Porter called up the subject in his pleasant little opening speech, and Lord Coleridge acknowledged that he had been posted that very morning with reference to Mr. Adams's address attacking the curriculum for which Yale is especially distinguished. But it was a little cruel not to have allowed his lordship more time, so that he might at least have refrained from giving away his whole case. Lord Coleridge was reported as saying: "I have done many foolish things in my life, and wasted many hours of precious time; but one thing I have done which I would do over again, and the hours I spent at it are the hours which I have spent most profitably, and the knowledge thus gained I have found the most useful, and practically useful. From the time I left Oxford I have made it a religion, so far as I could, never to let a day pass without reading some Latin and Greek, and I can tell you that, so far as my course may be deemed a successful one, I deliberately assert, maintain, and believe, that what little success has been granted to me in life has been materially aided by the constant study of the classics, which it has been my delight and privilege all my life to persevere in. This is not said for the sake of controversy; still less is it said to an audience of American university young men for the purpose of appearing eccentric; but it is said because I believe it to be true, and I will tell you why. Statement, thought, arrangement, however men may struggle against them, have an influence upon them, and public men, however they may dislike it, are forced to admit that, conditions being equal, the man who can state anything best, who can pursue an argument more closely, who can give the richest and most felicitous illustrations, and who can command some kind of beauty of diction, will have the advantage over his contemporaries. And if at the bar or in the senate anything has been done which has been conspicuously better than the work of other men, it has, in almost every case, been the result of high education. I say high education, not necessarily classical, because every man can not have it. The greatest orator of my country at this moment, as he himself has often said, has 'only a smack of it.'"

But for the gravity of the occasion, and the dignity of those who figured in its proceedings, we should say that this was a little funny, and might query whether the noble lord had not been misreported in citing the greatest orator of England in connection with classical education. But there can be no mistake, for his lordship again remarks, "The man who has influenced his contemporaries the most is, generally speaking, the man of highest education" and he had previously said, "If John Bright comes here, you will know what English speaking is—you will know what English oratory is." Since the celebrated case of Balaam, who was sent for to prophesy one way, and, when it came to the pinch, went back on his employers, and prophesied in exactly the opposite way, there has been no more conspicuous instance of incalculable waywardness in mental operations than was here furnished by the Chief-Justice of England. He might as well have broken into a eulogy of Napoleon Bonaparte before the Peace Society as to have named John Bright in Yale College in connection with dead-language studies. He was expected to applaud the ancient classical scholarship as the supreme incomparable means of bringing the human mind up to its highest power; and he did this by quoting a man as the most commanding orator of England who knew nothing about ancient scholarship, and who has achieved his distinction entirely by the study of the English classics. He came to eulogize the dead languages, and gave super-eminence to a man who knew nothing of either, and had devoted himself exclusively to the mastery of his vernacular speech. Lord Coleridge represented the intellectual accomplishments that give the highest advantage in the bar and the senate as fourfold. The highest education is exemplified by (1) "the man who can state anything best"; (2), "who can pursue an argument more closely"; (3), "who can give the richest and most felicitous illustrations"; and (4), "who can command some beauty of diction"; and he then pointed to the man of all England who possesses the traits in the highest degree, and who is confessedly only a smatterer in Latin and Greek. He commended classical education, but he referred to another education, not classical, which yields still higher results. Certainly, if the Yale boys turn this memorable occasion to its highest uses, they will be incited to tread in the path followed by the most distinguished orator of England, and, wasting little time upon the dead languages, will concentrate their main efforts in gaining a skillful and powerful control of the living language in which all their work is to be done.

The case of John Bright turns the tables upon the classicists. His example, like that of many other of our strongest men, proves the advantage of not squandering mental force over a wide field of lingual study. If the native speech, as an instrument of expression, is to be perfected, it must become an object of systematic, undivided cultivation. This is a dictate of common sense, and has been long understood. We dissipate our energies upon foreign tongues, and it is still as true as it was in the time of Dryden, that "the properties and delicacies of the English are known to few." The mediævals studied Latin because they had to make use of it. All learning was in Latin, and the language had to be acquired for practical purposes. Melanchthon, in 1528, made a report on churches and schools which became the basis in Saxony of a reformed education independent of Rome, and the example was followed in other German states. In this report it is recommended that "the children be taught Latin only, not German, Greek, or Hebrew. *Plurality of tongues does them more harm than good.*" In the very nature of the case, our craze for foreign languages, living and dead, must be at the expense of a perfected English. It has been well said that "the idea of training upon a foreign language had grown up in modern times. The Greeks did not train upon Persian or Scythian; they knew no language but their own." This is not only a fact of profound significance, but it is a crushing answer to the modern polyglot superstition. Everybody is recommended to study Greek because the language is so beautiful and perfect. Obviously the true lesson is that the Greeks made it so because they were shut up in it, and could give their whole power to its improvement. Granting the unapproachable perfection of Greek literature, and that the Greeks surpassed the world in philosophical acuteness, the invincible fact remains that they expended no effort in the study of foreign languages, and common sense declares that it was because of it. In his defense of the wholesale study of language, in the St. Andrew's address, Mr. Mill encountered this perplexing consideration, and his treatment of it was hardly more adroit than Lord Coleridge's reference to Mr. Bright. Having pointed out the numberless advantages of a knowledge of many languages, and then having to explain how the Greeks succeeded so remarkably without any such knowledge, he is driven to the shift of suggesting that these Greeks were a very wonderful people. He says, "I hardly know any greater proof of the extraordinary genius of the Greeks, than that they were able to make such brilliant achievements in abstract thought, knowing as they did no language but their own." From which we are to infer that if these clever Greeks could have had a couple of dead languages to train on, and three or four living languages to expand on, their achievements would have been simply prodigious! Another illustration of the power of fetich-worship to pervert the logical intellect.

On the whole, we can not think the Yale devotees have made much by trying to play off the Lord Chief-Justice of England against Mr. Adams on the classical question. They are very much in agreement. Mr. Adams said that he had forgotten his Latin and Greek; Lord Coleridge says that by calling in the aid of religion he has been able to hold on to his classical acquisitions. But Mr. Adams was before him, as shown by the title of his address, in recognizing the peculiar function of religion in the case.

We owe thanks to our classical friends for keeping the question in a lively condition. They have had much to say about the German experience with classical and scientific studies; we will see how much they make by that next month.

LITERARY NOTICES.

What Social Classes owe to Each Other. By William Graham Sumner, Professor of Political and Social Science in Yale College. New York: Harper & Brothers. Pp. 169. Price, 60 cents.

This little volume has exceptional claims upon the attention of thinking people. It is not of the current order of social science literature, but is rather a trenchant protest against its prevailing spirit, and an able attempt to substitute the scientific for the sentimental mode of studying the relations of men in society. Professor Sumner finds a very loose state of thinking in regard to social obligations, their grounds, and their extent, what people owe to each other, and what they expect from each other, and he shows very clearly that from erroneous views upon these subjects spring a large number of the worst evils of the social state.

The general object of beings who recognize evil as something to be avoided, and good as something to be sought, and who look forward to ends to be secured and work for the accomplishment of these ends, is undoubtedly to make things better, but how to do this it is by no means so easy to determine. The most conflicting projects are offered for the attainment of the end, and the discords of opinion as to what things are socially best show that ignorance, prejudice and passion have still a great deal to do with the subject. In any treatment of it, therefore, that can become instructive and helpful, the first thing is to get at the facts and call things by their right name. Professor Sumner has this unquestionable merit, that he refuses to be misled by words, and insists upon stripping off the illusions in which the subject is shrouded, and getting at the real things represented. This is not an agreeable task. It requires some courage to encounter an ignorant public sentiment which appropriates to itself the whole terminology of charity, benevolence, and sympathy for the poor and weak, and denounces as cold and hard-hearted all who do not share its sentimental views upon social questions. Professor Sumner comes in for a liberal amount of reprobation, the "New York Tribune," for example, saying that his book is characterized by "an insolent dogmatism," and its critic declares that he "can not resist the feeling that our professor has a great contempt for the poor."

Professor Sumner is charged with contravening alike the dictates of Christianity and the impulses of humanity in the views he presents, but such a charge is clearly groundless. For, if anything is established by the widest experience, it is that Christian philanthropy and benevolent impulse require a good deal better guidance than they have hitherto had. Instinctive sympathy is not enough, and it is simply notorious that indiscriminate charity does more harm than good. The more the subject is looked into, the greater is the accumulation of proof that benevolence and generosity, if not exercised with intelligent caution, work widespread mischievous effects. What we need, therefore, is a clearer understanding of the principles of the subject; and he who helps us to these may claim to be the most truly Christian and humane, because he shows us how to secure the most permanently beneficent ends. In spite of the literary cant about "Gradgrind," and the "dismal science," what we want most urgently are facts and their rational interpretations. Professor Sumner has been accused of an unfeeling indifference to the trials of the helpless and unfortunate, and of recommending the hard and selfish policy of looking out for one's self and neglecting those who need assistance. But this is a wholly unjust imputation. What he demands is simply that aid shall be given with a good deal more discrimination than is customary, and only where the giver is certain that he will not make matters worse by his charity. He never says that men in society owe nothing to each other, but he is very decided in the conviction that no class owes to another class that which will injure it. What they owe to each other are mutual guarantees of the opportunity to earn, possess, and enjoy, and do the best for themselves without interference or impediment. He says:

"The only help which is generally expedient, even within the limits of the private and personal relations of two persons to each other, is that which consists in helping a man to help himself. This always consists in opening the chances. A man of assured position can, by an effort which is of no appreciable importance to him, give aid which is of incalculable value to a man who is all ready to make his own career, if he can only get a chance." But "the aid which helps a man to help himself is not in the least akin to the aid which is given in charity."

But it is best to let Professor Sumner speak more fully for himself, and we accordingly give some extracts from his book in another part of the "Monthly." We have to apologize to the author for the fragmentary representation of his thoughts, but the reader can repair that by getting the book.

First Annual Report of the Board of Control of the New York State Experiment Station. For 1882. Pp. 156.

The grounds of the station are situated near Geneva, and embrace one hundred and twenty-five acres. The object of the institution is understood to be to ascertain, verify, and group facts the knowledge of which shall assist the farmer in carrying on his business. Its duties also comprise the dissemination of information; and for this purpose the director has published weekly bulletins of the progress of the experiments which were sent to newspapers, to the directors of other stations, and to men identified with agricultural progress. Special effort has been made to instruct visitors, and every intelligent visitor has brought information of value to the station. The investigations have had a practical rather than a theoretically-scientific bearing. As represented in the report, they have had a wide scope, and involve an immense number of details.

Fifth Annual Report of the State Board of Health of the State of Connecticut. Hartford: Case, Lockwood & Brainard Company. Pp. 128.

The report is for the fiscal year ending November 30, 1882. It includes several valuable papers on subjects of theoretical and practical sanitation. Among the most interesting topics discussed is that of the progress of epidemic and intermittent fever in Connecticut and other parts of New England, concerning which Dr. G. H. Wilson contributes a very suggestive paper, and the secretary's report embodies many valuable facts.

Annual Report of the Board of Regents of the Smithsonian Institution, for the Year 1881. Washington: Government Printing-Office. Pp. 837.

The scale and magnitude of the work accomplished by the Institution have been greatly increased in comparison with the work of previous years, while the expenditures have not been augmented. The building for the National Museum has been completed and occupied, and a large proportion of its material has been provisionally arranged for instructive display. Suitable accommodations have been provided within it for the chemical laboratory. A considerable number of original researches have been undertaken under the direction of the Institution, among the most important of which were, perhaps, those in Alaska. The twenty-third volume of the "Contributions to Knowledge" has been published, and contains six treatises; and the twentieth and twenty-first volumes of the "Miscellaneous Contributions" contain three parts or memoirs each. A valuable work has been done by the Ethnological Bureau, under the direction of Major Powell, particularly in the line of Mr. Cushing's investigations among the Zuñis, and Mr. James Stevenson's among other Pueblo tribes. Other scientific enterprises with which the Institution is allied are noticed; and the report-volume itself embodies the results of a considerable amount of research in meteorology and allied subjects, astronomy, physics, chemistry, botany, zoölogy, and anthropology, with numerous special papers in the last-mentioned subject.

God and Creation. By Robert Reid Howison. Richmond, Virginia: West, Johnston & Co. Pp. 578.

The author of this work is a Presbyterian clergyman of Richmond, Virginia, who here deals with scientific as well as theological questions, bringing to aid him in his task the results of the thoughts and studies of years. Starting with the principle that belief in Eternal Being is a necessary result of human experience and of all thought on the origin of things, the question arises what is this Eternal Being? To the author it is not solely matter or solely spirit or mind, but—and this is what it is the avowed purpose of the book to maintain—it "consists in God, the Eternal Spirit, or Mind, immanent in and working upon eternal matter, and bringing out of it, in time, the best results that perfect wisdom, benevolence, and power can produce." This at once brings the doctrines of materialism into the discussion. "But as materialism necessarily denies the existence of a spiritual and personal God, and asserts itself as a rival and conflicting system of faith, of course its advocates can not be overthrown by appeal to the authority of Scripture. . . . If met at all, they must be met on the ground of unrevealed knowledge." A summary of the history of materialism and the materialists, from Democritus down, is given, and the conclusion is expressed that "Darwin, Huxley, Spencer, and Tyndall, have not advanced a step nearer to the construction of the universe without the aid of a spiritual intelligence than Lucretius did in his poem." The attempt is next made to show that the doctrine of creation out of nothing is not found in any of the canonical books of the Bible, nor in any authoritative Christian creed or confession of faith of a date older than A. D. 1500; and the idea of a creation in six days is dismissed as untenable. The atomic theory of the constitution of matter is reviewed, and declared not competent to account for the phenomena, and a counter-hypothesis is advanced, which is called the nomian theory, or the hypothesis of law, the substance of which is that "God is the Eternal Power, Force, and Cause, in the universe." The rest of the book is mainly theological, and the conclusion is reached, agreeably to the philosophies of Kant and Hamilton, that "a science of ontology in its full meaning is impossible to man," or that, though we know that spirit *is*, and that matter *is*, we do not know, and probably never will know, what is the essence either of spirit or of matter."

A New School Dictionary of the English Language: On the Basis of the Latest Edition of the Unabridged Dictionary of Joseph E. Worcester, LL. D. Philadelphia: J. B. Lippincott & Co. Pp. 390. Price, 90 cents.

The former edition of Worcester's "Elementary Dictionary" was published in 1835, and was revised and enlarged in 1860. So many changes have been made of late in our language that it has been deemed expedient to supersede the old work by this essentially new one. Besides the vocabulary proper, it contains tables of words and phrases from foreign languages; of pronunciation of biographical, mythological, and geographical names; of abbreviations used in writing and printing; and of weights and measures, the metric system, foreign coins, etc.

Historical Studies. Edited by Titus Munson Coan. New York: G. P. Putnam's Sons. Pp. 205. Price, 25 cents.

This is the fourth number of Messrs. Putnam's "Topics of the Time" series, and includes five essays, viz.: "Village Life in Norfolk Six Hundred Years ago," by the Rev. Dr. Augustus Jessopp; "Siena," by Samuel James Cappar; "A Few Words about the Eighteenth Century," by Frederic Harrison; "France and England in 1793," by Oscar Browning; and "General Chanzy," from "Temple Bar."

The Factors of Civilization, Real and Assumed; considered in their Relation to Vice, Misery, Happiness, Unhappiness, and Progress. Atlanta, Georgia: James P. Harrison & Co. Vol. i., Pp. 347.

The second volume of this work, in which were considered the unhappiness arising from poverty and that arising from uncongenial pursuits and labor, was published some months ago, when in our review of it (see the "Monthly" for March, 1883, p. 711) we indicated the general character and scope of the work as a whole. In the present volume, which, though following the other in the order of time, is intended to precede it in logical connection, are discussed the unhappiness due to erroneous theological conceptions and doctrines; that arising from bad forms of government; and that arising from ignorance. Much attention is given to the doctrines of Mr. Henry George.

A History of the New York State Teachers' Association. With Sketches of its Presidents and Prominent Members. By Hyland C. Kirk. New York: E. L. Kellogg & Co. Pp. 175.

This book aims to give an accurate account of such matters in the history of the Association as seem to be of the most importance, and of such as would present the work of the teachers in the advancement of education in the State. Summaries are given of the proceedings of each of the thirty seven meetings of the Association. Many of the biographical sketches are accompanied with portraits of their subjects, which, unless the artist's or the printer's work were better done, had better been omitted.

Verbal Pitfalls. A Manual of 1,500 Words commonly misused. By C. W. Bardeen. Syracuse, New York: C. W. Bardeen. Pp. 223. Price, 75 cents.

This work is intended to include all the words the use of which has been questioned by the numerous verbal critics whose works are current, to collate the verdicts of the different authorities, and estimate, where it is practicable, the weight to be attached to their views. A strictly alphabetical arrangement is adopted; and the indication is given, by distinctions in type, at the head of each article, whether the word in question is indefensible or in dispute, or whether it may be regarded as legitimate.

Astronomy. By Simon Newcomb, LL. D., and Edward S. Holden, M. A. New York: Henry Holt & Co. Pp. 338. Price, $1.40.

The present treatise is a condensed edition of the larger "Astronomy" of the same authors, from which some of the less essential details of practical astronomy and most of the mathematical formulas have been omitted. Some of the space thus gained has been utilized in giving a fuller discussion of the more elementary parts of the subject, and in treating the fundamental principles from various points of view.

Finland: Its Forests and Forest Management. Compiled by John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 290.

Dr. Brown has undertaken, as rapidly as his means will allow, to publish a kind of library of forestry, to which this is the third contribution. The other two volumes, relating to forestry in England and in France, have already been noticed in our pages. The object sought in the publications is to produce popular technical treatises which may be useful to students of forest science who have not access to the works quoted, by stating views that have been advanced and have required attention, and by citing statements bearing upon them in such form as to place readers in a position to work out for themselves the solution of problems raised. Much of the information was collected by the author during a journey in Finland and Scandinavia.

God out and Man in: or, Replies to Robert G. Ingersoll. By W. H. Platt, D. D., LL. D., Rector of St. Paul's Church, Rochester, New York. Rochester: Steel & Avery. Pp. 320.

As the title of this book sufficiently indicates, it is a polemic on the various issues between infidelity and Christianity, and is lively and interesting, and as decisive as such works usually are. It is, of course, not a systematic treatise in defense of Christianity, but takes up many objections that are urged by unbelievers. The form of the discussion favors explicitness of treatment, and is attractive to the reader. Various of Mr. Ingersoll's statements, put forth in his books and in his published lectures, are taken up as texts, and commented upon and replied to generally briefly, but sometimes with amplification. Dr. Platt is familiar with the recent forms of controversy which have arisen through the progress of science and the later aspects of philosophy, and he makes free and effective use of the arguments and concessions of eminent representatives of what is called the agnostic or materialistic school. The attention which he has given to this aspect of modern religious controversy enables him to handle it with unusual ability, and imparts to his volume perhaps its strongest claim to the reader's attention.

A CORRECTION.

In our notice of Spencer's "Cyclopædia of Descriptive Sociology," which appeared in the October "Monthly," there occurs a misleading statement which it is desirable to rectify. Part III of that work, devoted to "Types of Lowest Races, Negritto Races, and Malayo-Polynesian Races," carelessly represents that the Negritto races and the Malayo-Polynesian races were specified as races meant by the title "Types of Lowest Races." This is incorrect. The title is meant to indicate three separate groups, of which "Types of the Lowest Races," including Fuegians, Veddahs, and Damans, constitute only the first. The other groups do not fall within this category; the Malayo-Polynesians, various of them, being quite high races both in type and civilization. It is desirable to avoid error and confusion in this important gradation.

PUBLICATIONS RECEIVED.

The Classification, Training, and Education of the Feeble-Minded, Imbecile, and Idiotic. By Charles H. Stanley Davis, M. D. New York: E. Steiger & Co. Pp. 46.

Variations in Nature. By Thomas Meehan. Salem Press, Salem, Mass. Pp. 14.

Bureau of Education Circular: Proceedings of the Department of Superintendence, American Educational Association, 1883. Washington: Government Printing-Office. Pp. 81.

A Physician's Sermon to Young Men. By William Pratt. New York: M. L. Holbrook & Co. Pp. 48. 25 cents.

Das Studium der Staatwissenschaften in Amerika (The Study of the Political Sciences in America). By Dr. E. J. James. Jena: Gustav Fischer. Pp. 26.

The North-Atlantic Cyclones of August, 1883. By Lieutenant W. H. H. Southerland, U. S. Navy. Washington: Government Printing-Office. Pp. 22.

Transactions of the New York Academy of Sciences, December, 1882, and January, 1883. Pp. 36. The same, February and March, 1883. Pp. 32. Editor, Alexis A. Julien, School of Mines, Columbia College, New York.

Programme of Studies, No. 10 Gramercy Park, New York. Pp. 20.

Some Researches after Hæmoglobin. By Robert Saunders Henry, A. M., M. D., Charleston, W. Va. Pp. 7.

Quarterly Report, Bureau of Statistics, Treasury Department, relative to Imports, Exports, Immigration, and Navigation. For Three Months ending June 30, 1883. Washington: Government Printing-Office. Pp. 112.

Incineration. By John D. Beugless. New York Cremation Society. Pp. 16.

On the Present Status of the Eccentricity Theory of Glacial Climate, pp. 8, and On the Origin and Hade of Normal Faults, pp. 5. By W. J. McGee.

Ueber das galvanische Verhalten der Amalgame des Zinkes und des Cadmiums (On the Galvanic Behavior of the Amalgams of Zinc and of Cadmium). By William L. Robb, A. B. Berlin: Gustav Schade. Pp. 31.

The Sun changes its Position in Space. By August Tischner. Leipzig: Gustav Fock. Pp. 37.

Evolution of the American Trotting-Horse. By Francis E. Nipher. Pp. 6.

Notes on American Earthquakes. By Professor C. G. Rockwood, Jr., Ph. D., Princeton, N. J. Pp. 8.

Description of a New Hydrobiinoid Gasteropod from the Mountain Lakes of the Sierra Nevada. By Robert E. C. Stearns. Pp. 6.

Cholera a Disease of the Nervous System. By John Chapman, M. D. London: J. & A. Churchill. Pp. 16.

Latitude, Longitude, and Time. By J. Anthony Bassett. Syracuse, N. Y.: C. W. Bardeen. Pp. 42. 25 cents.

Horses: their Feed and their Feet. By C. E. Page, M. D. New York: Fowler & Wells. Pp. 150. 50 cents.

Dime Question-Books: Grammar, pp. 37; Arithmetic, pp. 32; Geography, pp. 40. Syracuse, N. Y.: C. W. Bardeen. 10 cents each.

United States Salary List and the Civil Service Law, Rules and Regulations. Washington, D. C.: Henry N. Copp. Pp. 141. 35 cents.

Prison Labor. Some Considerations in Favor of maintaining the Present System. By John S. Perry. Albany: Weed, Parsons & Co. Pp. 128.

The Treatment of Wounds as based on Evolutionary Laws. By C. Pitfield Mitchell. New York: J. H. Vail & Co. Pp. 29. 50 cents.

The Mounds of the Mississippi Valley Historically Considered. By Lucien Carr, Cambridge, Mass. Pp. 107.

Transactions of the Medical and Chirurgical Faculty of the State of Maryland, April, 1883. Baltimore: Isaac Friedenwald. Pp. 302.

Aperçu sur la Théorie de l'Evolution (Summary of the Theory of Evolution). By Dr. Ladislao Netto. Rio de Janeiro: Le Messager du Brésil. Pp. 22.

Questões Hygienicas (Hygienic Questions): Animal Mephitism. The Sewers of Rio de Janeiro and their Influence on the Public Health. Some Hygienic Counsels to the People. By Dr. João Pires Farinha. Rio de Janeiro: Typographia Nacional. Pp. 54.

Die Physik im Dienste der Wissenschaft, der Kunst, und des practischen Lebens (Physics in the Service of Science, Art, and Practical Life). By Dr. G. Krebs. Stuttgart: Ferdinand Enke. Part I. Pp. 112. 2 marks.

Beyond the Sunrise: Observations of Two Travelers. New York: John W. Lovell Company. Pp. 237. 20 cents.

King's Hand-Book of Boston. Cambridge, Mass.: Moses King. Pp. 360. $1.

Ancient Egypt in the Light of Modern Discoveries. By Professor H. S. Osborn, LL. D. Cincinnati: Robert Clarke & Co. Pp. 232. $1.25.

The Handy Book of Object-Lessons. By J. Walker. Philadelphia: J. B. Lippincott & Co. Pp. 129. $1.25.

Sea-Sickness: Its Cause, Nature, and Prevention. By William H. Hudson. Boston: S. E. Cassino & Co. Pp. 147. $1.25.

Chemistry: General, Medical, and Pharmaceutical. By John Attfield, F. R. S. Philadelphia: Henry C. Lea's Son & Co. Pp. 727. $3.

History and Uses of Limestones and Marbles. By S. M. Burnham. Boston: S. E. Cassino & Co. Pp. 392. $6. Illustrated.

Natural Philosophy. By Isaac Sharpless, Sc. D., and G. M. Phillips, A. M. Philadelphia: J. B. Lippincott & Co. Pp. 342.

A Natural History Reader, for School and Home. Compiled and arranged by James Johonnot. New York: D. Appleton & Co. Pp. 414. $1.25. Illustrated.

Animal Life. By E. Perceval Wright, M. A., M. D. London, Paris, and New York: Cassell, Petter, Galpin & Co. Pp. 618. $2.50. Illustrated.

Bulletin of the United States Fish Commission. Vol. i, 1881, pp. 466; vol. ii, 1882, pp. 467. Washington: Government Printing-Office.

The English Grammar of William Cobbett. Revised and annotated by Alfred Ayres. New York: D. Appleton & Co. Pp. 254. $1.

United States Geographical and Geological Survey of the Territories: Wyoming and Idaho. By F. V. Hayden. Part I, pp. 809; Part II, pp. 503; both with numerous Plates. Also a volume of Maps and Panoramas. Washington: Government Printing-Office.

Mineral Resources of the United States. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 813.

The Law of Heredity. A Study of the Cause of Variation and the Origin of Living Organisms. By W. K. Brooks, Associate in Biology, Johns Hopkins University. Baltimore: John Murphy & Co. 1883. Pp. 336.

Cumulative Method for Learning German. By Adolph Dreyspring. New York: D. Appleton & Co. Pp. 253. $1.50.

POPULAR MISCELLANY.

Glacial Theories at the American Association.—Topics connected with the glacial theory received much discussion at the Minneapolis meeting of the American Association. In his paper on "The Life History of the Niagara River," Mr. Julius Pohlman held that the falls had no part in excavating the gorge below the whirlpool; but that, Lake Ontario subsiding slowly, no waterfall was formed at its entrance, and the lower part of the gorge was worn out by the river as a rapid in an old shallow valley, till at the whirlpool this path met the ancient river-valley, while it was along that valley only that the falls receded to their present site. In a paper on "Glacial Cañons," W. J. McGee, of Salt Lake City, suggested that the formation of the cañons could be accounted for by presuming that typical water-cut cañons were temporarily occupied by glacial ice, which would convert them from a V into a U shape, and that their features do not "necessarily imply extensive glacial excavation, or indicate that glaciers are superlatively energetic engines of erosion." In his paper on the extent, character, and teachings of the ancient glaciation of North America, Professor Newberry maintained that—1. Glaciers covered most of the elevated portions of the mountain-belts in the far West as far south as the thirty-sixth parallel, and in the eastern half of the continent to the fortieth parallel of latitude. 2. The ancient glaciers, which occupied the area above described, were not produced by local causes, but were evidences of a general climatic condition. 3. They could not have been the effect of a warm climate and an abundant precipitation of moisture, but were results of a general depression of temperature. Having stated his objections to the iceberg theory, Professor Newberry added that "the record of the ice period on our continent is far more impressive and extensive than it has been represented. The phenomena were due to an extraneous and cosmical cause, not to anything local or even telluric. The question here passes from the geologist, and must be addressed to the astronomer." In another paper, on "The Eroding Power of Ice," Professor Newberry reiterated these views, and maintained, besides, in answer to objections, that "ice has a great, though unmeasured and perhaps immeasurable, eroding power; and that, in regions which they have occupied, glaciers have been always important and often preponderating agents in effecting geological changes." He supported his views with citations from his own extended studies of glacial action in the Alps and in many different regions of the United States and Canada. G. F. Wright, of Oberlin, Ohio, pointed out, in a paper on the "Result of Explorations of the Glacial Boundary between New Jersey and Illinois," that "the signs of glaciation cease where there is no barrier to account for their cessation, and where no barrier ever could have existed, such as must be supposed if the so-called glacial phenomena are the product of floating ice." To the question, Why is the boundary of the glacial area so crooked? the author replied, assigning, as a principal cause, aside from differences of level, the probability that unequal amounts of snow fell over different regions of the north, and this snow became very unevenly extended in its subsequent flow over the surface. A little reflection, he added, "will show that the glacial theory will not make extravagant suppositions as to the amount of ice required." In the general discussions of the subject, Dr. Dawson objected to the loose significance with which the term "moraine" has been used, and especially to the definition of it as "detrital matter heaped up by the forcible mechanical action of ice"; and pointed out that such a definition would certainly include work which was not performed by land-glaciers. Major Powell called attention to the fact that wholly different agencies, each acting in its own way, produced a class of geological features that went under the general name of "terraces." We have sea-beach terraces, lake-shore terraces, and yet another class of terraces exceedingly common in the Rocky and Cascade Mountains, due to a different cause from the others.

Parental Rights and the Gens among the Omahas.—Alice C. Fletcher, of New York, gave, at the recent meeting of the American Association, a paper on the laws and privileges of the *gens*, among the Omaha Indians. A child who has lost its father or mother is considered an orphan. Its particular place is gone, and it passes into the *gens*. If it is the father who dies, the mother loses all maternal rights. Each child, unless of very tender age, will be separated from the mother, and will go into the family of some one of the father's relatives. It may thereafter be claimed as his own child by the male head of the family to which it has been allotted. This separation of her children from a widow is permanent. She usually marries again, and in that event is not burdened with her offspring by previous husbands; but, if she remains unmarried, she is expected to work for the family that has adopted her children, rather than for the children themselves. The women are not wanting in affection for the children of whom they are bereft; but the separation is looked upon as a matter of course, and none of the interested parties regard it as a grievance, or even as a hardship.

Tarantula-Bites and the Dancing-Cure.—The tarantula, that gigantic spider of supposed very poisonous qualities, is native in Italy, and in the neighborhood of Tarento, whence its name is derived. Its bite and sting have been supposed to be extremely painful, and to produce a periodical derangement, manifesting itself in various ways. The affected persons were fabled to be attacked with a kind of compulsion to dance, which was called, after its cause, *tarantismus;* and real benefit, in the shape of a dilution of the poison, and a weakening of its effects, was supposed to accrue from subjecting the bitten person to a violent exercise of dancing. The doctors regarded the tarantismus as a kind of hypochondria, to which the women of Southern Italy were peculiarly subject, and some had prescriptions of particular kinds of music and special dances for its cure. Some held that different kinds of music should be prescribed to different persons, according to their character and temperament. Possibly, however, a play upon names is connected with these conditions; and the dance called the *tarantella*, which is in great favor in Italy, may have derived its name in the same way as the great spider, simply from the fact that it is indigenous to the Tarentine province. The tarantula insect will bite, like any spider, when it is trodden upon; but that its bite is more dangerous than the sting of the hornet has not been proved. It is still customary in Apulia to make one dance who thinks he has been bitten by a tarantula. Waldemar Kaden relates that he was disturbed once by the noise of music and dancing, and that looking out he saw a youth, who was supposed to have been bitten while asleep in the field, going through the performance. The poor fellow was in the center of a circle of persons of all ages, held by the collar and arms by a strong peasant, and compelled to make the motions whether he would or not, while the crowd kept him excited with their shouts and clapping. The great point to be gained was to make him sweat, and, when this was brought about, the crowd rejoiced and gave him a glass of wine. The only mark on the youth was a red spot on the forehead that might have been a scratch. He had never seen a tarantula, and felt no pain or uneasiness, and was out at play an hour after the dance. Herr Kaden inquired of the people how many of them had been *tarantolati*. Not one of them had ever seen a tarantula, but they had all danced!—*Die Natur*.

The British Association.—The meeting of the British Association for 1883 was held at Southport, beginning September 19th. The President for the year was Professor Cayley, whose address on the "Obligations of Mathematics to Philosophy, and to Questions of Common Life," though it may have been to minds trained in mathematical modes of thought an admirable presentation of the subject, was far too abstruse to be capable of popular adaptation. Professor Ray Lankester opened the Biological Section with an address, urging greater liberality on the part of the state in encouraging the prosecution of biological studies. He drew a comparison decidedly unfavorable to England with what is done in this line on the Continent, especially in Germany, and, dwelling on the practical utility of such studies, declared that forty new biological institutes, requiring a capital sum of about two millions sterling, were needed in England. The section suggested the foundation of a marine laboratory at some point on the British coast, as a suitable object to which the surplus of funds anticipated from the Fisheries Exhibition could be applied. Dr. Gladstone's address in the Chemical Section was on "The Elements," and covered the history of the theories that have prevailed and the knowledge that has been gained on the subject; and showed that we have much yet to learn upon it. Among the more important papers read in this section was that of Professor A. W. Williamson, "On the Constitution of Matter." Professor W. C. Williamson, as Vice-President, gave in the Geological Section "a clear and concise exposition" of our present knowledge of the carboniferous flora. By the doctrine of evolution, there must have existed prior to the Devonian period, when the cryptogams were flourishing in wonderful grandeur, and distributed all over the earth, a vast succession of forms of vegetable life; yet hardly a vestige of this pre-Devonian flora has been unearthed; and it is clear that we are not yet in a position to construct a genealogical tree of the vegetable kingdom. Colonel Godwin-Austen addressed the Geological Section on the orography and geology of the Himalaya Mountain system; and Mr. Trelawney Saunders explained the scheme for connecting the Mediterranean with the Red Sea by means of a navigable canal through the valley of the Jordan. A communication was received in this section from Mr. Stanley, advising the establishment of a British protectorate over the Congo. Mr. Pengelly, of the Anthropological Section, having the discoveries in Kent's Cavern as his subject, adduced new evidence in favor of the belief in glacial or even pre-glacial man. Professor Henrici, in the Mathematical Section, spoke of the position of the study of geometry in England. In the Mechanical Section, Mr. Brunlees, engineer, traced the growth of mechanical appliances for the construction and working of railways and docks. In his address he referred to the assistance Mrs.

Roebling had given her husband during the construction of the Brooklyn Bridge, which he characterizes as "honorable to the individual woman, to the energetic nation to which she belongs, and to the better half of the human race." In the Statistical Section was presented the final report of the Anthropometric Committee, which has been for several years engaged in collecting evidence as to the stature and other physical characteristics of the inhabitants of the British Isles. The evening lectures were on "Recent Researches on the Distance of the Sun," by Professor R. S. Ball; "Galvani and Animal Electricity," by Professor McKendrick, of Glasgow; and "Telephones," by Sir F. Bramwell. The next meeting of the Association will be held in Montreal, and the meeting for 1885 in Aberdeen.

The Study of our Sidereal System.—In his address before the American Association, on "The German Survey of the Northern Heavens," Professor William A. Rogers defined the present condition of knowledge regarding the proper motions of the stars and of the solar system in space. Struve concluded several years ago that the solar system was moving in a direction toward a point in the constellation Hercules, and Mädler has indicated Alcyone in the Pleiades as the probable center of the greater system of which it forms a part; but, "Biot in 1812, Bessel in 1818, and Airy in 1860, reached the conclusion that the *certainty* of the movement of the solar system toward a given point in the heavens could not be affirmed. . . . It must always be kept in mind that the quantities with which we must deal in this investigation are exceedingly minute, and that the accidental errors of observation are at any time liable to lead to illusory results. . . . It can not be affirmed that there is a sidereal system in the sense in which we speak of the solar system. . . . Admitting that the solar system is moving through space, can we at the present moment even determine whether that motion is rectilinear or curved, to say nothing of the laws which govern it?" The questions connected with these points, if solved at all, must be solved by a critical study of observations of precision accumulated at widely separated epochs of time. The first step in the solution has been taken in the systematic survey of the northern heavens undertaken by the [*Astronomische*] *Gesellschaft*, and in the survey of the southern heavens at Cordova by Dr. Gould. "The year 1875 is the epoch about which are grouped the data which, combined with similar data for an epoch not earlier than 1950, will go far toward clearing up the doubts which now rest upon the question of the direction and the amount of the solar motion in space; and it can not be doubted that our knowledge of the laws which connect the sidereal with the solar system will be largely increased through this investigation."

Ideas about Fossils.—Professor August Quenstedt gives in his "Petrefacten Kunde" a review of the hypotheses that have been advanced at different times concerning the nature and origin of fossils, and of the slow processes by which the true theory of the subject has been reached. The views of the ancients were crude enough, but among them were some more intelligent and nearer to the truth than any that were held during the middle ages. The crude speculations of the latter period survived down to an age of greater scientific enlightenment; and the time is not extremely remote when belemnites were regarded as thunderbolts, and other fossils were looked upon as sports of Nature, or as efforts of Nature to prepare in the bosom of the earth the material forms of bodies preliminary to their receiving the breath of life. At a later period the belief arose that the fossils were once actually living creatures, and had been destroyed by the flood; and, as recently as 1828, Buckland supported such a view in his "Reliquæ Diluvianæ." This author was one of the earliest cave-hunters, and believed that the bones found in the caves were those which had been washed into them by the Noachian deluge. With such views having held a footing in our own century, we have little right to be amused at those who, in the age of Scheuchzer and Leibnitz, thought the bones of the gigantic salamander (*Salamandra gigantea*) were the remains of an old human sinner destroyed in the flood. Even Leibnitz had no doubt that the remains of a mammoth which were found near Quedlinburg belonged to the unicorn of the Bible. Because the Bible assigned extremely long terms of life to the antediluvian patriarchs, popular belief ascribed a gigantic size to the ancestors of the present human race; and parts of huge fossil skeletons were occasionally preserved in the churches as relics. Such a belief was already so extensive, even in the time of Empedocles, B. C. 450, that a mass of hippopotamus-bones found in Sicily was declared by the learned of the day to be the remains of the giants who fought against the gods. The Mohammedans believed that Adam was as tall as a palm-tree, or about sixty feet, and found a mound of corresponding size in Syria to answer for his grave. The academician, Henrien, in 1718, described Adam as thirty-eight and a half metres and Eve as thirty-seven metres high, and herein did not greatly disagree with St. Augustine. The former world was long believed to have been constructed on a much more gigantic scale than the present; and the opinion that the old order of things and organisms was vastly different from the existing one, and was subverted by a tremendous revolution, prevailed quite generally, till Lamarck and Cuvier pointed out the way to a more consistent theory.

Defective Hearing in School-Children.—Dr. Gellé, a French physician, has recently published an important paper on defects of hearing among school-children. Dr. Weil, of Stuttgart, a year or two ago expressed the opinion that about thirty per cent of the children in commercial schools, and ten per cent of well-to-do school-children, hear but imperfectly. Dr. Gellé, from the examination of fourteen hundred cases of deafness in schools, fixes the proportion of children thus affected at about twenty or twenty-five per cent of the whole number. The deficiency is most obvious in the case of the consonant-sounds, the very ones most essential to the understanding of what is said. Dr. Gellé observes that the range of hearing for a given sound diminishes outside the class-room, or even in a covered yard; that mistakes cease or diminish as the distance of the teacher from the pupil is lessened; and that deafness increases with age. To make the conditions convenient for the hearing of the pupil, the teacher should take pains to place himself in the most favorable position and to articulate distinctly, and the size of the class-room should be adjusted according to the laws which limit the range of the most distinct hearing to about twenty-three or twenty-seven feet. The scholars, having been previously examined with reference to their hearing, should be arranged so as to place those most deficient in this respect nearest to the teacher.

Significance of the Aboriginal Mounds.—In the discussions of the Anthropological Section of the American Association, respecting the mounds, Dr. S. D. Peet divided those structures into five classes, as follows: 1. Emblematic mounds, built by hunters who worshiped animals. 2. Burial-mounds, a class mostly represented in Michigan, Illinois, and Minnesota. 3. Mounds which are probably the remains of the stockades of an agricultural people. 4. Village mounds—the remains of villages, and their high places for worship. 5. The peculiar mounds of the Pueblos and Aztecs. The emblematic mounds, having the forms of animals hunted, served a useful as well as a religious purpose, and were used as screens from behind which to shoot the animals that would pass along the game-drives between them. Of their religious significance, Dr. Peet's theory is, that the animals were supposed to be scattered about to guard the central sacrifice or altar mound. He has been led to this belief by observing that the altar-mounds are nearly always situated on high ground, overlooking a river, while the emblematic mounds are so disposed around the altar-mounds as to suggest the notion of guarding the latter.

The Singing-Sands of Manchester, Massachusetts.—A. A. Julien and Dr. H. C. Bolton presented a paper to the American Association, on the sands of the singing-beach, at Manchester, Massachusetts. On the beach, feldspathic rocks are intersected by numerous dikes of igneous rocks. The sonorous phenomenon is confined to particular parts of the sand, and is exhibited in areas to which closely contiguous ones are silent. The sound is produced by pressure, and may be likened to a subdued crushing of low intensity and pitch, not metallic or crackling. It occurs when the sand is pressed by ordinary walking, increases with sudden pressure of the foot upon the sand, and is perceptible upon mere stirring by the hand, or even plunging one finger and removing it suddenly. It can be intensified by dragging wood on the beach. Somewhat similar phenomena have been observed in sands at various other places. The authors explain the phenomena upon the hypothesis that the sand, instead of being, as ordinarily, composed of rounded particles, is made up of grains with flat and angular surfaces. In the present instance, the plane surface of feldspar is apparent in many of the grains. Probably a certain proportion of quartz and feldspar grains is adapted to give the sound, while less or more of either component would fail of the result. It is concluded that the sound is produced either by the intermixture of grains having cleavage-planes, or of grains with minute cavities.

Use and Abuse of Check-Reins.—Bearing-reins, or check-reins, in the harness of horses, are useful and advantageous in their places and when rightly adjusted, but the instances in which they simply torture the animals that have to endure them are more conspicuous. In crowded streets, with high-mettled horses that run freely up to their bits, a well-fitted bearing-rein gives the driver a more thorough control of the animal that is valuable in avoiding collisions. A bolting horse, says the "Pall Mall Gazette," endeavors to get his head well down, so as to extend his neck, and thereby obtain a stronger purchase against the restraint of the reins; and if he is restrained by a bearing-rein, so that he can not lower his head below the level to which he would require to carry it for ordinary equilibrium in draught, his powers of bolting are greatly circumscribed, and if he is not excessively borne up he is not conscious that the rein is restraining him, and his powers of draught are not cramped. The fashion of coachmen is, however, to pull the bearing-rein up so tight that the horse's neck is cramped, and the animal is thrown into an unnatural and painful position, and is deprived of much of his power to draw the load that is intrusted to him. His feeling must be much the same as that of a man would be whose head was pulled back so that he would have to stand for hours looking up at the sky without being able to turn his eyes away, and had while in such a position to draw a baby-carriage. The fact that the adjustment of the rein is painful can be recognized from the unnatural attitude of the horse's neck, and from his fretfully tossing his head every few minutes to relieve himself, and shake off the foam from his jaws. "This tossing of the head and flecking of flanks, brisket, and harness with foam, seem to the coachman and to the upracticed observer to be picturesque, and characteristic of high courage; to the experienced eye they betray that the animal is not only inconvenienced but is also pained by his position." Besides this annoyance, the animal thus tightly checked, being unable to throw the head reasonably forward when feeling his collar, can not utilize his natural powers of draught, and, in default of them, has to draw from the lateral purchase of his limbs instead of from his height, and thereby unduly to tire his muscles and joints and strain them; and, if he stumbles, the danger of his falling is increased. The instinct of a horse in stumbling is to let his head drop to a certain point where it helps to restore equilibrium. A rein adjusted to catch the head at that point would be helpful, but the common tight reins prevent its dropping at all, and thereby augment the insecurity of the horse.

Cultivation of the Date-Palm.—Dates are cultivated profitably in two oases of the Algerian Sahara. At the oasis of Rir, where the conditions are most favorable, an unfailing supply of water is obtained by artesian wells from a depth of about two hundred feet. The use of these wells has been known to the natives from time immemorial, but has been facilitated, and the number of them has consequently increased since the introduction of improved systems of boring by the French. Sixty-four of the wells had been bored by the French in 1878, furnishing an average of more than 1,500 quarts of water each a minute. They vary among themselves greatly in capacity, one of them being rated at 4,800 and another at 20 quarts a minute. At the averaged rate of supply, each of the wells should furnish water enough to sustain 15,000 palm-trees, representing a plantation of 425 acres. Each tree, if thriving, well manured, and cared for, will bear from one hundred to one hundred and twenty-five pounds of dates; raised by the quantity and without manure or particular attention, the average crop per tree is thirty-five or forty pounds, and this is worth about sixty cents. It is not a matter of very great expense to start a plantation of dates. A lot of five or six hundred acres, on which 30,000 trees may be planted, can be bought for about five hundred dollars; the wells will cost eight hundred dollars apiece; the trees cost about thirty cents apiece; and M. Jus estimates the whole expense of stocking an oasis with 10,000 trees at about $4,000. The trees are expected to bear a crop in the fifth year after planting. The cost might be greater and the time of waiting longer than is calculated, as will often probably turn out to be the case, and the enterprise still be a profitable one, especially as the expense of the outlay, it is thought, may be nearly covered by the barley that may be raised with the aid of the winter rains. The care of the young trees is intrusted to tenant farmers, who take half the barley and a sixth of the dates. When the plantation has come into bearing, it will return, if all is prosperous, 375,000 pounds of dates, worth $6,000 gross, of which the proprietor receives $4,800, or a few hundred dollars more than his estimated first outlay. The prospect has proved flattering enough to attract the attention of a few capitalists who have started several plantations near Ourlana, in the center of the oasis.

The Poisonous Principle of Bulbs.—Professor Husemann remarked several years ago that a certain class of poisons was generally diffused in plants of the families *Liliaceæ* and *Amaryllideæ*. His view has been confirmed by the results of later researches. Gerrard has extracted from the tulip a poison called *tulipin*, the nitrate of which, according to Sydney Ringer, has the power of stopping the contraction of the heart, with many of the properties of veratrin. Professor Warden, of Calcutta, has extracted from a lily of India a very poisonous principle (superbin), which appears to be identical with the scillitoxin of the squill, and a very small dose of which killed a grown cat. The presence of the poisonous principle in bulbs, on which many plants are more dependent for propagation than on the seed, has an important bearing on the perpetuity of species by its agency in preserving them from the attacks of animals which would be likely to destroy them by eating them. While the poisons are comparatively harmless to men, they are peculiarly deadly to the *rodentia;* and it is from the depredations of animals of this class that bulbs would be most likely to suffer.

Scope and Value of Anthropological Studies.—Professor Otis A. Mason, in his address before the Anthropological Section of the American Association, on the "Scope and Value of Anthropological Studies," answers the inquiry as to what benefit the world has derived from the cultivation of that science: First, every study is improved by study, and, if "the proper study of mankind is man," it is eminently important that that should be improved and pursued scientifically. Secondly, the value of a study must be estimated by its effects upon human weal; and are not the questions agitated by anthropologists connected with human welfare? "Do they not relate to the body, mind, and speech of man, to the races of mankind, their arts, amusements, social needs, political organizations, religion, and dispersion over the earth? For instance, the French in Africa, the British in India, and our own citizens in malarious and fever-laden regions, have they not learned from loss of treasure, ruined health, and the shadow of death, that there is a law of nature which can not be transgressed with impunity? It is the same with sociology and religion. The pages of history glow with the narratives of crusades against alleged wrongs, which were in reality campaigns against the sacred laws of nature. Social systems, which had required centuries to crystallize, have been shattered in some effort to bend them to some new order of things. Arts and industries planted in uncongenial soil, at great expense, have brought ruin upon their patrons, who had not studied the intricate laws of development. . . . The better knowledge of races and race peculiarities has revolutionized and humanized the theories of aborigines. The doctrine of extermination, formerly thought to be the only legitimate result of colonization, has become as odious as it is illogical. The inductive study of mind has hardly begun; but how much more successfully and rapidly will education and the development of the species progress when the teacher and the legislator can proceed at once from diagnosis to safe prescription, when natural selection and human legislation shall coöperate in the more speedy survival of the fittest"! A third benefit of the study is the opportunity which the science affords for the exercise of every talent, even the highest. It is possible for every craft to prosecute its researches and make its contributions on the subject.

The Big Trees of Turkistan.—According to ancient accounts, the mountains of Turkistan were formerly covered with large and handsome forests. Now, the absence of trees and the savage nudity of the mountain-slopes are what most strike the traveler in that country. The denudation would, perhaps, have been complete by this time if the Russian Government had not interposed to prevent further waste; and the restoration of the forests is at present under consideration by a commission. The growth of plants in as hot a climate as that of Turkistan is very rapid. Trees at Samarcand and Tashkend have been known to make growths by measure in a single year of from fifteen to nearly twenty feet, and a corresponding development in thickness. Nevertheless, fine trees are very rare, though a few exist of extraordinary size. They are generally found near some holy place or overshadowing some mosque or hermit's retreat, where they owe their preservation to the respect in which the natives hold the shrines to which they appertain. The Sartes of Tashkend tell of an arbor-vitæ, in the inclosure of one of the mosques of their town, which is nearly six feet and a half in diameter and five thousand years old. A French traveler has measured mulberry-trees at Ourgout and at Salavad that were more than sixteen feet in circumference at the height of the shoulder, but they did not seem to grow proportionately in height. These trees were all in religious places, and were accompanied by plane-trees of equal size. The latter tree is occasionally found of really wonderful dimensions. Madame O. Fedtchenko made a drawing of one which was six feet four inches in diameter, the interior of which had been converted into a little *medresseh.* It was growing on a saint's tomb, not far from Samarcand. A plane-tree in the Tajik village of Saïrôb is twenty-seven feet and a half in circumference at the height of the shoulder. It has been protected from the wash of rains by a barrier of stones, and its hollow trunk has been formed into a square room and fitted up as the village school-house. Near it is another twenty-six paces in circumference at the base. The people say that these trees were planted by Ali. Of a group of old plane-trees at Chojakend, east of Tashkend, the largest is a rotten and hollow old stump, looking like the ruin of a giant wall, from which six vigorous lateral trees have shot up. The whole plant is forty-eight paces in circumference at the base, and the hollow of the principal trunk is nine metres, or more than twenty-seven feet, in diameter. A party of a dozen tourists from Tashkend once had a feast in the inside of this stump, and were not cramped for room.—*La Nature.*

Anthropology and Philanthropy.—Professor Otis T. Mason, in his American Association address on the "Scope and Value of Anthropological Studies," speaking of their value to philanthropy, says: "With what admiration do we read of the devotion of those missionaries who have suffered the loss of all things in their propagandist zeal! Science has her missionaries as well as religion, and the scientific study of peoples has notably modified the methods of the Christian missionary. The conviction that savage races are in possession of our family records, that they are our elder kindred, wrinkled and weather-beaten, mayhap, but yet worthy of our highest respect, has revolutionized men's thoughts and feelings respecting them. The Bureau of Ethnology has its missionaries among many of the tribes in our domain, no longer bent on their destruction, but treating them with the greatest consideration, in order to win their confidence, to get down to their level, to think their thoughts, to charm from them the sibylline secrets. It sounds something like the old Jesuit relations to hear of Mr. Cushing at Zuñi eating vile food, wearing savage costume, worshiping Nature-gods, subjecting himself to long fastings and vigils, committing to memory dreary rituals, standing between disarmed Indians and their white enemies on every hand, in order to save their contributions to the early history of mankind. You will recall the fact that an honorable senator more than a year ago offered, as an argument against sudden disruption of tribal affinities, an elaborate scheme of the Wyandotte Confederacy."

Farming in Japan.—According to the report of Consul Van Buren, the Japanese farmer holds in public opinion and estimation an exalted position. He is owner of the soil he tills, is generally represented by members of his class as officers in the agricultural villages, and has electoral rights which are in some instances exclusive. His position has been raised, and his privileges have been increased, during the last two years. A considerable percentage of the land-owners are able to employ laborers, and are thus not themselves tied to labor; but the farm-work allows no rest, for in the mild climate the hardier crops may be raised in the winter as well as others in the summer. Almost every farmer can read, write, and keep his farm accounts. He sends his sons to school, and his daughters are taught needlework and music at home. The labor on the farm is all mere hand-work; a plow is seldom seen, but a kind of long-toothed harrow is sometimes used to follow the mattock. The laborers are treated with great kindness. Those engaged in the cultivation of tea, silk, and sugar, need more skill than the others, and are paid higher wages. They live almost entirely on vegetable food, refraining from the use of meat by virtue of religion, custom, popular prejudice, and necessity. Their clothing is extremely light, and does not cost more than about four dollars a year. Several holidays are allowed each year for religious festivals and family celebrations, and the laborers generally have small gardens attached to their cottages. Women and children are employed in tea-picking, and in the lighter and in-door operations of silk-culture, and are paid for skill. The labor employed on the cotton plantations is not skilled, and is paid for at low rates. A farming population of 15,500,000 is engaged on 12,000,000 acres of land, giving about three quarters of an acre to each person. The tillage is of the most thorough order. Two crops are raised each year, so that the producing capacity of the land is double what it appears to be.

Animal Plagues.—Mr. George Fleming, in his recent work on "Animal Plagues," remarks that no description of disease, sufficiently exact to be identified with the type of which pleuro-pneumonia is an example, is found till about two hundred years ago. Even then, the earliest record suggesting that disease is of a doubtful character. It dates from 1613, when there had been a course of years marked by phenomenal disturbances, mildew, and blight. Oxen and cows died in great numbers from a pulmonary phthisis that appears to have been brought on in part by severe cold after intense heat. Men also were attacked with dysentery and malignant fevers. In 1713, again, a "cattle-plague," distinctly so described, raged over Europe, and wild creatures suffered with the tame. In 1725 a wet and chilly year of blight was followed by an exceedingly dry and hot one; honey-dew and rust were abundant on the crops and foliage; a great mortality prevailed among cattle; while the deer perished in numbers, and even the fish suffered. In 1769, after a rainy year and a bad harvest, a lung-disease, called *muric* in Franche-Comté, raged among the cattle and horses in the north of France; but it appears to have been less virulent than genuine bovine contagious pleuro-pneumonia. About 1779 the last-named disease, now thoroughly ascertained and distinguished from other cattle-plagues, appeared in Upper Silesia and Istria; then, after holding its ground there for many years, it spread to Bavaria. It was carried into France during the wars of the French Revolution, into Italy in 1815, and into Holland and Belgium in 1827. Having established itself upon the Continent, it was introduced into England in 1841, when

Liverpool and other ports at which diseased animals were landed became centers of contagion. The history of this disease is only one example out of many in the list of maladies to which animals are liable. The study of Mr. Fleming's histories induces the conviction that hardly a creature in any way connected with man, or coming under our observation, is free from liability to hosts of plagues, or has not its full share of special or common troubles. Mr. Fleming's work is published in England.

Wind-Sounds in the Desert.—The travelers' tales of sounds like the ringing of bells, which they have heard in deserts and lonely places, are familiar. Some of them are too well substantiated to admit of serious dispute. Among them is that of the noises heard at the Gebel Nakus, in the Sinaitic Peninsula, which the Arabs say proceed from a convent of damned monks; the musical cliffs of the Orinoco, told of by Humboldt; and the sounds which the French *savants* Jollois and Devilliérs declare they heard at sunrise at Karnak, Egypt, and described as comparable to the ancient fable of the vocal Memnon. The sounds are not always or exactly like the ringing of a bell; sometimes they resemble the music of a string, and may be generally described as of an intermediate character between the two classes. A characteristic of the sounds is, that no one can discern where they come from. M. Émile Sorel, *fils*, in order to determine their origin, has made some successful experiments in reproducing them artificially. Taking his gun into an open field, he placed it at an angle of 45° against the wind, when it gave forth a sound. Then moving it around, he caused it to utter the exact tone he sought. The sound could not be localized. Addressing a peasant, he asked him, "Do you hear my gun?" "Pardon, monsieur, it is the bells of ——." A similar answer was got from every one whose attention was called to the noise. It was believed to come from about two miles and a half to the windward. M. Sorel believes this experiment authorizes the hypothesis that the ringing is the result of the blowing of the wind over a slope at the foot of which is something that may act as a resonator. What is done on a small scale in a gun may be done on a large scale in nature, on the face of a mountain or a rock which is backed by a valley or a ravine, or which is itself elastic enough to give the resonant effect. The sounds are apparently not as readily given when the vibrating surfaces and media are moist.

Artificial Drying of Fodders.—A practical, economical apparatus for artificially drying fodder-crops might be the means of effecting immense savings to farmers in bad seasons for hay-making. Mr. William A. Gibbs has described before the British Society of Arts two such apparatuses which, he claims, accomplish the object at a cost that makes their use profitable. His own apparatus, which he has spent many years in perfecting, is in its primitive and simplest form a stove or furnace for burning coke, to which is attached a fan for blowing the hot air resulting from the combustion—of a temperature that may rise to 520°—through the wet grass. An exposure of from four to six minutes is sufficient to convert each lot of grass—the proportion of which is adapted to the force of the blast—into hay. This has been developed into a machine of eleven tons weight "which, when in action, eats up a one-horse load of coke, draws off ten to fifteen tons of water, and converts twenty great cart-loads of wet rubbish into good stack-hay in a single day's work." The perfected machine has a system of giant forks and flat iron plates, kept in rapid action, through which the wet grass is shaken down in successive stages while it is permeated through and through with the hot air. Another process, the invention of Mr. Neilson, is for cooling hay in the stack, and uses the heat which is developed in the natural process of "heating," to dry the whole. A hole six inches in diameter is bored through the stack to the point at which the greatest heat is developed, and a fan fixed at the outlet of the hole is made to draw off the heat from that point and promote the ventilation and drying of the whole mass. Mr. Gibbs believes that these processes are about equal in value, and that their value is real. He also described a "sheaf-tube" for drying sheaves of wheat. It is "like a gun-barrel open at both ends, and about eighteen inches long; such tubes as these are stuck into sockets all over a plate-iron floor, at just such a distance apart as will enable a wheat-sheaf to be comfortably spiked upon each tube. The floor, with its small forest of tubes, is laid, air-tight, upon a dwarf foundation wall of about two bricks high, with a partition down its center. The hot-blast is then blown into the closed space thus formed between the ground and the tube floor, and rises through the tubes into the sheaves just where they are wettest, viz., at the band. A simple shunting valve directs the hot air first under one half of the floor, and then under the other, so that, while the sheaves on one half are drying, the others may be lifted off and replaced with more wet sheaves."

Fogginess of Malaysian Ideas.—Mr. D. D. Daly, who has been engaged in surveys of the native states of the Malay Peninsula, says that the natives show an almost total lack of notions of definite points, and have only the vaguest ideas with reference to the determination of boundaries. "The boundary of our state," said one, "extends as far as the meeting of the fresh water with the salt water of the river"; or, "If you wash your head before starting, it will not be dry before you reach the place"; or, "The boundary may be determined on the river, as far as the sound of a gun may be heard from this hill." The shot might be fired from a smooth-bore or from a twelve-pounder, or a gale of wind might carry the report farther than was contemplated. Such ambiguous phrases were calculated to mislead, but they were essentially Malaysian in their generality.

Electricity from Gas.—A German professor, Dr. Von Marx, has shown that more light can be obtained from a given quantity of gas by burning it in a gas-motor which drives a dynamo-machine, than by burning it in the ordinary burner. His estimate is based on the following calculations: A gas-motor will consume on the average thirty-seven cubic feet of gas per hour for each horse-power. An argand burner, giving a light equal to eighteen candles, will consume five and a half cubic feet per hour, so that the amount of light obtained by burning thirty-seven cubic feet of gas in an argand burner will equal one hundred and twenty candles. In the Swan system of electric lighting, the light obtained from each horse-power (or by burning thirty-seven cubic feet of gas) is stated to be equal to one hundred and fifty candles. The light obtained by the Edison lamp he gives as between one and two hundred candles. Mr. Lungren, in his paper in the September number of "The Popular Science Monthly," estimates that eight lamps can be maintained for each actual horse-power, and if we make each lamp equal eighteen candles, we have a total of one hundred and forty-four candles per horse-power, a gain of twenty per cent over the use of an argand burner. When the Jablochkoff candle is used, the results are much higher, each horse-power yielding a light equivalent to four hundred and seventy-two candles; while other arc systems run four or five times as high. In showing that more light is obtained by burning thirty-seven feet of gas in a gas-motor than by burning it in an argand burner, Professor Von Marx does not prove that it would be economical to do so, for the margin, taken as twenty per cent, is not sufficient to cover the cost of converting gas into electricity, so to speak. That the latent energy pent up in illuminating gas should produce more light when converted into electricity, notwithstanding the loss at each stage of the operation, than when burned directly, is explained by the fact that the larger part of the energy of burning gas is manifest in the form of heat, the lesser part in the form of light. In electricity we have just the opposite conditions.

Transparent Points in Leaves. — M. Theodore Bokorny has published a prize essay in the University of Munich on the "Transparent Points in Leaves." These points, which are quite common in some plants, mark the places where a group of cells, containing resin or an ethereal oil, has been collected. One of the most familiar instances of this kind is that of the St.-John's-wort (*Hypericum perforatum*), in which mediæval superstition imagined a connection between the lucid spots and the wounds of Christ, and assigned a healing virtue to the plant. In other cases the points in question are caused by cells with a slimy coating which produce secretions of slime, or by the presence of cells containing crystals of oxalate of lime. The operation of these agencies is associated with the action of secretory organs, or glandular processes, causing a tendency of particular substances to certain points. The cells forming the transparent points probably have some particular significance in connection with the life of the leaf, for their occurrence is so uniform in particular species that they become distinguishing marks by which the species is known. So, also, the presence of raphides-cells (cells containing needle-shaped crystals of oxalate of lime) is constant in some families, as in the *Dioscoreas*, *smilaxes*, and *Taccaceæ*, although the transparent points are rarely observed in their leaves. Cells containing resin or ethereal oil are constant in at least three species of pepper, and in all of the *Monimiaceæ*. Interior glands, with brown radiating crystals of resinous substance, are characteristic of the *Myrsinieæ*, and are wanting in only a few species. The anatomical structure which leads to the production of these points evidently has some systematic importance, and should not be overlooked in the determination of the characteristics of the different groups.

NOTES.

In Dr. Pyburn's article on "A Home-made Telescope," in the last (November) number of the "Monthly," page 86, seven lines from the bottom, the diameter of the thirty-inch roller is given as "two and five eighths inches"; it should read "one and five eighths inch."

Professor Baird announces the final solution of the problem of the culture of oysters from artificially impregnated eggs. The Government station at Stockton, Maryland, had in September last many millions of young oysters three quarters of an inch in diameter, which had been hatched from eggs artificially impregnated forty-six days before. Oysters had already been artificially impregnated by Dr. Brooks, but the practical difficulty existed of preventing the young oysters, which could pass through the meshes of the most closely woven fabrics, from escaping.

Our Educational Bureau is circulating an excellent paper from an address given to school-teachers in Switzerland on how natural science should be taught. The object, it says, should be, not to fill the mind with facts, but to bring all the scholars, including the slowest ones, to discover and observe facts for themselves. Books should be little used, and nothing about an object should be taught without the object being before the class. The next lessons should be in describing the facts observed, with the help of drawing, if possible. Plants should be chosen first, then animals of different classes, then minerals, with observations of mechanical and afterward of chemical effects upon them. But the bare making of collections should not be particularly encouraged.

The "United States Hay Fever Association" held its tenth annual meeting at Bethlehem, New Hampshire, during the last week in August. The speeches made and the experiences related indicate that the cause and specific cure for the uncomfortable disease in question are yet to be found. A particular preparation which has been much recommended was, by nearly general consent, pronounced of no value as a remedy. Much information regarding the malady had been gathered by Dr. Geddings.

The lowering of the freezing-point of water by increased pressure is frequently illustrated by the experiment of Bottomley, which consists in throwing across a cake of ice a wire weighted heavily at both ends. The wire slowly sinks through the cake, the ice melting beneath it and freezing above it. Professor Guthrie, at a meeting of the Physical Society in London, has stated his belief that the wire conducts heat to the ice from the atmosphere, and that therefore the experiment does not illustrate the fact above mentioned. A silk cord weighted to the same amount as a wire will not cut through a block of ice.

The death is recorded of Hermann Müller, of Lippstadt, one of the most industrious and distinguished scientific investigators of the day. His specialty was the fertilization of flowers by insects, in which subject he was regarded by naturalists as the highest authority. He was the author of two books on the subject, "Die Befruchtung der Blumen durch Insecten" ("The Fertilization of Flowers by Insects"), recently translated into English, and "Alpenblumen, ihre Befruchtung durch Insecten" ("Alpine Flowers, their Fertilization by Insects"); of an article in Schenk's "Handbuch der Botanie," and of frequent contributions to the German periodical "Kosmos."

Ernest Ingersoll observes, in the "American Naturalist," that if we judge by the standard of their possessing a convenient currency, the American Indians must be ranked high among barbarians in point of advance toward civilization. They had in their wampum a regular money of recognized value. It marked an advance upon the African cowry, for, while the latter was simply a shell with a hole in it, wampum was a manufactured article, made with a degree of patient labor which was included in estimating the value given to it. That to which the most value was attached was made from the dark part of clam-shells. An inferior "coinage" was made from the white parts of the shells, and from periwinkle-shells. The value of wampum was almost as well defined as that of our own money, and regular tests were in use for judging of it. Shell-money was also used by the Indians of the Pacific slope; and Mr. Ingersoll describes three kinds of it, all somewhat different from genuine wampum.

Mr. Ernest Hart, Chairman of the London Smoke Abatement Institute, remarks that at the recent exhibition by that society improvements in the construction of open fire-places were shown by which common bituminous coal can be consumed in a practically smokeless manner. Simple methods of underfeeding were exhibited which proved to be productive of admirable results both in respect to economy of fuel and reduction of smoke from ordinary coal. Mr. Hart recommends as an elementary measure of economy the use of equal quantities of coke and coal mixed. He has great expectations of the realization of Dr. Siemens's projects for using gas as a heating agent.

The French Academy of Sciences has had a discussion about busts. It was invited to witness the progress of the bust of Leverrier, and express an opinion as to the quality of the resemblance and the work. M. Bertrand took the opportunity to speak of the scandalous badness of some of the busts in the hall of the Academy, particularly of those of Delaunay and Claude Bernard, which, he said, were mere caricatures, and to advise that they be turned out at once; and M. Dumas remarked that several of the busts were in reality only fit to be used for making carbonic acid.

Mr. Cromwell Fleetwood Varley, F. R. S., an English engineer distinguished for his work in connection with electric telegraphs, died September 2d. He devised a method of locating distant faults in land telegraphic wires, and was associated with other engineers in devising the first really successful Atlantic cable.

The curious question has been raised in England whether the recent decline in the death-rate has actually added to the average length of useful life, or whether its benefits have not chiefly been spent in relatively unimportant prolongations of the lives of children and of the aged. It has been answered by Mr. Noel A. Humphreys, after a new examination of the returns of mortality, and the compilation of new life-tables. He finds that the average expectation of life of males at birth has been raised from 39·91 years, as it was fixed in Dr. Farr's tables, to 41·92 years by the new tables, or has been increased by two years, or five per cent; and that the expectation of females has been raised from 40·86 years to 43·56 years, or by 2·70 years, or nearly 7 per cent.

Charles F. Parkes, Curator of the Academy of Natural Sciences of Philadelphia, died September 7th, after a long illness. He had considerable distinction as one of the leading botanists of America, and had paid special attention to the botany of New Jersey.

Professor C. V. Riley, in a paper read at the American Association recommends emulsions of petroleum to be applied to plants as insecticides. A soap emulsion of twenty parts of scraped bar-soap, ten parts of water, thirty parts of kerosene, and one part of fir-balsam, is stable enough for all practical purposes, but milk emulsions are better. One or two parts of refined kerosene to one part of sour milk is quite satisfactory. It must be churned till a butter is formed, which is thoroughly stable, and will keep indefinitely in closed vessels, and may be diluted at pleasure with water when needed for use. An emulsion of gum from the root of *Zamia integrifolia*, of Florida, has proved useful. The diluted emulsion, of strength varying according to the plants and insects to which it is applied, should be finely sprayed upon the insects to be killed.

Science has furnished another victim to African sickness in the person of Mr. William Alexander Forbes, Prosector to the Zoölogical Society of London, whose death on the Niger River has been reported. He made an excursion to the forests of Pernambuco, Brazil, in 1880, afterward passed some time in the United States, and started from England for Africa and the eastern tropics, in July, 1882. His published works consist chiefly of about sixty papers in the "Proceedings of the Zoölogical Society" and the "Ibis."

M. Engelman has been studying the manner in which the movements of the lower organisms are influenced by light. He finds that light may act in three ways: 1. Directly, by a modification of the exchanges of gases; 2. By modifications of the sensation of respiratory necessities, and, 3. By means of a specific special process corresponding probably in some sort to our luminous perception.

Mr. Thomas Plant, a life long student of meteorology, died in Birmingham, England, about the 1st of September. His regular records of the weather and associated phenomena are complete for forty-six years.

ÉTIENNE GEOFFROY SAINT-HILAIRE.

THE

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THE CLASSICAL QUESTION IN GERMANY.

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THE struggle between the adherents of the old classical curriculum and the representatives of modern culture has nowhere been carried on with more bitterness than in Germany. In no other land have the respective antagonists shown more narrowness and bigotry, or been less inclined to allow their opponents the possession of common sense or pure motives.

The representatives of the classics, intrenched behind a strong wall of tradition and usage, were from the first in the enjoyment of all the honors and privileges. They were supported by the mighty power of a public sentiment which had been begotten at a time when the classics and mathematics formed the only subjects worthy of serious study, and had been nourished by a long line of illustrious men whose only school-education had been a training in Latin, Greek, and geometry. They were upheld by the powerful force of a government which made the acquisition of such an education the condition of all its favors. They looked down, therefore, naturally enough, with a certain contempt and loathing upon those rude materialists who insisted that there was something in the modern world worthy of serious study. The other party, on the contrary, driven to extremes by the bigotry and obstinacy of their opponents, were compelled to make war to the death, by denying all virtue of any sort to a classical training. They insisted on purely modern subjects as opposed to classics, on a multiplicity of branches in preference to a few, on technical education for particular callings instead of a liberal training for good living.

But in the course of events we find both parties in that country receding from their extreme positions and gradually approaching each other. We find the "classicists" agreeing that the study of modern languages may also be made valuable; that modern literature is adorned with names which rival in luster the greatest of the Greek or Roman. They give up slowly more and more of that valuable time formerly spent in conning Greek and Latin grammars, or in learning to write Greek and Latin verses, or to talk a jargon which they dignify by the name of classical Latin, to the study of French, Italian, Spanish, German, and English. They allow the elements of the natural sciences, one after another, to creep in, and even grant some hours a week to modern history. They still devote the most of their attention, however, to Latin and Greek, and justify their course by the claim that the shortest road to modern literature is through Athens and Rome; that modern languages are so intimately connected with the classics that, after mastering the latter, the acquisition of French, English, Italian, and Spanish, is a matter for leisure hours, a mere after-dinner amusement; that the nomenclature of the modern sciences is so largely Greek that time would be saved in learning them by first mastering Homer, Xenophon, and Plato; that modern history is only the second chapter of the world's history, and can be rightly understood only after learning what goes before.

Their most thoughtful opponents have also given up many of the claims advanced by their prototypes. They allow that there is a vast difference between knowledge and power; that a mass of undigested facts in the memory is as depressing for the mind as a mass of undigested food in the stomach is for the brain. They, or at least the most advanced among them, allow that the old humanists followed sound pedagogical principles in selecting but few subjects, and in lingering over them long enough to secure that mental power and grasp which come from the detailed and long-continued study of any great branch of human knowledge. They grant that the secondary schools should give a liberal education, in the sense of an education which shall prepare the students, not for the particular calling which they may afterward take up, but for right and intelligent living, in any sphere to which circumstances may call them. They maintain, however, that for the purposes of such an education modern subjects are as good as or better than ancient; that French and English, if properly taught, can afford, so far as is desirable, the same kind of mental discipline as that obtained from Latin and Greek; that modern literature embraces classics as worthy of detailed and continuous study as ancient literature; that the proper study of the modern sciences develops certain faculties with a completeness of which no other instrument is capable; that modern history offers subjects as worthy of labor, as fruitful in results, as anything which ancient times can afford.

The objective points of the contest have also changed in the course of time. The old philanthropinists demanded the total abolition of all classical study as a waste of time. The classical party of that period resisted the introduction of any studies but Latin, Greek, and mathematics. The "modernists" of to-day demand the abolition of Greek as a required study in a liberal course. Many of them, indeed, would like to send Latin the same road. The modern "classicists" are on the defensive, and constantly grant more concessions, or see them wrested from them.

This discussion, which in one form or another has appeared in every civilized nation, has been everywhere marked by bitterness and prejudice, and has resulted in a slowly-growing victory for modern culture. The question has attracted renewed and wide attention in this country of late, owing to Mr. Charles Francis Adams's attack upon the requisition of Greek as a part of the course in Harvard College. The old weapons on both sides have been again brought out and burnished, and made to do valiant service in the good cause. The result of the criticism and counter-criticism has been to demonstrate pretty clearly that, however we may feel about it, the fact is, that the cause of the "modernists" is gaining ground. President Porter, in a rejoinder to Mr. Adams, in the "Princeton Review" for September last, remarks, in substance, that the proposition to drop Greek from the list of required studies was somewhat "hesitatingly urged many years ago by the adventurous and sanguine President of Harvard College." If the writer is not greatly mistaken, President Eliot did not only urge it years ago, but has vigorously and persistently urged it ever since, and it is probably only a question of time when his policy will be adopted, whether urged by him or by some one else.

The discussion as to the relative merits of the classics and other subjects, as constituents of a liberal course of study, has always been marked by a great deference to authority. The assertions of eminent men, as to the advantage or disadvantage to them of the classical course which they pursued while young, always play a prominent part. The testimony of eminent educators, as to their observation of the effect that a study of the classics seemed to have on the minds and hearts of their pupils, is quoted and requoted. The tradition and usages of hundreds of years are strongly appealed to in order to show the superiority of the one system over the other.

The present discussion in our American press has been no exception to the rule. But, in addition to the regular authorities which are quoted on all occasions, a new witness has been appealed to in this controversy, whose testimony on the question is regarded by many as decisive and final. This is the experience of the Germans, embodied in what is known as the "Berlin Report," and which has been widely urged as an authoritative answer to Mr. Adams's argument. It seems to be supposed that this thorough-going people have entered into the subject experimentally and on an extensive scale, with a view of settling it effectually. They have made, it is asserted, a fair trial of these two systems of education, and, having weighed both in the balance, they have found the modern system wanting to such a degree that they have concluded to discard it forever. There seems to be wide-spread misconception about this German experiment, and the conclusions drawn from it are so unwarrantable that a review of the main features of the case may be useful in correcting erroneous impressions.

As is well known, there are two classes of schools in Germany which prepare boys for the university—the *Gymnasien* (gymnasia) and the *Realschulen* (real schools). The former are the classical schools, whose curriculum consists in the main of Latin, Greek, and mathematics, and graduation from which confers the right to enter any department of the university. The real schools are institutions whose course of study embraces less Latin than the former, and no Greek, the place of the latter being represented partly by more of the modern languages and partly by natural science. The gymnasia are old schools, being the legitimate successors of the schools which dated from the revival of letters. The real schools are products of the modern spirit, and, although dating from about 1740, they did not acquire a recognized standing until late in this century. The earliest of these schools were the answer to the demand for "practical" education in the narrowest sense of that term. It was not until 1859 that the Government of Prussia fully recognized them. In that year, the schools passing under that name were classified, according to length of course, into first, second, and third class. The course of the first class was made of the same length as that of the gymnasium—that of the other classes was shorter. From that year the friends of the real schools demanded that graduates of schools of the first class should be admitted to the universities. Their claims excited at first only a smile of derision, but so vigorously did they push matters that the Government, in 1869, was persuaded to take the first move in the case by asking the faculties of the various Prussian universities for their opinions on the subject. This called out a series of reports which were very strong against admission. It is curious that in this series of reports language was used from which we might infer that the universities had already tried the experiment; as when it is asserted in one report that the gymnasium students soon overtake real-school students even in natural science—that at a time when real-school graduates were not admitted to the universities. The Government decided, however, to admit the real-school students to certain branches, which it did by the order of December 7, 1870.

Until 1871, then, the graduates of real schools were not admitted to any department of the universities in Prussia as candidates for a degree. In that year they were allowed to matriculate in the university for the study of modern languages, mathematics, and natural science. After an experience of about eight years, on the 18th of December, 1879, Professor Droysen, of the University of Berlin, moved that the faculty of that institution request the Government to reconsider its policy in regard to the admission of real-school students to the philosophical faculty. After some discussion, Professor Hübner, the dean of the faculty, was requested to ask the various professors for statements of their experience with the two classes of students. These statements were laid before the faculty, and the most important being incorporated in the form of a report, were sent in, March, 1880, to the Government, with the petition that the latter would reconsider the whole matter—the real object of the report being to move the Government to rescind the order of December 7, 1870. These were not the first statements on the question, for the Minister of Public Instruction had already, a short time before, made inquiries of many leading professors in the various universities as to their experience in the matter since 1871. The most of them held views similar to those of the Berlin professors. The set of statements, with the petition above referred to, constitutes the "Berlin Report," and, on account of its formal and authoritative character, has excited world-wide attention and discussion.

These reports are now quoted by many as a final settlement of the much-disputed question between the "classicists" and the "modernists," and by many more as expressing the judgment of educated Germany, at least, on the subject. Thus, President Porter, in the article above mentioned says: "The question of the superiority of a classical to a modern training has of late been subjected to a practical trial on an extensive scale, by a comparison of the results of the gymnasial curriculum and that of the *Realschule*, as a preparation for a university course and indirectly for civil administration. In most of the German states—in Prussia pre-eminently—an attendance upon the university course, with a certificate of fidelity and a succession of satisfactory examinations, had been the essential prerequisites to many of the most desirable official positions in civil life. To admission to all the privileges of the university an attendance upon the gymnasium with the classical curriculum was an essential prerequisite, carrying with it the consequence that to all the higher posts of civil life a course of classical study, including Greek and Latin, had till recently been a *conditio sine qua non*. The *Realschulen*, which gave a shorter and a more scientific and popular course, in which Greek was not included, and the Latin was scanty, furnish an example of a modernist education. It was very natural that this condition of things should be felt to be inequitable by the teachers and pupils of these schools, and that an earnest movement should be made to set it aside. In several of the states it was successful. In Prussia, against strong conviction to the contrary, it was allowed for a term of years by way of experiment, that the 'modernists' (the *Abiturienten der Realschulen*) should enter the university and enjoy all its privileges. When this term had expired, elaborate reports were called for from the leading instructors in all the universities, of their judgment as to the proved capacity and success of the students who had attended upon their classes, from each of the two preparatory institutions with their separate curricula. With but few exceptions the reports were decidedly in favor of the classical curriculum as giving a better training even to the students of the mathematical and physical sciences."

We wish to call attention here to the fact that President Porter's first sentence, though evidently without any intention on his part, is misleading. He says that "the question of the superiority of a classical to a modern training has of late been subjected to a practical trial." Not at all; but simply the question of the relative superiority of the graduates of the German gymnasia and real schools, as they exist to-day in Germany, as indeed President Porter himself states in the next to the last sentence quoted above. This last is a very different question, indeed, from the former. The one is, so to speak, concrete; the other, abstract. The professors were not asked for their opinions as to whether a classical is better than a modern training, but is the gymnasiast, as you know him from the existing schools, better fitted for your work than the real scholar who during the last eight years has attended the university?

If it should appear upon examination that the curricula of the real schools are not what is demanded by the most thoughtful "modernists," that the teachers are not, as a class, equal to those in the gymnasia, that the pupils are, as a whole, inferior in natural ability, that the real schools are not fostered by the Government to the same extent as the classical schools, it will be evident to every one that the significance of the Berlin report for the real question at issue—viz., classics at their best *vs.* modern subjects at their best on an equal footing in every respect—becomes very slight.

As appears from what we have said above, President Porter is mistaken when he says that the graduates of the real schools were admitted to all the privileges of the university. They were only admitted to certain branches in one faculty, viz., the philosophical faculty. They were not, however, admitted for a definite number of years, as President Porter states, but for an indefinite period. The ministerial regulation admitting them says nothing whatever of any number of years for which it is valid. It holds good until supplanted by one prohibiting the admission of real-school students, and there is no sign that such a regulation will ever be made.

To begin with, then, all this quoting of the Berlin and similar reports in favor of retaining Greek as a required study in our liberal curricula is aside from the point, since that report was made on a very different subject. The attempt to apply conclusions on concrete questions in one country to concrete questions in another is at all times a misleading and often a dangerous procedure.

Now as to the report itself, it may fairly be objected by the real-school men that the real schools have not had a fair trial, that the period of probation has been so brief that any report made now, whether favorable or unfavorable, must be regarded as premature and at best merely provisional. The real schools of the first class are not yet twenty-five years old. The regulation admitting their graduates to partial university privileges bears date, as said above, of December 7, 1870. In less than ten years they were expected to win a place by the side of their rivals, which even their bitter opponents (for the professors who made the reports were all graduates of the gymnasia) should acknowledge to be an equal one, and if they should not succeed in doing this they were to be condemned as unable to fit boys properly for the university. Further, they were expected to do this with almost no aid from the Government, while their rivals were largely supported by contributions from the state. How just this complaint is may be seen from the reports of government aid accorded in Prussia to these two classes of schools. In the year 1869 the Government contributed 714,148 thalers out of a total expenditure of 2,851,253 thalers for gymnasia ; and in 1874, 1,319,990 thalers out of a total of 4,385,940 thalers for the same purpose. In the former year the real schools of the first class cost 666,368 thalers, of which the Government contributed 15,558 thalers. In the latter year the respective sums stood 1,251,921 and 97,421 thalers. It thus appears that the Government paid in 1869 nearly forty-six times as much toward supporting gymnasia as it did toward supporting real schools, and in 1874 over thirteen times as much. In 1869 it paid over twenty-five per cent of the total expense of all gymnasia, and less than three per cent of that of the real schools ; in 1874 the respective rates stood over thirty per cent and less than eight per cent. It will thus be seen that the Government has proceeded on the plan of allowing the real schools to pay their own way. The wonder is, that they have such good results to show for their work under such circumstances. It should be also considered in this connection that the proper equipment of a real school, with first-class apparatus, etc., costs much more than that of a gymnasium. Another fact should be borne in mind, that owing to this lack of support the number of such schools is much smaller than that of the gymnasia, and they have consequently not had so extensive a field to draw from as the latter. Another important point must be mentioned in this connection. Up to 1871 the graduates of the real school passed immediately into active life instead of attending a higher institution of learning. The matter and methods of the school had, therefore, exclusive reference to that fact, and under the new system they must have time to modify and adapt themselves to the altered circumstances. Any practical teacher will appreciate the importance of this consideration. These are some of the objections which the defenders of the real schools have to urge against any unfavorable report made at this stage of the work. Against this particular series of reports, made in the manner in which they were, they have still more serious objections, which we shall notice later.

Turning aside now to another phase of the subject, let us see whether any influences have been at work which tend to give the gymnasia a better class of material to work with. If the boys who enter the gymnasia are decidedly superior in ability to those entering the real schools, we shall have a partial explanation of the better results achieved by the former.

The first point to be mentioned in this connection is that the traditions of Germany are classical. For decades and decades nearly every prominent man in law, medicine, theology, teaching, and (so far as nobility has not been accepted as a substitute for education) in the civil and military service of the country, has enjoyed the benefits of a classical education, if for no other reasons, simply because he was obliged to "enjoy" them as a condition of entering these careers. We all know how easily we associate two things which we always see together, in the relation of cause and effect. And so this eminence and culture which, owing largely to the artificial pressure we have mentioned, have for years and years in Germany been found in connection with a more or less complete knowledge of Latin and Greek, have come to be associated with the latter as effect from a cause. The sign has come to be largely accepted in place of the thing signified. It can not have escaped the observation of any reflective person who has ever lived in Germany, that there is a very wide social chasm in that country between the so-called liberally educated (*die Studirten*) and those who have not pursued such courses. There is, so to speak, an educational hierarchy, and the only path to it lies through the gymnasium. As in all hierarchies, so in this, there is an immense amount of Pharisaism, a touch-me-not and a come-not-near-with-unholy-hands kind of spirit which looks down on everything not of its type as something infinitely lower. The *Studirter* looks down, not only on the merchant or the artisan, but also upon the *Volksschullehrer* (common-school teacher) with a calm sense of superiority and a provoking self-conceit—no matter how successful the career of the latter may have been. A small professor in a small university, of small ability and still less success, commiserates the most successful common-school teacher because he has not studied Latin and Greek; and we must add that the latter envies the former, taking the sign (Latin and Greek) for the thing signified (culture). No *Studirter* thinks of seriously discussing any question with a *Non-studirter*, but disposes of all difficult objections by the crushing answer that his opponent is an *ungebildeter Mensch.*

The artisan or merchant sees that no amount of culture derived from the study of modern subjects, or in the pursuit of his calling, or from the vigorous contact with active life, can secure for him a social recognition or equality with the *Gelehrter;* the common-school teacher sees that no career of public service in his sphere, however useful or successful, can secure entrance for him into that charmed circle of the *Gelehrtenthum*, and silently resolves that his boy must have a different chance from that which he has had. Of the force which this traditional influence exerts no one can form an adequate idea who has not had the opportunity of associating intimately with the various classes of the people; for, although a similar spirit may be met in America, it is of such small influence as hardly to be discernible.

A classical education has, then, come to be the proper thing in Germany for every aspiring man. It is a stamp of gentility, an absolute essential to high social position and influence. Every parent desires to give it to his boy, if for no other reason, simply on account of this different social position which it confers upon him. To give him this education he must send him to the gymnasium.

But there is another and still more powerful influence at work to secure the attendance at the classical schools. We have already corrected President Porter's statement that the graduates of the real schools are admitted to all the privileges of the university. They are not allowed to enter the law, medical, or theological faculties, and their privileges in the philosophical faculty are practically limited to the study of natural science, mathematics, and modern languages. That is to say, if a father wishes to keep open to his son when he becomes twenty years of age the choice of the learned professions, and the possibility of obtaining any of the higher positions of the civil service, he must put him through the gymnasium in the first place.

Of course, under such circumstances, all professional men desire their boys to follow one of the learned professions, and send them consequently to a gymnasium. During an extensive tour in Germany last summer, the writer had the opportunity of meeting a large number of university and other professional men. In answer to the question which was quite regularly asked, "What school do your boys attend?" they replied, almost without exception: "The gymnasium, of course; we send them to the real school only when they are too stupid or too lazy to keep up in the gymnasium." Thus the educated and intelligent classes send their boys, who, to some extent at least, have inherited their intelligence and ability, to the gymnasium. Those members of the mercantile or artisan class, who have bright boys from whom they hope much, strain every nerve to support them at the school which forms the sole avenue to all government honors and social position.

Do we not find here the explanation we are seeking? Is not this the secret why the boys who graduate from the gymnasium are as a class superior to those who finish a real-school course? They are the brighter boys of the community; they are, as a rule, of educated blood, from homes where education and refinement prevail, and life within which is of itself an education, where they find wise and discriminating assistance in their studies, and encouragement and incitement to effort.

But the case is not by any means fully stated. The gymnasium not only gets better material to work upon than its rival, but it has also a superior corps of teachers. The writer was told by a gentleman who was a graduate of a real school, and who had been a teacher in one for some time, but had afterward made up the Greek and Latin of a gymnasium course in order to qualify himself for teaching in a gymnasium, that no teacher of ability and enterprise would remain in a real school any longer than he was obliged to remain there. "There is no career in that line of work," said he, "and only blockheads and lazy hides (*Dummköpfe und Faulpelze*) stay in it." Of course, that was a great exaggeration, and yet it contained an element of truth, viz., that a process of selection is going on between these two schools, not only in regard to pupils, but also in regard to teachers, and the gymnasium has its pick of both.

The reason is not far to seek. It is to be found in the higher social position which tradition assigns to the office of gymnasial teacher, and the better career which the Government opens to it. How idle, in the face of all these facts, is the assertion that the Berlin report has settled the question between the real school and the gymnasium, or that it is of paramount significance in the deeper question of classical against modern training!

To get a fair idea of the significance of this report, let one imagine the state of things which would exist in this country if the law of the land had for generations permitted no one to practice law or medicine, or enter the ministry or the civil service, or become a teacher in our higher schools and colleges, who had not first completed the classical course in an average college, and then attended a professional school for three years. Suppose that, after such a law had been enforced for a century, a proposition were made to allow such scientific schools as could spring up under those circumstances to present their students for certain subordinate places in the civil service and in the academic career. Can there be any doubt that the adherents of the classical culture would point with pride to the fact that every eminent professional man for several generations had been the graduates of classical schools, and would make that a reason, as they do now in Germany, for refusing to admit any man with a different education to the practice of those professions? Would they not dwell on the great danger to the national civilization which would arise from the fact that an element of discord would be introduced into the culture of the people by educating the young along two widely different lines? *

* This argument plays a large part in the German defense of a single school and a single course in preparation for all higher professions. "Our education," says one, "is homogeneous. Let the real school carry its point, and a hopeless and fatal element of

Would not our professors complain, as does one in Berlin, that they could not make so many references to Greece and Rome in their lectures, since some of their hearers would not understand them?

Let us suppose further that the above proposition should be accepted, and that after eight years a committee of the opponents of the measure should be called upon to express their opinions as to the results of the experiment. Could their report be considered as settling anything between the two opposing parties—the defenders and opponents of classical culture? Could the statement of these witnesses, that the students who, under such conditions, came from the scientific schools were not fully equal to those coming from the classicals chools, be regarded as forever disposing of the claims of modern culture? The answer to this question can hardly be doubtful. And yet those who quote the Berlin report, as settling this much-vexed question, must maintain that such a report as the imaginary one above described would be satisfactory and conclusive.

We have thus far proceeded upon the assumption that the Berlin and similar reports were prepared by unprejudiced men, after a careful and detailed examination of the records made by the graduates of these two schools, and uninfluenced by extraneous considerations. We are compelled to believe, however, after a somewhat detailed investigation, that no one of these assumptions is true.

The men who were asked for their opinions on this subject were almost, if not absolutely, without exception graduates of the gymnasia. That lay, of course, in the nature of the case. Real-school graduates could not enter the universities until the spring of 1871. Allowing four years for the average length of time spent in the universities, the first real-school men were graduated in 1875, and in 1879 the first of these reports was prepared. As the candidates for admission to the university faculty must study one year more before entering the lowest grade of academic positions, and as promotions are very slow in Prussia, it would be a very rare thing for a graduate of 1875 to have reached a professorial chair by 1879. Those who made these reports were therefore men from rival schools, men imbued with prejudice in favor of the preparatory curriculum which they themselves had completed, men entirely under the sway of the traditional feeling in regard to the classics, and, of course, inclined to look with disfavor upon real-school men as representing a movement which questions the worth of classical culture. It is a well-known fact that there is usually a strong tendency for a man to attribute his general success in life to the particular things which he did, or left undone, and that it is an easy thing to regard an incidental as an essential. The worthy German professors are no exception to the rule. Many of them were so strongly convinced of the superiority of classical to modern training

antagonism will be introduced into our national life, and our higher scholarship, that fairest flower of our civilization, will perish from the earth!"

that they went out of their way to declare that a study of Latin and Greek is absolutely essential to high excellence in any department of intellectual effort!

All these reports, both those of 1869 and those of later years, so far as they were made by the faculties, were as a rule drafted by volunteers in the faculty, and some rabidly classical man generally offered to do the work. When his report was laid before the faculty, many voted for it, or refrained from voting against it, for the simple reason that they did not have time to offer such modifications as they would like to have seen made in the language or matter of the report. Thus, the writer was told by one professor in a university which sent in a very strong report in favor of the gymnasiasts as against the real-school graduates: "Professor So-and-so" (mentioning his name—one well known in Germany) "drew up our report. He is perfectly crazy on the subject, but there was no one else to do it, and after he submitted it we did not want to do such an ungracious thing as reject a service which nobody else would undertake. I voted for his report, though I should have been glad to have a much more moderate and judicial report than the one we sent in." It thus appears that these reports were prepared by men who were not only graduates of the gymnasium, but who were also, in some cases at least, regarded by their own friends as extremists. Add to this the fact that there were no representatives of the real schools in the reporting board who might have called attention to exaggerations or misstatements, whether intentional or unintentional, and it is pretty clear that these reports can not be called judicial, either in their form or spirit, but partake largely of the character of advocates' pleas.

It would be fair to suppose, however, that these men would at least examine the facts in the case as to how these real-school graduates turned out in after-life, before making a report on their comparative ability. But even this supposition turns out to be an unfounded one. As is well known, there is no general system of recitation and record-keeping in German universities, such as we have in our American colleges. The professor has, therefore, as a rule, no means of judging of a student's attainments. There are no examinations except the final one for a doctor's degree. The only institution bearing a resemblance to our recitation is the *Seminar*, a voluntary organization which many students never enter, and which varies greatly in character, according to the temperament of the professor in charge or to the subject-matter discussed. Being at times a society for the training of the members in the power of independent investigation and research, it becomes often a mere "quiz," or indeed but little more than a two hours' lecture on the part of the leader. With the exception of those students who enter the *Seminar*, the professor has no means of judging of the ability or training of the university students. The only test, therefore, is the record of such students in the final university examinations for a degree, which comparatively few students ever attempt, their record in the state examinations which nearly all try, and the final and decisive test of practical life and its demands.

Now, it is a pretty plain fact that the professors who made these reports did not take the trouble to investigate the results of these various tests, since it was reserved for a director of a real school to collect the first reliable and comprehensive statistics on the subject, and that *after these reports were prepared.* The data were furnished by the reports of the universities as to the number of degrees granted to real-school graduates, by the reports of government examiners as to standing attained in the public examinations of such students, and, finally, by the reports from the present positions and sphere of labor of all real-school graduates who had taken degrees from the universities, or who had passed into the ranks of teachers without trying the university examination. We have not room to introduce the statistics here. Suffice it to say that they make a very good showing for real-school graduates. The point that interests us most in this immediate connection is, that these facts were not ascertained or considered by the university professors who reported on this subject.

The same gentleman who collected these statistics tells a well-authenticated story of Professor Hanstein, of the University of Bonn, which very well illustrates the fairness, deliberation, and investigation which preceded and accompanied these reports. Upon receiving the notice asking for his written opinion, he remarked to his assistant: "So we have to commit ourselves in writing again, do we? Of course, the gymnasia students are superior." "But, Herr Professor," objected his assistant, "Mr. X——, who recently took his degree in natural science, passed *summa cum laude*, and he is a real-school graduate." "Yes; well, he's an exception." "And Herr Dr. ——, the *Privatdocent* here in Bonn, is also from a real school." "He's an exception too," answered Hanstein. "And a few weeks ago," continued his assistant, "one of our real-school students passed his teacher's examination in chemistry and natural history No. 1." "Exceptions—all exceptions!" replied the professor. "Yes, but, Herr Professor, there are only seven or eight of us real-school men altogether here in Bonn." "We? Are you a real-school graduate?" "Yes, sir." "Well, you are the biggest exception of all." And, with that, he turned and left the room. The story, which is vouched for, needs no comment.

There is still another point to be considered. The practical object of these reports, as some professors conceived it, was to ascertain whether the faculties were in favor of excluding real-school students from the universities, and indeed the language of the request justified that view. Some voted for the reports, therefore, because they thought that the attendance at the universities is too large, and that the exclusion of real-school graduates offers a convenient means of getting rid of the surplus students. The writer visited twelve out of the twenty-one German universities, during the last semester, in order to ascertain what is doing in the various departments in which he takes special interest. Everywhere the question was asked of university professors, "Do you think that too many are studying at the universities?" Almost uniformly the answer was returned, "There is no doubt about it." A few figures will make clear how rapidly of late years the number of students has increased. During the five years ending 1861, for every 100,000 inhabitants in Germany there were, on an average, thirty-two students in the universities. During the year 1881–'82 there were fifty-one students for the same number of inhabitants. Of these in the former period eight were enrolled in the philosophical faculty (the only faculty to which real-school students are admitted); in the latter period 20·7. That is, in a little more than twenty years the number of students in the philosophical faculty per 100,000 inhabitants has more than doubled. The average for the five years ending 1881 was eighteen, and the proportion is still increasing. This enormous increase in the number of students excites the gravest apprehension, and is characterized by thinking men as a sad state of affairs.

It may seem somewhat ludicrous to us to hear of an over-production of educated men. A German professor gave the key to the riddle, in a remark to the writer, that Germany is fostering the growth of an intellectual proletary—i. e., a class of professionally educated men for whom there is no room in the professions, and who are too proud to go into business of any sort. This state of affairs can not be fully appreciated without going further into detail than the limits of this article allow. Suffice it to say that the German universities are essentially professional schools. A man who enters such an institution intends to be a lawyer, a physician, a minister, teacher, professor, or member of the civil service of the country, and he receives there his professional training. It is easy to see that there can be an over-production in each and all of these fields. In this country such a state of things is easily remedied. If a man finds he has no chance to succeed as a lawyer, a year or two will turn him out a physician. If he fails in that, he can try theology, or he may go into business of some sort, or anybody can go into politics. In Germany the case is widely different. The Government demands such a long preliminary training and such intense and laborious effort in preparation, that, by the time a man finds there is no place for him in the profession he has chosen, his elasticity has gone, and there is no desire or ability to try anything else. To take up another profession he has become too old, and to go into mercantile or industrial life he is forbidden by his ideas of social position and scholarly dignity. To such a man two courses are open—to drag out a bare existence, with many wants which his education has developed, but which he has no means of gratifying, or—to commit suicide. Many take the latter alternative, and the enormous increase in suicides during the last few years is one of the saddest and most striking phenomena of German society, high and low.

That there is an over-production in the professional fields nearly all German thinkers agree. How can it be helped? The Government has lately called the attention of parents and teachers to the fact that the higher administrative positions in the civil service are all provided for, and that all vacancies for years to come can be filled from the present candidates. The opponents of the real schools now come forward and say: "We can help the matter very easily. Shut out real-school graduates from the philosophical faculty and there will be room enough for the surplus students of law and medicine to find careers." Some professors voted for exclusion because they thought that the shutting out of real-school students would meet this rapidly-growing evil of over-production in professional spheres.

We think enough has been advanced to prove—1. That the Berlin report has little bearing on the question we are discussing in this country as to the respective merits of classical and modern training, for the simple fact that it was on an altogether different point. 2. That as to the particular subject, in regard to which it was prepared, it can lay no claim to be considered final, because it was made prematurely, at a time when the institution judged could, by the very nature of the case, have had no fair trial, and because it was made by prejudiced parties without sufficient investigation, and influenced by considerations which should have had nothing to do with the decision.

As a matter of fact, the opinion seems to be quite general in Germany that the real schools are bound to go forward to new struggles and to new conquests. They have lost none of the ground which they have ever won; they are gaining new ground every day. It is a mere question of time when the medical schools will be opened to them, and some even dare hope that the law schools must yield also. They may suffer temporary reverses, but they are sure to win in the long run. One significant fact may be noted, which is beginning to tell in their favor. The men in Germany who have made the deepest and longest studies in the science of education are assuming a more favorable attitude toward the real schools.

The writer recently visited Professor Masius, who holds a chair of Pedagogics in the University of Leipsic. He was for years the director of a gymnasium, then of a real school of the first rank, and then for years a member of the Ministry for Public Instruction in Saxony. On being asked what his position on the question of real school *vs.* the gymnasium is, he replied: "If you mean to ask me, whether the real-school graduates I get in my work are the equals of the gymnasium graduates, I should say, no! If you mean whether our real schools, as they are, afford as good a liberal training as the gymnasia, I should say, no! If you mean whether a real-school, as fully equipped in regard to teachers and apparatus as an ordinary gymnasium, and with a simplified course of study, could give a liberal training equal to that afforded by the gymnasium, I should reply, I do not know, as the experiment has never been tried; but I am inclined to think it could."

The most advanced thinkers on pedagogics are coming to agree that the subject taught has much less to do with its value as a disciplinary and liberalizing study than the method of teaching it. Arithmetic may be so taught as to afford a much better training in language than half of our Latin and Greek teaching affords. There is a certain convertibility in the possible subjects in a curriculum with regard to liberalizing effects which is often lost sight of, but which our best thinkers on the science of education are more and more inclined to emphasize.

It has been already remarked that it is a dangerous procedure to apply concrete conclusions in one country to concrete conditions in another. The quoting of German authority in favor of a gymnasium course in order to bolster up the classical course of an average American college is a good instance in point. The German gymnasium gives nine hours a week for five years, and eight hours a week for four years more, to the study of Latin—i. e., seventy-seven hours a week for one year. It devotes to Greek seven hours a week for four years, and six hours a week for two years more—i. e., forty hours a week for one year, or to both languages the equivalent of one hundred and seventeen hours a week for one year. It will be stating it beyond the truth to put the time devoted to Latin in our average American college up to the close of the sophomore year at five hours a week for six years—i. e., thirty hours a week for one year, and to the Greek at five hours a week for five years—i. e., twenty-five hours a week for one year, or to both together the equivalent of fifty-five hours a week for one year. The German gymnasium thus gives more than twice as many hours to Latin and Greek as the average American college course. Now, the leading German authorities who favor a gymnasium course have repeatedly opposed lessening the amount of time devoted to these two subjects, and have expressed their opinion to the effect that any considerable reduction in the number of hours would be equivalent to depriving the course of all its value—i. e., so far from approving our classical curriculum, they unite in asserting that it is worth nothing whatever!

A part of President Porter's argument in the article already referred to proceeds on the assumption that the average college boy acquires enough Latin and Greek to be able to read it easily. Whatever may have been true in President Porter's college-days, the fact must appear evident to any one who has ever visited the sophomore classes in Greek in our American colleges, that the average boy does not acquire ability to translate even such an easy author as Xenophon or Homer without difficulty—not even in Yale College; and the boy who takes up a Greek author and reads him for the pleasure that he derives from the thought is an *avis rara* indeed. It is the writer's opinion, based upon considerable investigation and comparison of notes with Greek teachers, both in America and Germany, that it is impossible for the average boy who spends the average amount of time on his Greek up to the close of his sophomore year to acquire the power of reading it easily. It is a universally admitted fact in Germany that the gymnasiast, who spends so much more time and labor than the American college boy, never acquires this power; and it is as true of the former as it is of the latter that the last day of his school-life is the last day of his Greek reading, with the exception of those following a profession which calls for a knowledge of the Greek, such as the philologists, philosophers, and clergymen.

One other point is worthy of notice. President Porter attempts to show that the main reason for unsatisfactory results in Greek study is the bad teaching of Greek which prevailed long ago, and which he hints has almost disappeared. That the teaching of Greek is now superior to what it was a generation ago we are very ready to believe, but it can hardly be said that there is any greater agreement among teachers as to the proper object of Greek study and the advantages to be derived from it. A visit to several of our leading colleges last winter, and conversation with the professors and instructors in Greek, revealed to the writer the very greatest differences of opinion, not only among the various colleges, but even among the representatives of that study within the same college. It is evident that the teachers who believe that the most important object to be attained is the ability to read Greek at sight, and to understand it without having to translate it, will pursue a very different method from those who see in the "incidental training" in grammar, logic, philology, etc., the chief benefit from Greek study. And yet the writer recently found these two opposite views held by two men in the same department of one of our leading colleges, the one of whom had one division of the sophomore class and the other the second division. It is hardly necessary to say that, however much the second may have benefited his class, the first did not get his division to read Greek at sight.

The writer does not wish to be misunderstood. He is making no attack on the study of Greek. He remembers well the keen pleasure and, as he thinks, profit with which he pursued the study of Greek under an exceptionally able series of teachers, and *his viris illustrissimis summas gratias agit, semperque habebit.* But he realizes well the great importance of these educational questions, and that many of them can never be settled except by actual experiment. It is of the highest importance that all things should be fairly tried, and that held fast which is good. It is demanded in the interests of society that modern education have a fair chance by the side of classical education. That chance it has, as yet, nowhere had. Our colleges, so far as they have admitted scientific students, have allowed them to come in with a very inferior preparation. The French and German, and for that matter the English, too, in most of our colleges, are mere child's play, where they are not broad and ridiculous farces, the butt of students and professors alike. Let some of our colleges inaugurate the reform : lay out a "modern" course for admission and for college on the same general principle as the classical course—few subjects, but long-continued and detailed study in each of them—and insist on as thorough and vigorous work as they do in their Latin and Greek, and then, after a fair trial, compare results. The friends of "modern" education are willing to abide by the outcome. In the mean time it will be wise for the classicists to avoid quoting reports that have nothing to do with the question, and appealing to authority which, upon investigation, turns out to be squarely on the other side of the point in dispute.

EARLY COLONISTS OF THE SWISS LAKES.

By F. A. FOREL.

THE depression of the waters of the Lakes of Neufchâtel, Morat, and Bienne, which the Swiss Confederation has been having executed during the last ten years, has been a most fortunate event for archæologists ; and with pick in hand, and on a relatively new ground, they have been able to recover hosts of treasures from the buried ruins of the lake-villages. The few scattered relics which they had succeeded in fishing up out of the water with tongs and drags have been multiplied into immense proportions since the hunters have been able to work upon the solid land that has been reclaimed from the edges of the favored lakes. By thousands and thousands the relics of human industry have been heaped up in the archæological collections, and the knowledge of the curious civilization of the early inhabitants of Switzerland has made, by the aid of these facts, very interesting progress. We need only cite, in proof of this, the very important memoir which Professor Théophile Studer has recently published in the "Bulletin" of the Society of Naturalists of Bern. Taking up, after M. L. Rütimeyer, of Basel, the study of the bones found in the archæological deposit of the *palafittes* (a term designating a wooden construction built on piles), and making use of the immense material collected from the stations of the Lake of Bienne, he has drawn from them most interesting details respecting the variations of the animal population during the different periods of these prehistorical ages, and respecting the progress of the domestication of the races useful to man.

A comprehensive account of the present condition of our knowledge of human industry in the lake epoch is furnished in the book just published by Dr. Victor Gross on "The Proto-Helvetians, or the Earlier Colonists of the Borders of the Lakes of Bienne and Neufchâtel"

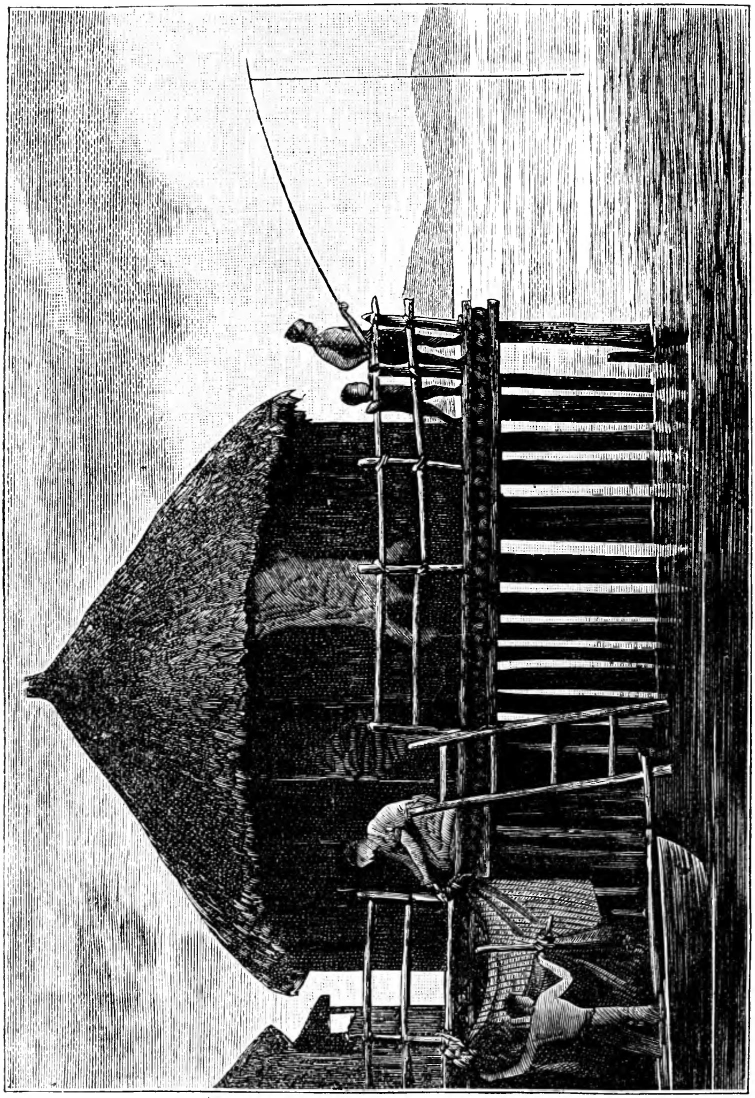

Fig. 1.—Restoration of a Dwelling of the Primitive Lake-Villages of Switzerland. (After Dr. Victor Gross.)

("*Les Protohelvètes, ou les premiers colons des bords des lacs de Bienne et de Neuchatel*"). The author, a practicing physician at La Neuveville, on the shore of the Lake of Bienne, has had the good fortune to become possessed of products of all the special excavations made upon that lake, and of a good part of the finds of the Lake of Neufchâtel, so that he has been able to form a collection unequaled in its richness, in the number of the specimens, and in the rarity of the pieces, frequently unique, that he has accumulated.

Wishing to give the scientific world a share in the enjoyment of these treasures, he has published in a beautiful quarto volume descriptions of the principal results of his researches, illustrated by photographic plates, in thirty-three of which are represented more than nine hundred and fifty of the more important pieces. I do not hesitate to style Dr. Gross's the finest known collection in prehistoric archæology, for while the series in some large museums may be more numerous than those of Dr. Gross, the latter have the superiority over all the others of relating to a single civilization, in different ages of its development, and to the same people in all the details of its intimate life with an incomparable luxury of illustration. The ruins of each one of our lake-villages may be compared to a Pompeii on a small scale. Let us suppose fifty Pompeiis, the destruction of which took place, one after another, during the ages from the primitive times of Roman history to the end of the decline of the empire, and we may be able to calculate what treasures of documents we might find in them wherewith to restore the history of industry, of art, and of civilization in ancient Italy.

The study of the larger collections of Swiss antiquities gives us a very clear impression of the wealth of the lacustrine populations, especially of the period known as the fine bronze age. We see in them universally evidences of abundant resources, and in no case of poverty. The inhabitants of the *palafittes* had at their disposal mechanical means, probably simple, but sufficient to fix in the ground the thousands and tens of thousands of piles on which they built their villages, Having an agriculture, and raising cattle, they were only exceptionally obliged to have recourse for food-supplies to the more primitive art of the chase. An extensive commerce brought them metals, amber, glass beads, and worked objects of foreign origin. A pure taste raised their artisans to the dignity of real artists. The reader who observes in Dr. Gross's plates the remarkable elegance of the designs of arms, of tools and ornaments of bronze, and of potter's work, like those represented in Fig. 2 (Nos. 1, 3, 4, and 10), can not deny that the civilization of the Swiss lake-dwellers was rich and flourishing.

The mass of metal they possessed was considerable ; and, having regard to the innumerable pices of bronze found at some of the stations, I believe it will not be wrong to assert that in proportion to the population they had a weight of bronze at their disposal nearly equal to the weight of iron, aside from the heavy castings of the large agricultural machines, to be found in any of the most prosperous existing villages of the country. A figure will give an idea of this abundance and richness. M. Gross has made an account of the bronze pieces

FIG. 2.—ARTICLES FROM THE PREHISTORIC COLLECTION OF DR. VICTOR GROSS.

1. Bronze sword-handle (station of Mörigen).
2. Ornamented ear-drops (Auvernier).
3. Cup in hammered bronze (Corcelettes).
4. Clay vase, with incrustations from lamellæ of tin.
5. Comb of yew-wood (Fenil).
6. Bronze ear-drops (Auvernier).
7. Mold in sandstone, forming one of the shells of a mold for two knives and twenty-seven rings (Mörigen).
8. Hair-pin (Estavayer).
9, 10. Bronze knives (Auvernier).
11, 12. Ear-drops of deer-horn.

taken from the Lakes of Bienne and Neufchâtel, and makes the number 19,600, more than 5,000 of which are in his own collection.

The wealth of the Proto-Helvetians, as Dr. Gross happily calls them, so manifest in the bronze age, was also as real, though less evident, in the stone age. I come to this conclusion from the presence in the ruins of that period of some classes of objects that could have reached the country only by means of a very extensive commerce. Amber was brought to them from the shores of the Baltic Sea, and rare stones of very precious qualities, from which they made their cutting-tools, came to them from still farther; nephrite, a handsome stone, clear, green, and semi-transparent, was brought to them from Turkistan, or Southern Siberia; gray jade-stone came from Burmah; and *chloromélanite*, a black stone with yellow streaks, also probably came from Asia, but from beds that are still unknown. The lake period was of long duration, and included the whole time in which man rose by successive steps from the primitive stages of civilization in which he was not yet acquainted with metals to the higher stages, when he became acquainted with bronze and then with iron. Whatever a certain German school may say about it, the existence of a bronze age intermediate between the stone age and the iron age is demonstrated. That such a progressive and continuous development took place is proved with strong evidence from the archæological study of the products of human industry, and appears definitely in the study of the bones of animals gathered in the ruins of the lake-stations. In this respect, the conclusions of M. Studer are as affirmative and demonstrative as were twenty years ago those of M. Rütimeyer.

Dr. Gross distinguishes three successive periods in the stone age: A primitive, earlier period, making a poor showing of coarse potteries and imperfectly worked stones, with no nephrite or other stones of foreign origin. The station of Chavannes, near La Neuveville, is regarded by him as the type of that remote age. A second period exhibits the civilization of the stone age in all its glory. The stone instruments are finely cut, exotic stones are abundant, and the potter's art has reached an advanced degree of perfection. Locras and Latrigen represent this age on the Lake of Bienne. A third period bears evidence of the introduction of metals. The general character of the civilization remains the same as in the preceding age, with the same styles of pottery and the same abundance of stone implements. But the first tools of metal have been imported. At Finels, on the Lake of Bienne, we find copper worked in a manner still quite primitive; and at Mōrigen, in the station of Les Roseaux, we have bronze in the form of very simple hatchets. After this came the fine age of bronze, with its magnificent development of civilization; then, later, iron appeared.

Bronze, the metal chiefly in use in the finest age of the lake civilization, is not indigenous. Neither copper nor tin, the metals which alloyed with each other in proper proportions constitute this metal, is found in the Swiss plain nor in the Jura. It is true that copper minerals exist in some of the valleys of the Alps, but it is very probable that the ancient lake-dwellers received the metal from more distant countries where the mines were more easily worked. With respect to tin, it is at any rate certain that the nearest beds are in Saxony, in Cornwall, and in Spain. It has long been debated whether these metals, tin, copper, and bronze, were brought to Switzerland already worked, or were cast on the spot; whether there was a local, native industry, or the arms, instruments, and ornaments were brought, having been already wrought out in foreign lands. It is now possible to answer the question. Some of the articles were imported already manufactured, for they evidently exhibit types of foreign industry. A superb vase of cast bronze and a fibula from Corcelettes, on the Lake of Neufchâtel, are preserved in the Museum of Lausanne, the form and ornamentation of which are manifestly Scandinavian. Other pieces, more numerous, recall forms of the south of France or of Italy. On the other hand, ingots or pigs of unworked metal are very rare in our finds. There was, however, also a local industry; and the lake-dwellers knew how to cast and hammer bronze in their own villages. We have proof of this in a relatively considerable number of molds deposited in the Swiss museums, among others at Lausanne, at Geneva, and in Dr. Gross's collection. In the plates illustrating the last collection are figured no less than three bronze molds, two of which are double, eight clay valves or fragments of molds, and seventeen molds or fragments in molasse (Fig. 2, No. 7). Sometimes one of the stone molds served for the casting of several objects; and the seventeen molds of Dr. Gross contain the matrices for seventy-two different pieces. Besides these molds, castings of bronze hammers, anvils, shears, and punches, complete the outfit of the founder, and demonstrate that his industry was indeed practiced on the spot. Whether the founder was a native, and established where he worked, or whether, like the tinkers of our own days, he was a foreigner and a wanderer, is a question to which a definite answer can not be returned.—*Translated for the Popular Science Monthly from La Nature.*

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

III.—THE EVOLUTION OF CONDUCT.

AS structures are evolved, so are the functions which structures subserve. And as the functions of the body are evolved, so are those combinations of bodily actions evolved which we include under the general term conduct.

We are considering the functions of the body when we are inquiring into such actions of the various structures internal and external as involve internal processes, simple or complex. But, when we begin to consider combinations of actions externally manifested, we are dealing with *conduct*—except only in the case of such actions as are independent of control.

But at the outset of the evolution of conduct even this distinction is scarcely to be recognized. Every external combination of actions is in the lower types of animal life a part of conduct—at least of such conduct as is possible in the lowest orders of creatures. Evolution of conduct begins with the gradual development of purpose where at first actions were random and aimless. The *Amœba* wanders from place to place, not by the action of limbs, but by a process which may be called diffluence. In so doing it may come into the neighborhood of objects fit to form its food; these it inwraps, and absorbing what is digestible rejects the rest. Or its wanderings may lead it into the way of some creature by which it is itself absorbed and digested. There may be some higher law than chance guiding the movements of such creatures; but so far as can be judged this is not the case. In other words there is but the suspicion of something like *conduct* in the actions of the Amœba. Among other creatures belonging to the same kingdom, but higher in type, we find actions so much better adjusted, that, though even yet we can not recognize such evidence of purpose as enables us to describe their actions as conduct, we yet see in their adjustment to certain ends the development of something akin to conduct. The actions seem guided by what mimics purpose if it is not purpose itself.

Now, we note that with the improved adjustment of actions comes an increase in the average duration of life, or rather in the proportion of this average to the length of life possible among these several creatures.

So when we pass to higher and higher orders of animals, we find in every case among the lower types irregular and seemingly purposeless actions, while among the higher we find actions better adjusted to the surroundings. And, again, we note that, where the combination of actions, or what we may now call the conduct, is not adjusted to the environment, the creatures' chances of life are small, great numbers dying for each whose life approaches the average duration. An improved adjustment of conduct to environment increases the chances of survival, many attaining and some passing the average of longevity in their particular type or order.

Now, structural development is guided by the fitness or unfitness of particular proportions in such and such structures for the great life-struggle in which all animal life is constantly engaged; and functional development is guided by the corresponding fitness or unfitness of such and such functional activities. Just as certainly the development of conduct in all orders of living creatures is guided by the fitness or unfitness of such and such combinations of external actions for the constant life-contest.

We might find illustrations of this in every kingdom, sub-kingdom, order, and type, of animal life. Let us, however, content ourselves by noting it in man.

In the lower races of man as at present existing, and in still greater degree among the lower races when the human race as a whole was lower, we see that the adjustments of external actions to obtain food, to provide shelter against animate and inanimate enemies, and otherwise to support or to defend life, are imperfect and irregular. The savage of the lowest type is constantly exposed to the risk of losing his life either through hunger or cold, or through storm, or from attacks against which he has not made adequate provision. He neither foresees nor remembers, and his conduct is correspondingly aimless and irregular. The least provident, or rather the most improvident, perish in greatest numbers. Hence there is an evolution of conduct from irregularity and aimlessness by slow degrees toward the regularity and adaptation of aims to ends, seen in advancing civilization. The ill-adjusted conduct which diminishes the chances of life dies out in the struggle for life, to make way for the better-adjusted conduct by which the chances of life are increased. The process is as certain in its action as the process of structural evolution. In either process we see multitudinous individual exceptions. Luck plays its part in individual cases; but inexorable law claims its customary rule over averages. In the long run conduct best adapted and adjusted to environment is developed at the expense of conduct less suitable to the surroundings.

With man, as with all orders of animals, conduct which tends to increase the duration of life prevails over conduct having an opposite tendency. Wherefore, remembering the ever-varying conditions under which life is passed, the evolution of conduct means not only the development of well-adjusted actions, but the elaboration of conduct to correspond with those diverse and multitudinous conditions.

To these considerations we may add that the evolution of conduct not only tends necessarily to increased length of life (necessarily, because shortening of life means the diminution of such conduct as tends to shorten life), but it results in increased breadth of life, and (in the highest animal) in increased depth of life also. It is manifest that, in the elaboration of activities by which length of life is increased, breadth of life is increased *pari passu*. For these activities may be said to constitute breadth of life. Passing over the numerous illustrations which might be drawn from the lower orders of animal life, we recognize in man a vast increase in the breadth of life as we pass from the limited orders of activity constituting the life of the savage to the multiplied and complex activities involved in civilized life. Increased depth of life we recognize only (but we recognize it clearly) in the most advanced races of that animal which not only thinks and reasons but reflects.

We find, then, that the evolution of conduct is not only accompanied by increased fullness of life, but is to be estimated by such increase. We do not say that that conduct is good in relation to the individual which increases and that conduct bad which diminishes the fullness of individual life in the individual. We assert, for the present, only what observation shows—that conduct of the former kind is favored (other things equal), and therefore developed, in the life-struggle, while conduct of the latter sort tends to disappear as evolution proceeds.

Thus far we have only considered conduct in relation to individual life. We have still to consider the evolution of conduct as related to the life of the species.

In considering the evolution of structures and functions we have not only to consider the influence of the struggle for inidvidual existence, but also the effects of the contest in which each race as a whole is engaged—and to do this we have to consider, first, those circumstances which affect the propagation of the race; secondly, the relation of the individuals of the race to their fellows; thirdly, the relations of the race as a whole to other races. Something akin to this must be done in considering the evolution of conduct. We have seen how modes of conduct which favor the continued existence of the individual are developed at the expense of modes of conduct having an opposite tendency. These last die out, because the individuals of the race who act in these ways die out. But it is obvious that conduct will be equally apt to die out which tends to prevent or limit the adequate renewal of the race from generation to generation. It is equally obvious that whatever conduct causes contests (whether for life or subsistence) within the race or species, tends to the elimination of members of the race, and so diminishes the chances of the race in the struggle for existence with other races. Lastly, the relations of a race to surrounding races are manifestly of importance in the evolution of conduct, seeing that conduct will equally tend to be diminished whether it is unfavorable to the existence of the race in which it is prevalent, or simply unfavorable to the separate existence of an individual member of the race.

Now, with regard to conduct affecting the propagation of a race, we find that, like conduct affecting individual life, it has been developed from what can hardly be called conduct at all in the lowest grades of life to fully developed conduct, with elaborate adaptation of means to ends in the highest. In the lowest forms of life, propagation proceeds by mere division and subdivision, not depending so far as can be judged on any power of controlling the process, which such creatures may possess. In fact, the *Protozoa* multiply by dividing. We have to pass over many grades of life before we reach such imperfect care for propagation of the race as we find among those orders of fish in which the male keeps watch and ward over the eggs. Still higher must we pass before we find any trace of affection for the young, and higher yet before we see care given to feed and protect and keep the young till they are able to provide for themselves.

This brings us in fact very near to the human race, which, in its lowest races, is distinguished from other animals chiefly by the length of time during which it feeds, protects, and trains its young. In the higher human races all these processes are conducted with greater care and elaboration; more varied wants are considered and attended to, more elaborately varied means are used for the purpose. It is easily seen how such conduct by aiding the development of the race aids the development of the conduct itself by which that result is favored. Among those members of a race in whom the proper race-propagating conduct is not adequately shown, propagation proceeds less effectively—which is the same as saying that, relatively, such conduct itself must be diminishing.

This conclusion is not inconsistent, as at first sight it might appear, with the fact that mere numerical increase of propagation, though it means increase in quantity of life, is not always or even generally a proof of the growth of the race in what may be called race-vitality. Here as elsewhere adaptation of means to ends has to be considered, and that kind of conduct by which such adaptation is secured has the best chances of development in the long run. Let us, for instance, take an illustration from civilized life: An early marriage between two persons, careless alike of present duties and future difficulties, seems at first to tend directly to the increase of carelessness and thoughtlessness; for from such a union there will probably come into existence more than the average number of offspring, repeating in greater or less degree the weak characters of their parents: the totality of life characterized by undesirable qualities and conduct will thus be increased, and increased in a greater ratio than the totality of prudent, steady, and thoughtful life, by a well-considered union and well-judged conduct thereafter. Yet in the long run the result proves usually otherwise. (We consider only average results.) The larger number of offspring of inferior qualities receive less care and inferior training; so that for them there is greater probability either of early death or of defective adult life. The parents suffer also in the struggle thus brought on them, for which they are ill-fitted. A diminished amount of life is likely to result, and (taking the average of many cases) probably does result; while certainly there is diminished life-quality. Hence results a correspondingly diminished amount and influence of the inferior kind of conduct shown by thoughtlessness or carelessness about life's duties. On the other hand, the well-judged and not too hasty union of two care-taking persons, though it may add a smaller number of individual lives to the life of the race, adds better and more enduring life, life more likely to maintain and sustain the qualities of the parents, giving therefore to these qualities in the race at once more stability and wider influence. In other words, the qualities best suited for the propagation of the race, and best suited for the race, will on the average be developed, while qualities having opposite tendencies will either be eliminated, or though they may remain will occupy a lower place and have diminished influence on the fortunes of the race —a circumstance tending of itself still further to their eventual elimination.

But, within a race and in the relations of the race to other races, there are causes which influence the evolution of conduct. Members of a race fight out the contest for existence not alone but more or less in the presence of their fellows and in the presence of members of other races. Each individual in providing for his own wants or for his own defense affects more or less others, either of his own race or of other races, in their efforts to defend or sustain *their* lives. Very often, as Mr. Herbert Spencer quaintly puts it, "a successful adjustment by one creature involves an unsuccessful adjustment made by another creature, either of the same kind or of a different kind." The lion and the lamb, for instance, already anticipate the millennium; but the lion adjusts matters so much more successfully than the lamb as to take the outside place; the lamb lies down with the lion, but—inside. Among all races, herbivorous as well as carnivorous, similar relations exist. The more vigorous get the better food, food which the weaker contend for in vain or have to resign, when obtained, to superior strength. Within one and the same race there is still the same law. The stronger monopolize, if they can, the feeding-grounds of the race. The weaker, whether originally so, or become so through age or disease, succumb in greater numbers than the stronger in the struggle for existence. Only, while the death of those weak through age does not affect the evolution of the race, the greater mortality among those originally weaker than the rest modifies the race-qualities.

In these contests conduct plays an important part. Unnecessary contests involve unnecessary risks. That conduct must prevail best in the long run, and therefore that conduct must eventually be evolved and developed, by which adjustments for the advantage of one creature do not needlessly interfere with adjustments for the advantage of other creatures. If we imagine a carnivorous animal carefully limiting his search for animal food to his requirements, not killing where there was no occasion, and keeping carefully all food he had once obtained, we see that his chances in the life-struggle would be better than those of a carnivore of the same race who killed whenever he got the chance. It would be more the interest of other creatures (as for instance those who wanted the same sort of food) to eliminate the carnivore of the latter sort, than to remove the more prudent member of the race. In the long run this would tell even among the lower animals. But, as we approach the relations of men to men and men to animals, we see more obviously how conduct in which the interests or the wants of others are considered is safer in the long run, more conducive (in hundreds of ways more or less complex) to prolonged existence, than conduct in which those interests and wants are neglected. Hence there will be a tendency, acting slowly but surely, to the evolution of conduct of the former kind. More of those whose conduct is of that character, or approaches that character, will survive in each generation, than of those whose conduct is of an opposite character. The difference may be slight, and therefore the effect in a single generation, or even in several, may also be slight; but in the long run the law must tell. Conduct of the sort least advantageous will tend to die out, because those showing it will have relatively inferior life-chances.

Mr. Spencer seems to me to leave his argument a little incomplete just here. For, though he shows that conduct avoiding harm to others, in all races, must tend to make the totality of life larger, this in reality is insufficient. He is dealing with the evolution of conduct. Now, to take a concrete example, those of the hawk tribe who left little birds alone, except when they had no other way to keep themselves alive but by capturing and killing them, would help to increase the totality of life, by leaving more birds to propagate their kind than would be left if a more wholesale slaughter were carried out. But this of itself would not tend to develop that moderation of hawk character which we have imagined. The creatures helped in the life-struggle would not be the hawks (so far as this particular increase in the totality of life was concerned), but the small birds; and the only kind of moderation or considerateness encouraged would be shown in a lessening of that extreme diffidence, that desire to withdraw themselves wholly from hawk society, which we recognize among small birds. But if it be shown that the more wildly rapacious hawks stand a greater chance of being destroyed than those of a more moderate character, then we see that such moderation and steadiness of character are likely to be developed and finally established as a characteristic of the more enduring races of hawks. And similarly in other such cases.

It is, however, in the development of conduct in the higher races only, that this comparatively elaborate law of evolution is clearly recognized. Among savage races we still see apparent exceptions to the operation of the rule. Individuals and classes and races distinguished by ferocity and utter disregard of the "adjustments" of others, whether of their own race or of different races, seem to thrive well enough, better even than the more moderate and considerate. Forces really are at work tending to eliminate the more violent and greedy ; but they are not obvious. As society advances, however, even this seeming success of the rapacious is found to diminish, though as yet there has been no race or society from which it has been actually eliminated. Conduct which is imperfect, conduct characterized by antagonisms between groups and antagonisms between members of the same group, tends to be more and more reduced in amount, by the failure or by the elimination of those who exhibit such conduct. What is regarded as gallant daring in one generation is scorned as ferocity in a later one, resisted as rapacious wrong-doing yet later, and later still is eliminated either by death or nearly as effectually (when indirect as well as direct consequences are considered) by imprisonment.*

As violence dies out, and as war diminishes—which usually is but violence manifested on a larger scale—the kind of conduct toward which processes of evolution appear to tend, "that perfect adjustment of acts to ends in maintaining individual life and rearing new individuals, which is effected by each without hindering others from effecting like perfect adjustments," will be approached. How nearly it will ever be attained by any human race—*quien sabe?*

One further consideration, and we have done with the evolution of conduct, the right understanding of which is essential to the scientific study of conduct. The members of a society, while attending to adjustments necessary for their wants or interests, may not merely leave others free to make their adjustments also, but may help them in so doing. It is very obvious that conduct thus directed must tend to be developed. As Mr. Spencer says, such conduct facilitates the making of adjustments by each, and so increases the totality of the adjustments made, and serves to render the lives of all more complete. But besides this (as he should also have shown, since it is an essential part of the evolution argument), it tends to its own increase : for, being essentially mutual, conduct of this kind is a favorable factor in the life-struggle.

We have next to consider what, seeing thus the laws according to which conduct is evolved, we are to regard as good conduct and bad conduct.

* Many overlook the bearing of imprisonment on the evolution of conduct—its influence (when long terms are considered) in diminishing the numerical increase of particular types of character, and therefore in diminishing the quantity of particular forms of conduct.

FEMALE EDUCATION FROM A MEDICAL POINT OF VIEW.*

By T. S. CLOUSTON, M. D.

AS the result of my inquiries among pupils and teachers in the advanced schools for young ladies, I find that about five or six hours of actual school-work, and from two to four hours of preparation at home, may be taken as the time that is each day occupied in education. Many of the ambitious, clever girls, in order to take high places and prizes, work far longer than the time I have mentioned in preparing at home, especially if the musical practicing is taken into account. At certain times of the year, before examination, some of these girls will work twelve and fourteen hours a day, and take no exercise to speak of, and but little fresh air. For those who attend the day-schools a somewhat solemn walk to and from school is the chief means the body has of keeping healthy at all. To satisfy the requirements of the brain, and the blood, and the muscles, and the digestion, and the nutrition, and the general growth, we have a girl getting up at seven o'clock in the dark winter morning, dressing, eating a hasty breakfast (as if that was a secondary matter that was too unimportant to waste much time over), having a revise of some special subject learned the night before, walking to school in perhaps thin-soled boots, and doing the most physiologically profitable thing of the day in the chat and gossip on the way. School and lessons from nine o'clock till two or three, or four often, in questionably aired, overheated, and dull class-rooms, with not a bright bit of paint or color in them to counteract the sunless gloom of our Scotch winter weather. Who ever saw a class-room in a school where taste had been exercised in the decoration and painting? In my opinion our school-rooms should be made at least as nice as our drawing-rooms. Then the walk home, a hurried dinner, a little rest, and to work till nine or ten o'clock at night in gas-light. That is the sort of life, and these are the conditions, under which we expect not only prodigies of learning in all the sciences, but sweet tempers and sweetly healthful bodies to be developed. That is the actual treatment to which thousands of our girls are subjected during the most momentous period of their lives, physiologically; when the growth of the body is being completed, its symmetry and perfection are being reached, when the latent energies for a life's work are being or should be accumulating, and when a certain amount of joy and fun and play is Nature's best aid to health of body and mind.

There is another class of young women who have even a harder lot in many cases, and these are the pupil-teachers in the board-schools.

* The second of two lectures delivered at the Philosophical Institution of Edinburgh, November, 1882.

Their work is, in some cases, simply continuous all day, and part of it is irksome, uninteresting drudgery; their homes are often far from being cheerful, and their food far from being very abundant. I know as a fact that the lives of some of our female pupil-teachers are such that as melancholy a "Song of the School" could be sung of them as Hood's "Song of the Shirt."

In both these cases—the scholars in the higher class of girls' schools and the female pupil-teachers—the range of subjects to be learned at the same time is often enormous. Six, seven, eight, nine, and even ten different subjects, all being learned at once, is no uncommon thing! I am glad to say that this is being corrected in the best schools, and only four or five subjects are allowed to be taught at the same time. This is surely enough.

If I had a school to construct on ideal principles, I should have it placed on the north side of a large space of ground. I should have it one story only, and every class-room lofty, and with roof-lights to let in as much as possible of our scanty Scotch sunlight. I should have the walls of the class-room painted in light, cheerful, tasteful colors, to produce a cheering effect on the minds of the pupils. I should have big, open fireplaces to cheer and to ventilate the rooms. I should have, as an essential adjunct, a great room, where gymnastics, romping, dancing, and play should all have full scope, when the weather did not admit of the girls going out. I should not restrain romping and play, even in girls of eighteen, between classes. Girls between thirteen and twenty will romp well, if they are in health, and there is no pressure put on them that it is not the thing for them to do. I should not have more than four hours of good hard work at school, and two of preparation at home. The fact is, that our scholars lose the benefit for their health of the best part of our Scotch winter days, the forenoon, when we sometimes have both sunshine and dryness in the air. By the time school is over, the day is done.

One of the practices most energetically relied on in the higher class of girls' schools is that of the competition of one scholar with another. In some of them this competition is terrific. It extends to every subject; it becomes so keen as to put each girl who is in the foremost rank in a fever-heat of emulation before the examinations. In some cases it overmasters every other feeling for the time being. No doubt, from the schoolmaster's point of view, it is the very thing he wants. In his professional enthusiasm he aims at the highest mental result. He is not professionally interested in the health or the special nervous constitution of his girls; he does not regard them as each one a medico-psychological entity and problem. I don't say this by way of reproach. All good men try to attain the highest result in their special departments. The educator has no means of knowing the constitution and hereditary weakness of his girls—that the mother of one died of consumption, that the father of another was insane, that neuralgia is hereditary in the family of a third, that one has been nervous, another had convulsions when a baby, another has been threatened with water in the head, etc. His own education and training have not taught him to notice or know the meaning of narrow chests, or great thinness, or stooping shoulders, or very big heads, or quick, jerky movements, or dilated pupils, or want of appetite, or headaches, or irritability, or back-aches, or disinclination to bodily exertion. But all these things exist in abundance in every big school, and the girls handicapped in that way are set into competition with those who are strong and free from risks. It is the most nervous, excitable, and highly strung girls who throw themselves into the school competition most keenly. And they, of course, are just the most liable to be injured by it. All good observers say the intensity of feeling displayed in girls' competitions is greater than among lads, and that there is far more apt to arise a personal animus. Girls don't take a beating so quietly as boys. Their moral constitution, while in some ways stronger than that of boys, especially at that age, suffers more from any disturbing cause. The whole thing takes greater hold of them—is more real. It is more boys' nature to fight and forget, and take defeat calmly. Girls, I believe, suffer, when the competition in schools is too keen, in their tenderness of feeling and in their charity. They tend to attribute unfairness of motive to their teachers far more than boys, just because their affective nature is and should be stronger than their reasoning power. A man's idea of the perfection of feminine nature is, that it always has some self-denial and much generosity in it. Now, these keen school competitions admit in theory of no such notions of self-denial or generosity, though both are common enough in individual cases. An ideal woman should rejoice as much in sympathy with the winner of the first place as if she had won it herself. Men certainly don't, in their hearts, like to see girls competing keenly with each other for anything.

Young women at adolescence are apt to have in large degree the feminine power of taking it out of themselves for a time, more than they are able to bear for long. It is this power which enables a mother to watch a sick child for weeks without almost any sleep, and without feeling much sense of fatigue at the time. Now, when this power is called up for months for such a purpose as school competition—the feelings being stimulated by rivalry with others, and by the enthusiasm of that age, during a period of life when the body is undeveloped, and should be rapidly growing, and all these functions and faculties maturing—it is perverted from the real use that Nature meant it for, and the results can not fail to be bad. At that age girls are not only enthusiastic in perception and reception, but they are often very conscientious, and apply their ideas of right and wrong to things that have no ethical relationship. They are, in fact, hyper-conscientious, and make themselves unhappy about school deficiencies, for which they are not in the least responsible. I have known girls cry bitterly because an accident or headache prevented them preparing their lessons for the morrow, and blame themselves severely about it. It is not uncommon for our Scotch girls, at least, to think it is some dereliction of duty and sin on their part that prevents them from attaining a high place at school. The whole process of education, as it exists in some schools, with its competition, long hours of work, short hours of recreation, enthusiasm for work, and conscientiousness in the doing of it, takes up all the available energy of the girl. There is little left for joyous feeling and enjoyment of life for its own sake. The sources of vital energy in the brain are not sufficiently replenished by fresh air and the frolic natural to the age. Blood is not formed in sufficient amount, and pale cheeks and flabby muscles are the result. Nature can not get material and force to build up the form toward the fair woman's ideal, and, therefore, personal beauty and grace of movement are not attained to the extent they should be. As for a store of energy being laid up, as it should be at that age, for the future, for woman's work of the future, for motherhood, for the race of the future, how can it be, when every available energy is taken up in this educative process?

The methods of education are nowadays made far more pleasant for a pupil than they were formerly. Every art and device is now adopted to make it attractive and interesting. That, no doubt, is in the right direction, and it has resulted from a closer study of the mental nature of pupils. But it is attended with this danger, that, being more attractive, it can be pushed further and more hurtfully to the constitution, by the aid of the pupils, as it were. Its very seductiveness and interest, like the tempting courses of a feast, tend toward dangerous surfeiting.

It must be remembered that, in many respects, the female organism is far more delicate than that of men. This is especially so at adolescence. The machine is less tough, and breaks down at slighter causes. It has more calls on it. It needs more careful management. It is not steady in its action, but irregular. It is not fitted for the regular grind that the man can keep up. Having beauty and harmony as two of its great ideal aims, its strength is not so great. Having to lay up more for the future, it can't expend so much in the present. Sensitiveness always implies delicacy, and in many cases instability in nature. Even suppose it is granted that it was a good thing for a woman that her brain should contain all the book-knowledge that many modern educationalists demand, this good thing might be altogether counterbalanced if the labor of acquiring it stopped one inch of growth, or diminished the joy and organic satisfaction of life one iota. If the men of the future were to suffer and be degenerate through it in the faintest degree, then it would be radically bad.

There is one most unaccountable want in very many girls' schools in our cities. If boys need play, fresh air, games, muscular development, I have no hesitation in saying that girls need them all to the extent applicable to their constitution and strength still more. For boys will have them to some extent. If you don't give a boy a play-ground he will play on the street, which is better than no play. Now, the exigency of public opinion will not allow our young ladies to amuse themselves on the streets ; and, if not, how are they to get the fresh air and muscular exercise that are absolutely necessary for their health and proper development ? You can not starve a girl's life of these things without doing her harm, any more than you can with impunity keep her on a short allowance of food. A girls' school without a play-ground, a gymnasium, or public park near, I look on as a garden without sunshine, or a boat with one oar. It is deficient and one-sided ; it is a machine for production without sufficient provision for the renovation of wear and tear. Mind can't grow except by growth of brain ; brain can't grow but through good food, fresh air, work, and rest, in proper proportion. The blood will not renew itself properly in youth but by brisk circulation, and this can only be got by exercise in the fresh air. The muscles won't grow and harden but by having plenty of good blood and exercise. The fat, that most essential concomitant of female adolescence, won't form in the proper way, except the blood is rich. Fat is to the body what fun is to the mind, an indication of spare power that is boiling over and available for future use. I don't mean an excessive amount of fat ; I mean that amount that gives roundness, plumpness, and beauty. This little estimated substance is, with form, the great source of female beauty. Without it, form can not make a perfect woman ; without it, a young woman can not be said to be really in health ; without it, the body generally has, in most instances, too little spare energy to resist and to recover from disease. Therefore, a proper amount of fat should, in its way, be as much looked to in a young woman as intellectual power or keen feeling. The right sort of fat, firm and smooth, gives the lines of beauty and the idea of softness and health to woman. But to the physiologist its great value and importance are as an index of good nutrition and a reserve of spare material, not needed for work just now, but called up in any illness. When anything is both a beauty and a strength, it should not be decried or spoken disrespectfully of. I knew a man—not a lunatic—who always said it was his highest ambition to be fat. Certainly there are many more foolish wishes for our growing adolescent girls than that they should all be fat. It is just because this seems to be incompatible with the work in some of our modern city high-class schools, that I think that work must be conducted to some extent on wrong principles.

I am no educationalist, and may be accused of speaking about what I am ignorant of, if I suggest that too many things are taught at the same time, and too little time is taken for the whole process.

Think of an undeveloped brain getting up book-knowledge on ten different subjects all the same day, and this going on day after day for years! It is altogether contrary to the principles of a sound psychology to imagine that any sort of mental process, worthy of the name of thinking, can take place in that brain while that is going on. The natural tendency of a good brain at that age to be inquisitive and receptive is glutted to more than satiety. The natural process of building up a fabric of mental completeness by having each new fact and observation looked at in different ways, and having it suggest other facts and ideas, and then settle down as a part of the regular furniture of the mind, can not possibly go on where new facts are shoveled in by the hundred day by day. The effect of this is bad on boys, but is worse on girls, because it is more alien to their mental constitution. The effect on them of this unnatural process is to exhaust the nervous power at the time, and to leave the brain afterward filled with useless things that are soon forgotten and pass away; as Goethe said about professional men: they labor under a great disadvantage in not being allowed to be ignorant of what is to them useless. The vital energies and nervous power that had thus been thrown away should have gone toward a feminine equipment of a healthy, well-developed body, a mind built up and stored with knowledge that had a relation to its own nature and to the wants of its future life, affections not attenuated by scholastic routine, and a cheerfulness that is only compatible with good health. The cramming up of the dry facts of those many subjects is in most cases a weariness and pain, while the intelligent study of one third of them, selected on account of their fitness to the mental constitution of the learner, or her probable requirements in future life, might be a pleasure and a lasting profit. I would strongly advise parents occasionally to take their daughters' night tasks and do them themselves. It is far more important to extend female education till after twenty years of age than male education.

While education is going on, a regular periodic testing of the bodily growth and condition should also be carried out in the case of every girl. Her rate of growth should be marked by a notch on a stick every quarter. As regularly as the school fees are paid her weight should be taken, the color of her cheeks and lips should be looked at and noted, her appetite and digestion should be looked to, her habits of activity or otherwise should be observed, her power of sleeping should be noticed, the mode of growth should be observed—e. g., whether her chest is expanding, whether her shoulders are sloping or stooping, whether she is soft or firm in the flesh, etc. Her general mental condition, whether she is frolicsome or irritable, enthusiastic or sluggish, selfish and grudging, or not, is of great moment as an index of the general brain-condition. Of course, anything like disorder of health, or pain, or sleeplessness, or want of appetite, or pallor, or thinness, should be at once attended to before it goes too far. The great thing is to stop the beginnings of evil. If a girl has grown a couple of inches a year, then depend upon it she should not study hard. Nature has enough to do in such a case to firm up the body in proportion to its bulk. You want not only growth, but activity, grace of movement, alertness, strength. You won't have these if the girl goes on studying hard while she is growing fast.* If growth and increase in weight stop too soon, a wise parent will send off her daughter to the country to run to grass for a time, to see if mental inactivity will restore the body-growth. If she is getting thin, let her live out in the open air, instead of in a school, till her appetite becomes ravenous, and she puts on flesh.

There are three considerations that ought certainly to determine the mode, kind, and amount of the education given to any youth or maiden. These are—1. The hereditary constitution of the brain, including both its strong and weak points; 2. The actual ascertainable mental and bodily qualities and capacities and special tendencies of the child; and, 3. The purposes in life that he or she is destined to accomplish. It is owing to our backward physiological knowledge alone that the two former have not hitherto been taken into account, as they ought to have been, by doctors, parents, and teachers. In regard to heredity, when we know its laws more fully in human beings, we shall be able, by influences brought to bear on development and by appropriate conditions of life, greatly to counteract weak points, and to make strong ones available for the purposes of life. We are now able to do so to a considerable extent in the animal kingdom. Man has for his own purposes developed breeds of carrier-pigeons, race-horses, pointer-dogs, etc. We shall not be able to control the heredity of human beings as we can that of the lower animals, but we can apply conditions of life in a scientific manner for our aims. And, even in regard to the mode in which marriages are arranged, a medico-psychologist can not for a moment admit that young persons of either sex fall in love and assort themselves on no scientific principles. The sympathies and affinities of sex are just as much subject to law as any other part of nature. We doctors have much occasion to know that persons of a nervous heredity and disposition are extremely apt to fall in love with and marry each other. The way in which nervousness of all sorts is thus increased is extraordinary. The educators do their best to foster this tendency in the maidens by brain-forcing. The brilliancy of the results at the time are certainly very tempting.

* On October 1st I weighed and measured three children of one family, two boys and a girl, on their return to school after the holidays, and on November 30th I again did so. The boys had each gained four pounds in weight and grown half an inch, the girl had neither gained nor grown. The boys had had lots of play in the open air between lessons, the girl had been five hours each day continuously in school. The boys' class-rooms had been built for a school, the girl's class-rooms were in a small private house.

It may be that it will be for the advantage of the world deliberately to develop different kinds of men and women in the future. We may get better general results by having brain specialties fostered. We may thus have some families of special æsthetic power, some of mechanical genius, and some of enduring muscular work, just as we have pointers, greyhounds, and sheep-dogs. But even then it would be more than ever necessary to see that the special strong point did not override and interfere with the general nutritive power and vital energy. In training a greyhound, however anxious the trainer is to get speed, he takes care that the dog is very well nourished while he grows, and he never develops his speed till the growth is nearly done, and the bones are set. He doesn't all the time he is growing run the animal every day. He knows that would spoil the general strength, and shorten the period of greatest activity.

The development of special strong points during the process of the education of children I believe to be of vast importance to the race, but it must be done in accordance with Nature's general laws that govern the development of the organism as a whole. The special education must be accompanied by the general development. It must not be pushed to the extent that it absorbs energy needed for other purposes. I can imagine no more interesting or important problem in education than the successful cultivation of specialties. It is quite certain that as yet it has not been solved or even studied to any extent. If you hear of a young lady now who is very musical, you usually find she has so much music added to the grammar and the French and German. It is as important in education to know what things to omit as to know what things to press. It is enough to make one despair of the inherent reasonableness of human nature to think of the amount of time and toil that are given in Edinburgh to the learning of things for which there is no inherent capacity in the learners; things that go against the intellectual grain, that are learned poorly and with much difficulty, against Nature; and are forgotten at once, in accordance with Nature's laws. Think of the girls who toil at music, who have no inherent musical capacity; of the time that is taken in committing to memory rules of grammar, and doing parsing, the real meaning of which the girls' brains could not comprehend, if they lived till they were ninety; of the labor and sorrow given to acquire languages, by girls whom Nature meant only to speak their mother-tongue; of the futile attempts to take those past the rule of three, whom Nature intended to stop at simple division. The sad thing is that we all know each of those girls could do something or other very well and to some purpose in after-life, if we could only hit on what it is.

I don't want to frighten any one unduly by the list of bodily and mental diseases and defects that are in some cases attributable to wrong methods of education that I am about to refer to. I would beg every one who hears me to keep in mind that the worst of such things are the exception. No process of attempted educational stimulation will do much harm to very many brains, fortunately as I think. Their inherent stability—which, by-the-way, parents and teachers will ignorantly call stupidity or want of application—sometimes preserves them from being forced into work inconsistent with their bent and capacity. Who does not know dozens of fine girls—capable, practical, intelligent, affectionate, lively—who never could be made scholars of, and yet who know more that will be useful to them than some of the first prize-women? They never ran any risk of suffering from over-education, their only risk was badly ventilated school-rooms and want of scope for play. It is very difficult, I know, to treat of the professional aspect of a question popularly without producing misconceptions. If a case of consumption from ill-ventilated school-rooms is referred to, many people jump to the conclusion that all girls are in danger of consumption. Nothing could be more absurd. The fact is that, if we and our families were thoroughly healthy in original constitution, the educationalists and their present over-enthusiastic methods would not hurt our daughters so very much, perhaps, at least permanently. Nature would call a halt with sufficient distinctness before much harm was done, and then the wondrous recuperative power of that time of life would soon put matters right again. It is because few persons nowadays have faultless constitutions, and few families are altogether free from tendencies to some disease or other, that one needs to be now more careful of the constitutions of the mothers of the next generation.

The first bodily defect to which I shall refer, as the result of over-stimulation of brain, is what we doctors call *anæmia*, or in other words bloodlessness. The girls look pale about the lips, and have no rosy cheeks. This is manifestly most common in school-girls. Any one can see it.

The next faulty bodily condition that may be caused by wrong methods of education is that of stunted growth. I have seen girls, the daughters of well-grown parents, who simply stopped growing too soon. They are more or less dwarfish specimens of their kind, this being caused, as I believe, by the vital and nervous force being appropriated by the mental part of the brain in learning its tasks, and by the conditions of life in the school-rooms not being good, the air bad, insufficient play-hours, no play-ground, no play-room, no walking in the fresh air and sunshine. I have seen other girls who grew tall enough, but wouldn't fatten. They remained thin and scrawny. Now, this is not what a woman should be at any age if it can be helped.

The next condition sometimes produced is best described by the word *nervousness.* That is a condition of mind and body in which there is want of stability and fixity, undue excitability, bodily restlessness, want of solidity and calmness of constitution, ungrounded fears, deficient power of self-control, over-sensitiveness in all directions, and a very great many other unpleasant things, far too numerous to mention here. This nervousness is commonly hereditary, but may be greatly aggravated or counteracted by the conditions of life, especially in youth. Such a constitution is a great curse to a woman, and renders her liable to many diseases. It means a brain wanting in reserve or surplus energy. Such a brain is like a galvanic battery that does not work steadily, but gives out too much power at one time, then suddenly is exhausted, and is always needing replenishing. There can be but little doubt that the tendency of our modern life is toward the development of the nervous type of constitution, or *diathesis*. American physicians and socialists are unanimous that this constitution is very common in their country. I think there can be little doubt that, if we wish our descendants to multiply and cover the earth, we should try by all means and counteract this tendency to the nervous constitution in a morbid degree. It is most hereditary in all its forms. There are few families among the educated classes nowadays free from some taint of it, and it is easily increased. In the families that are now free there is much risk of its being developed in the period of adolescence in the girls, through the present system of education. All our modern ways of looking at life help to develop nerves in a bad sense. The ideal of man and woman has changed from strength to culture, from body to brain. The great brawny-muscled man, who knows nothing of sickness, but has few ideas, is looked down on ; the rosy mother of a dozen healthy children, who has no taste for books, is little thought of. It may be that the time will come when such people will be more highly appreciated. Out of the nervous diathesis may arise all the forms of nervous disease, when their exciting causes are put in operation.

Strongly connected with nervousness is the tendency to suffer from pain without any actual disease being present to account for it ; that is, to be the subject of headaches and neuralgias. Headache is the most common thing suffered by school-girls, and originated by the conditions of school-life. Dr. Truchler found that in Darmstadt, Paris, and Nuremburg, one third of the pupils in the schools suffered more or less from headaches. I think we should find this proportion in our advanced girls' schools in Edinburgh. He concludes that it is caused by the intellectual exertion, combined with bad air, with the annoyances and excitements and worries, the wasting and rasping anxieties of school-life. Nothing is so terrible as severe neuralgia, and beyond a doubt girls acquire it often enough by the conditions of school-life. Headaches in a school-girl usually mean exhausted nerve-power through overwork, over-excitement, over-anxiety, or bad air. Rest, a good laugh, or a country walk, will usually cure it readily enough to begin with. But to become subject to headaches is a very serious matter, and all such nervous diseases have a nasty tendency to recur, to become periodic, to be set up by the same causes, to become an organic habit of the body. For any woman to become liable to severe neuralgia is a most terrible thing. It means that while it lasts life is not worth having. It paralyzes the power to work, it deprives her of the power to enjoy anything, it tends toward irritability of temper, it tempts to the use of narcotics and stimulants.

There is but little doubt that a tendency to take stimulants to excess, a morbid craving for alcohol, or drugs that have something like the same effect, goes with the nervousness engendered by school-life. A healthy brain in a healthy body should have no inordinate craving for stimulants. Some of the worst examples I have seen of a craving for stimulants or opium, having become uncontrollable and a real disease, have been in our highly-educated ladies. Tea sometimes is craved for, and taken to excess in such cases.

The most important effect of all I can not very well enter on in detail, for it relates to woman's highest function, that of motherhood. But that this is affected, and most seriously, by over-education in bad methods and under bad conditions, no physician will deny. If the end of mind-culture is to be that its victim is to suffer in a more terrible way from mother Eve's primal curse, and is to have fewer offspring, and those she has are to be of a puny kind, the risk will be recognized by all thoughtful persons as too severe to be deliberately run for our daughters. Perfect health is a priceless blessing to all, but it means even more to women than to men. The cheerfulness and vivacity that are their special characteristic, seem to exist not for themselves alone, but for their families as well, and those are, generally speaking, wanting if the health is bad. Woman is gifted with the power not only of bearing her own share of ills, but of helping to bear those of others. She can't do so in the same degree if she is not in health. She is a plant more difficult to rear than man in our state of society. More care has to be taken of her to mature and consolidate all her organs and functions. Once fully formed as a woman, she can then stand much, but she is specially liable to the effects of adverse conditions during her development. The full bloom of her perfection as the tender mother, the never-tiring nurse of a large family of children, can not be attained if she has been stunted in her full development in any way. Whether she is an actual mother or not, she is infinitely the better for having the full capacity of motherhood. Be she teacher, scholar, or lady of fortune, she will be happier and do her work far better, if she has all the qualities of motherhood. They influence body and mind; any process of education that lessens them deprives the world of means of happiness. It stunts the woman and robs the world. No intellectual results, no culture, no mental elevation, can make up to the world for the loss of any perceptible degree of motherhood; and, as an actual fact, physicians find that over-education by bad methods and under bad conditions has this effect.

The first appearance of the conditions called *hysteria* is usually coincident with adolescence, and is undoubtedly caused in many instances by subtile disturbances of the health, due to prolonged school-hours. This is a most troublesome disease, and most varied in its manifestations. In nothing is the connection between mind and body, between function and feeling, better seen than in certain hysterical conditions. You have a splendidly educated girl according to the modern standard, with a physique that seems very fairly developed, just showing by certain subtile indications that the mental portion of the brain has been made too dominant. You have this girl prostrated in what seems the most mysterious way by hysteria, in one of its hundred forms. You can't actually say what is wrong, but you know that, if she had been brought up in the country, with moderate schooling, and four or five hours a day in the open air, there would not have occurred anything of the kind. It may result from idleness just as it does from over-brain-work, the one being as much contrary to the laws of nature as the other. It is an illustration of the fact that you may have effects produced by wrong methods of education that are not to be detected till they break out in actual disease. If the seeds of disease or the conditions that tend to it are laid by any system of training, it is nearly as bad as actual visible disease. Sometimes it is said about the girls in a school, "Just look at them, are they not fairly healthy for town girls who are working hard?" But one of the dangers is that we may not be able to see the beginnings of evil, and only by sad experience afterward find that they were there.

The last kinds of disease to which I shall refer as being a direct or indirect result, in some cases, of over-study under bad conditions, are inflammation of the brain and its membranes, and insanity—the former of which all physicians have often enough seen to be the direct result of over-study; while the latter may be regarded, in its essential nature, as the acme of all nervous diseases. In it, that highest portion of the brain that ministers directly to mind is disordered, that very portion that in over-education has been forced and crammed with book-knowledge. Mental disease is not common till toward the end of the period of adolescence, but the conditions that lead up to it are common enough before then. The mere acquiring knowledge seldom causes insanity. Its causes in youth are all the conditions of life that accompany over-education, as well as the brain-forcing itself, the want of fresh air, the poor bodily development, the poverty of blood, the deranged undeveloped bodily functions. Insanity in early youth always arises out of some nervous weakness in ancestry. It may not be mental disease itself—for a tendency to neuralgia or drunkenness, or mere nervousness in ancestors, may become insanity in the offspring, if wrong conditions of life are in operation. But it is often just the children of highly nervous parents—perhaps subject to "nervous depression"—who are quick, precocious, and educable in book-knowledge to a very high degree. They get pushed to their bent, and with all this they have little craving for fresh air and romping. They are often over-conscientious and most receptive. In fact, they are the very young women that delight the heart of the teacher, and sometimes carry off all the prizes at the end of a school session. The treatment of the teacher and the physician would be exactly opposite for such cases. The physician would take such brains to put them to grass for two or three generations—would scarcely educate them at all in the ordinary sense—would send them to grow up almost uninstructed in the country, cultivating blood, bone, muscle, and doing mechanical work alone. That would be the only salvation for such brains. But then we should perhaps miss having a genius once in a century. We should have our Chattertons working as joiners in the country, instead of writing poetry and committing suicide in town garrets. I could adduce many lamentable examples, from my own experience, of most brilliant school careers ending in insanity. If I had written down the fierce apostrophe of a young lady of twenty on her entry into the asylum at Morningside, at the end of a school career of unexampled success, the reading of it would do more to frighten the ambitious parents of such children from hastening their daughters forward at school too fast than all the scientific protests we doctors can make. She was well aware of the cause of her illness, and with passionate eloquence enumerated the consequences of her losing her reason.

It is not very long since a pupil-teacher, who had been working all winter about ten hours a day in teaching and preparation, and had taken no exercise or fresh air at all, after suffering for a while from headaches and confusion of mind, threw herself into a pond. She told me afterward that the harder she worked the more confused she got, then she got depressed, and then lost her self-control.

There can be no doubt that too hard school-work in young women during the adolescent period tends to bring out hereditary, nervous, and other weaknesses. The great natural protection against these is sound health and general bodily vigor in a frame that has been brought carefully to full maturity, harmonious and healthy in all its functions. This law is found to prevail in regard to nervous hereditary weaknesses, that the stronger and more direct the tendency, the earlier in life such weakness is apt to show itself. If we can postpone it, we can frequently avert it altogether.

Of the chief purely mental results of a brain-education higher than the whole organization can bear, one is unquestionably a certain change in the natural mental type of woman. I shall be asked, of course, What is the natural female psychical type? Is it to be found in the uneducated women of the East, or among the uncultivated classes of the West? Without going into argument, I may say that I should be willing to take the general character of womanliness pervading all the various types of young women created for us by the writers of genius, to whom I referred in my first lecture. That type is physiologically, as well as psychologically, true to nature. It is absolutely necessary as a complement to the masculine type of mind. Both are incomplete by themselves. The world can not do without them both ; they correspond to the bodily organization of each sex. Now, if the education process for the female is to be just on the lines of that for the male, if the mold into which the brain of each is to fit is to be the same type—and there is no question of emasculating the male type—then, undoubtedly, in the result, we must expect to find a change in the female type of mind. Very many competent observers say that this is actually very apparent in some of the school-girls of the present day. The unceasing grind at book-knowledge, from thirteen to twenty, has actually warped the woman's nature, and stunted some of her most characteristic qualities. She is, no doubt, cultured, but then she is unsympathetic ; learned, but not self-denying. The nameless graces and charms of manner have not been evoked as much as they might have been. Softness is deficient. It takes much to alter the female type of mind, but a few generations of masculine education will go far to make some change. If the main aims and ambitions of many women are other than to be loved, admired, helped, and helpful, to be good wives and mothers with quiverfuls of children, to be self-sacrificing, and to be the centers of home-life, then those women will have undergone a change from the present feminine type of mind. But we must comfort ourselves with Lord Bacon's reflection, that "Nature is often hidden, sometimes overcome, seldom extinguished."

American experience in the education of young women has been very instructive. The natural intelligence, the form of government, and the stimulating climate, have all united in making the standard of education very high for women as well as for young men. The national hurry has tended to make them do much in as short a time as possible too. In the Eastern States—especially Massachusetts—the schools for girls have for many years been most highly elaborated. At first the effects were not much noticed, or they were attributed to the climate, or to the hurry of life, or to the national fondness for pastry ; but soon the American physicians sounded the alarm about the way the New England girls were being educated. They pointed out that during education a high pressure was kept up in girls that no constitutions could stand without risk. They pointed to the thinness and the nervousness of American young women. Oliver Wendell Holmes directed attention to the "American female constitution, which collapses just in the middle third of life, and comes out vulcanized India-rubber, if it happens to live through the period when health and strength are most wanted." It was shown how small the families of educated American native-born women were, as compared with those of their German and English sisters, and with the Irish living among themselves. Dr. Clarke, in his most instructive book, "Sex in Education; or, a Fair Chance for Girls," pointed out to the American people the risks of forcing young women's brains, and the actual consequences that American physicians found to have resulted from that process. After pointing out that, as a matter of fact, girls in American schools work seven or eight hours a day, he says: "Experience teaches that a healthy and growing boy may spend six hours of force daily on his studies, and leave sufficient margin for physical growth. A girl can not spend more than four, or, in occasional instances, five hours of force daily upon her studies, and leave sufficient margin for the general physical growth that she must make in common with a boy, and also for her own development." In Dr. Beard's book on "American Nervousness: its Causes and Consequences," he says that, as the result of a large number of circulars sent to schools, the replies were sufficient to clearly show that "nearly everything about the conduct of the schools was wrong, unphysiological and unpsychological, and that they were conducted so as to make very sad and sorrowing the lives of those who were forced to attend them. It was clear that the teachers and managers of these schools knew nothing of and cared nothing for those matters relating to education that are of the highest importance, and that the routine of the schools was such as would have been devised by some evil one who wished to take vengeance on the race and the nation. . . . Everything pushed in an unscientific and distressing manner, nature violated at every step, endless reciting and lecturing and striving to be first—such are the female schools of America at this hour. The first signs of ascension as of declension in nations are seen in women. As the foliage of delicate plants first shows the early warmth of spring and the earliest frosts of autumn, so the impressible, susceptive organization of woman appreciates and exhibits far sooner than that of man the manifestation of national progress or decay."

It must be distinctly understood that my facts and arguments only apply to the young woman of average type and of average strength. There are plenty of individual examples, where there is naturally so much brain and strength that a very high kind of general masculine education can be given from thirteen to twenty without impairing the development. In such brains there is room for much learning and much affection and many charms. The reasoning power, the muscles, the fat, and the affections may be all equally developed in them.

It may be too, I am not prepared to deny it, that an education may be good for the individual in many cases, opening up sources of intellectual happiness, that is bad for the race. On the other hand, there is some truth in Beard's aphorism, that "ignorance is power as well as joy" to many men and women.

From a scientific point of view, I am well aware that the weak point of my argument is, that it is not founded on any basis of collated statistical facts. I have said to you, "I and many other physicians and physiologists have seen many undoubted instances of girls being hurt by over-education under bad conditions," but we can not say that out of every hundred girls such a percentage do suffer. We have not the facts to enable us to do so. I hope such facts will be recorded in the future, and may be all the more likely to be observed and recorded through attention being directed to the matter. I am well aware, too, that teachers are not most to blame for any bad results that are to be attributed to the present system of over-educating girls. Parents and the spirit of the time are more culpable than teachers. The latter are the public's servants, and must do the public's bidding. They are expected to work "The Code" energetically, to earn large grants, to make bricks without much straw in many cases, to turn out omniscient governesses and teachers in a few short sessions. Parents cry out to them about their children, "They are idle," if the whole evening is not taken up with lesson-learning, or if the animal spirits are too high or the holidays too long. I could tell some sad tales of brain break-down in overworked teachers, male and female, if that were not beyond the scope of this lecture.

I went last July to see the examination and distribution of prizes in a very large city school for young ladies. While the young girls there were very many of them fresh in complexion and plump, I must say that the majority of the girls above thirteen seemed to me jaded, and pale, and unduly thin. I did not see a dozen pairs of rosy cheeks in a hundred of them. To my eye, many of them bore very evident signs of over-brain-work and deficient physical energy. They didn't look joyous and full of animal glee, as girls at that age should look. Like Dr. John Brown's terrier, "life was too full of seriousness" to them. Two Sundays after, I was in a country kirk in the far north, where modern educational systems are as yet unknown, and I contrasted the appearance of the farmers' daughters there with that of the prize-winners in the city school. The difference was absolutely astounding. I only wish I could convey the impression I received in both cases from a critical doctor's survey of both sets of girls. If the one set exemplified health, robustness, organic happiness, strength, resistive power against disease, and potential motherhood, then, beyond a doubt, the other set did not fully do so. The question of the future is, How can we get, or how much can we get of, the intelligence and book-culture of the latter, combined with the health of the former? The health we must have, for it is requisite for the life of the race; the culture we must have in such degree as is consistent with the health.

THE CONTROL OF CIRCUMSTANCES.

By WILLIAM A. EDDY.

IN a previous article, we noticed that even circumstances which seem to result in accumulations involving vast lapses of time are seen to be temporary when considered with relation to very great and to us inconceivable periods. The stability is apparent only, and is due to our limited grasp of duration. The study of averages is valuable as showing the proportion of control attainable through knowledge of the limit of variation in certain kinds of events. It would require something like omnipresent intelligence to cope with the enormous variability in all events, so that were it not for the perception of identity, repetition, the law of probability, we would be as completely helpless in regard to circumstances as many claim we are. In extending this question of averages, demonstrating the illusion of chance, we see that the appliances of science and intelligence must lessen helplessness and misery with every coming century, although, owing to limitation of the individual, the control can never be anything like complete. It is important that we form right ideas of the control possible, so that we be neither like Don Quixote, who thought his power almost without limit, nor like a fatalist who resigns himself to the current of events. In the history of progress, we see that during centuries some suffering might have been escaped by a more complete knowledge of causes, as well as by better intellectual training resulting in more foresight. The delayed relief was and is due to crude methods of scientific thought and experiment, lack of that insight or flash of analogy by which all great truths are discovered. The power to group and combine complex results, shown by the most advanced minds when working under favorable conditions, is hardly sufficient for even a vague understanding of the development of diseased conditions. The mind is led step by step toward the truth, by means of scientific experiments. At last, Pasteur and others disclose the laws which account for some kinds of progressive destruction in the movements of organic or inorganic particles.

As we begin to comprehend vaguely the laws of events, and the importance of action as an element of modifying power—as we stand back and include a great number of incidents in our generalization—we see more relation between action and result. The direct importance of objective action, its immediate interest for us, is in considering the proportion of control which we can exert. This is one of the most complicated problems, because special thwartings conceal the control when we look from the "near point of view of daily life." Several years of experience are required to demonstrate the proportion of truth in the well-known business maxim that it is better to avoid joining fortunes with an unlucky man. Much of the misfortune is in the man's quality; for we say of the successful man that, if a given project fails, he still has something in reserve. He has foreseen and provided for failure, and has great power of readjusting his vocation in an emergency. Besides an accumulation of money, which he has thrown up as an embankment between himself and disaster, he has an even stronger reserve force in his knowledge of human nature, his address, and his strength of character. In this sense the average indicates that prolonged effort results in control. He reaches a point in after-years when the special event conforms to his effort easily.

But we must not overlook the conditions that limit success. There is a margin of uncertainty in the fact that the successful man is seen to suffer from temporary calamities, which clearly are not due to his action or inaction. We find an outward influence completely beyond his control. The fact that it can be conquered by perseverance and knowledge does not lessen its irresistible force in the present. The outer forces, largely social but not less powerful than those of organization and physical law, do not respond to his efforts—seem arrayed against him, or turn unexpectedly in his favor. It thus appears that the question of control might easily result in endless debate, because each side—the triumph of circumstances or of human will and perseverance—includes part of the truth. While admitting that the tendency is persistently in favor of effort, we yet find a positive conclusion impossible to hold. The control, even under favorable conditions, is incomplete. It is true we can not express this with even relative accuracy, yet a rough idea of the truth may be given by a statement of arithmetical proportion as applied to a large number of men having successful qualities—such as knowledge of human nature and perseverance. The proportion of control will seem much greater if we consider the effect upon a given calling or condition toward which the effort tends. When a person starts in life with one object—say, that of making money—and uses every available means to accomplish his purpose, saving and constantly watching the public wants with the intention of supplying them, working night and day at a sacrifice of social recreation, the average, we may say, is as high as ninety per cent that he will succeed. Many will put the possibility of failure at much less than ten per cent; but if the question be carefully considered, it will be admitted that sickness and other causes may make inroads upon prosperity, so that of a hundred persons with such qualities, ten might fail after a given lapse of time, owing to conditions beyond their control.

While noticing the proportion of failure which may result in spite of prolonged effort, we must not omit the immense differences due to the qualities with which men are born. This is the most important of all the conditions considered. After deducting a large number of exceptions, we would doubtless still find the balance heavily in favor of the children of efficient parents. It therefore follows that, although we can not trace the control absolutely to effort in the individual, we can still find a part of the difference accounted for in the efforts of a line of ancestors, or in parents whose special aptitudes, perhaps attained directly by work, are united with magnifying effect in one of their children.* If we go back of the effective qualities of men, we encounter the unfathomable fact of the persistence of force ; for the most important characteristic of these effective qualities is a certain mechanical motive power. It may be possible to definitely separate the force in men into the presence or absence of different kinds of it in a line of ancestors, but ultimately we are obliged to say that the first impulse took place for the same reason that the earth persists in its course round the sun, or for the same reason that motion appears to be an inevitable attribute of matter. Of course this is not accounting for it. It is simply reducing the question to a point of fact beyond which further investigation is apparently useless. In estimating our power of control, the right method is to start with the qualities existing, or latent, and then proceed to their effects. We may say, with Herbert Spencer, that special forms of thought-force were built up through processes of action and adjustment, but, as involved or noticed in his conclusions, this only dissolves the existing special manifestations of force into a general but at the same time unaccountable force.

While the enormous magnitudes and forces in nature remind us of our helplessness, it is yet clear that the tendency to master distant facts is constantly stimulated by natural phenomena. We ought not to be discouraged by the fact that exceptional events are not always classified or reduced to order by us—their connection is often lost, owing to our limited grasp of duration—nor by the truth that as natural phenomena recede from us we are more conscious of problems beyond the circumstances or surroundings which we partly control. Many apparent disconnections gradually lead us away from the series close at hand. The heavenly bodies, for example, manifest so much variation in movement and brightness, that men are led to undertake increasingly difficult or more delicate tasks of calculation, as in estimating the distances of *a* Centauri, Sirius, Vega, and other stars. Another result is, that attempts are made to form at least a theoretical idea of the physical conditions of suns and planets through knowledge attained by means of the spectroscope. The conclusions thus reached are necessarily imperfect because based upon fragmentary data, but the mental tendency to inquire is with scientific minds inevitable, because there are always appearing, with every increase of telescopic power, other stars beyond those last discovered.

It thus appears that while the high aims of Plato and Aristotle find

* A certain artist seems to have inherited his father's habit of keen observation and his mother's mechanical ingenuity. Very often, however, these characteristics can not be definitely traced back.

justification in the idea that effort is taught by nature, even when a definite result is invisible, yet the teachings of physical causation show that it is vain to expect an escape from some material trammels. We see the vibration of two apparently opposing social forces, in which the high and more intelligent force is slowly gaining the ascendency by a process of adaptation, so that the physical force is becoming a source of power to men instead of fear. Emerson's conclusion, like that of Kant, is two-sided—that the principle of mind is manifested to us through material action. This bolds true aside from Kant's "Forms of Thought" on one hand, or Herbert Spencer's relations between particles on the other. We can not have the unalloyed mind-power or control usually wished for, because our demands are unreasonable in the sense that we would dispense with the necessary and lower conditions upon which the higher depend, and thus thrust out causation, which is the principle of combination or order by which error and absurdity could be escaped if the relations between events were completely mastered. This mastery of physical power represents an ideal condition in which the mind is no longer enslaved by forces that seem material or mechanical.

In closing with a general view of this subject, we encounter the following contradiction : During a long period we see that fortunes and reputations grow by means of industry, and that a high percentage of the men having these industrious qualities accomplish their purpose. On the other hand, it is obvious that many of the physiological phenomena of the human body, the varying limitation of thought in individuals, and especialy the universe of matter, are not appreciably influenced by our actions or ideas. The idea of possible control narrows from a solar system to a planet, to a particular part of planetary surface, to a special series of effects, and to special kinds of callings. The arguer can truthfully claim that we have no control, and hold his position by referring to the material universe and the development of mankind ; but particular kinds of effort when so considered undermine his argument as applied to immediate results of actions. In arguing on the other side, he can maintain as truthfully, to put the same idea in different form, that the control is almost complete, but he must apply his argument to special and restricted conditions.

It has been denied that we can trace with certainty any manifestation of law in circumstances ; that there is a fatal error in conclusions regarding the inevitableness of causation or law ; that there is no perceptible law, because everything shows a margin of variation which may reach inconceivable results in the course of ages. Law, as understood by a member of the Theosophical Society, means the exact repetition of previous conditions, owing to vast averages and inconceivably great lapses of time.* The argument as to whether phenomena are

* This definition of law was advanced by one of the younger members of the society. It may not fairly represent the views of all the members.

exactly repeated is apparently of no consequence, as long as average results are known. The notion of infinite variation, as thus implied, is defective because the identity underlying the variation is omitted. It is fair to assume that identity will keep pace with variation, and that the margin of variation must always involve continuity, or a further illustration of the order or law manifested by the phenomena considered. The history of science shows that the new relations do not render absurd the verified conclusions of reason, though much is added that has to be classified and as far as possible reduced to a reasonable basis. In fact, the variations are seen to verify the known sequences instead of lessening their certainty. We may therefore assume that vast, far-reaching forces, or forms of force now unknown, will never even seem to interfere with the obvious and seemingly necessary laws manifested by known phenomena. Such interference of unknown laws would be, as far as we could perceive, a break in continuity, or causation, and the inflow of obvious absurdity. From this point starts the root of superstition; for persons without perception of the causation underlying all action endow the unknown forces with power to produce effects at variance with the simplest forms of sequence, the disturbance of which would at once render void the human intellect. Are we to believe that gloves were sent from Bombay to London in an instant, thus setting aside one of the first laws of matter learned in childhood? If such monstrous phenomena occur, then it is useless to think that we can trace method in circumstances.

All the evidence so far collected indicates that actions and results are related, and we are thus encouraged by the thought that no work is wasted—that it must stand to the credit of the worker. When the effect upon others is not discernible, we can be sure that the advantage still exists as latent force of character. The value of work remains good in spite of vicissitudes. This may seem trite, but we must remember that the relation between work and effect is constantly observed in a partial light, so that people are likely to be either fatalists like Micawber, or to look upon a special failure as inexcusable and as a certain indication of quality. It has been the object of this outline of so complicated a question to modify these opposing views, to encourage effort, to emphasize the rational perception of the continuity or order pervading events, and to put aside as far as possible the fearful possibilities with which some endow the mysterious power everywhere manifested in nature. As long as we feel conscious that the unknowable reality can never involve anything irrational, ill-fitting the harmony and grandeur of the sidereal universe, we feel that ideas may lessen the burdens of men, widen their thought, and teach them that these persistent effects following causes may be depended upon with entire trust. Meantime the progress of men in intelligence, toward a certain degree of happiness, continues. One of the principal factors of this advancement is that all should sincerely express personal conviction. The decline of intelligence and of our power to control circumstances may be conceived as beginning when old ideas are advocated merely because the first impression is that they are plausible, and particularly when certain books, purely intellectual, are avoided merely because the reader fears to find something unanswerable and convincing. By all means let us have free trade in ideas, from the theory of materialization advanced by Robert Dale Owen at one extreme to the scientific exactness of Herbert Spencer at the other. Let there be no protection of ideas, and let each one maintain its hold by virtue of its truth and power. Owing to the varying tendencies and views of men, the truth overlooked by one may be seen by another, so that if we encourage the expression of peculiar combinations or combining powers in minds, much suffering arising from our lack of knowledge may be escaped. Those who do not realize the value of ideas ought to reflect that, largely owing to our want of ingenuity and perception, we are still in the main at the mercy of particles in ways which could be spared us if we knew or had discovered more, or had more control of the onward march of the closely knit network of events and influences that make up our short lives. Lack of observation in a trifling matter, or short-sighted heed to the convenience of the present hour, may restrict the possible development of the finest powers, and so the development of intelligence, by widening these limits, indirectly as well as directly, may add to the power of men in a steadily increasing proportion. Those who do not see the helping power of science, or at least the promise of it, ought to remember that every omission to use the best intelligence in themselves, or to encourage it in others, results in a continuance of the amount of pain and disappointment now existing, which can only be lessened by the general development of intelligence, and by the use of the increasingly difficult and more subtile researches of men of science.

RELIGIOUS RETROSPECT AND PROSPECT.*

By HERBERT SPENCER.

UNLIKE the ordinary consciousness, the religious consciousness is concerned with that which lies beyond the sphere of sense. A brute thinks only of things which can be touched, seen, heard, tasted, etc.; and the like is true of the untaught child, the deaf-mute, and the lowest savage. But the developing man has thoughts about ex-

* This article will eventually form the closing chapter of "Ecclesiastical Institutions"—Part VI of "The Principles of Sociology." The statements concerning matters of fact in the first part of it are based on the contents of preceding chapters. Evidence for nearly all of them, however, may also be found in Part I of "The Principles of Sociology," already published.

istences which he regards as usually inaudible, intangible, invisible; and yet which he regards as operative upon him. What suggests this notion of agencies transcending perception? How do these ideas concerning the supernatural evolve out of ideas concerning the natural? The transition can not be sudden; and an account of the genesis of religion must begin by describing the steps through which the transition takes place.

The ghost-theory exhibits these steps quite clearly. We are shown that the mental differentiation of invisible and intangible beings from visible and tangible beings progresses slowly and unobtrusively. In the fact that the other-self, supposed to wander in dreams, is believed to have actually done and seen whatever was dreamed, in the fact that the other-self when going away at death, but expected presently to return, is conceived as a double equally material with the original, we see that the supernatural agent in its primitive form diverges very little from the natural agent—is simply the original man with some added powers of going about secretly and doing good or evil. And the fact that, when the double of the dead man ceases to be dreamed about by those who knew him, his non-appearance in dreams is held to imply that he is finally dead, shows that these earliest supernatural agents have but a temporary existence: the first tendencies to a permanent consciousness of the supernatural prove abortive.

In many cases no higher degree of differentiation is reached. The ghost-population, recruited by deaths on the one side, but on the other side losing its members as they cease to be recollected and dreamed about, does not increase; and no individuals included in it come to be recognized through successive generations as established supernatural powers. Thus the Unkulunkulu, or old-old one, of the Zooloos, the father of the race, is regarded as finally or completely dead, and there is propitiation only of ghosts of more recent date. But where circumstances favor the continuance of sacrifices at graves, witnessed by members of each new generation who are told about the dead and transmit the tradition, there eventually arises the conception of a permanently-existing ghost or spirit. A more marked contrast in thought between supernatural beings and natural beings is thus established. There simultaneously results a great increase in the number of these supposed supernatural beings, since the aggregate of them is now continually added to; and there is a strengthening tendency to think of them as everywhere around, and as causing all unusual occurrences.

Differences among the ascribed powers of ghosts soon arise. They naturally follow from the observed differences among the powers of the living individuals. Hence it results that while the propitiations of ordinary ghosts are made only by their descendants, it comes occasionally to be thought prudent to propitiate also the ghosts of the more dreaded individuals, even though they have no claims of blood.

Quite early there thus begin those grades of supernatural beings which eventually become so strongly marked.

Habitual wars, which more than all other causes initiate these first differentiations, go on to initiate further and more decided ones. For, with those compoundings of small social aggregates into greater ones, and recompounding of these into still greater, which war effects, there, of course, with the multiplying gradations of power among living men, arises the conception of multiplying gradations of power among their ghosts. Thus in course of time are formed the conceptions of the great ghosts or gods, the more numerous secondary ghosts, or demi-gods, and so on downward—a pantheon : there being still, however, no essential distinction of kind ; as we see in the calling of ordinary ghosts *manes*-gods by the Romans and *elohim* by the Hebrews. Moreover, repeating as the other life in the other world does, the life in this world, in its needs, occupations, and social organization, there arises not only a differentiation of grades among supernatural beings in respect of their powers, but also in respect of their characters and kinds of activity. There come to be local gods, and gods reigning over this or that order of phenomena ; there come to be good and evil spirits of various qualities ; and where there has been by conquest a superposing of societies one upon another, each having its own system of ghost-derived beliefs, there results an involved combination of such beliefs, constituting a mythology.

Of course, ghosts primarily being doubles like the originals in all things, and gods (when not the living members of a conquering race) being doubles of the more powerful men, it results that they, too, are originally no less human than ordinary ghosts in their physical characters, their passions, and their intelligences. Like the doubles of the ordinary dead, they are supposed to consume the flesh, blood, bread, wine, given to them : at first literally, and later in a more spiritual way by consuming the essences of them. They not only appear as visible and tangible persons, but they enter into conflicts with men, are wounded, suffer pain : the sole distinction being that they have miraculous powers of healing and consequent immortality. Here, indeed, there needs a qualification ; for not only do various peoples hold that the gods die a first death (as naturally happens where they are the members of a conquering race, called gods because of their superiority), but, as in the case of Pan, it is supposed, even among the cultured, that there is a second and final death of a god, like that second and final death of a ghost supposed among existing savages. With advancing civilization the divergence of the supernatural being from the natural being becomes more decided. There is nothing to check the gradual dematerialization of the ghost and of the god ; and this dematerialization is insensibly furthered in the effort to reach consistent ideas of supernatural action : the god ceases to be tangible, and later he ceases to be visible or audible. Along with this differentiation of physical attributes from those of humanity there goes on more slowly the differentiation of mental attributes. The god of the savage, represented as having intelligence scarcely if at all greater than that of the living man, is deluded with ease. Even the gods of the semi-civilized are deceived, make mistakes, repent of their plans; and only in course of time does there arise the conception of unlimited vision and universal knowledge. The emotional nature simultaneously undergoes a parallel transformation. The grosser passions, originally conspicuous and carefully ministered to by devotees, gradually fade, leaving only the passions less related to corporal satisfactions; and eventually these, too, become partially dehumanized.

These ascribed characters of deities are continually adapted and re-adapted to the needs of the social state. During the militant phase of activity, the chief god is conceived as holding insubordination the greatest crime, as implacable in anger, as merciless in punishment; and any alleged attributes of a milder kind occupy but small space in the social consciousness. But, where militancy declines and the harsh despotic form of government appropriate to it is gradually qualified by the form appropriate to industrialism, the foreground of the religious consciousness is increasingly filled with those ascribed traits of the divine nature which are congruous with the ethics of peace: divine love, divine forgiveness, divine mercy, are now the characteristics enlarged upon.

To perceive clearly the effects of mental progress and changing social life, thus stated in the abstract, we must glance at them in the concrete. If, without foregone conclusions, we contemplate the traditions, records, and monuments, of the Egyptians, we see that out of their primitive ideas of gods, brute or human, there were evolved spiritualized ideas of gods, and finally of a god; until the priesthoods of later times, repudiating the earlier ideas, described them as corruptions: being swayed by the universal tendency to regard the first state as the highest—a tendency traceable down to the theories of existing theologians and mythologists. Again, if, putting aside speculations, and not asking what historical value the "Iliad" may have, we take it simply as indicating the early Greek notion of Zeus, and compare this with the notion contained in the Platonic dialogues, we see that Greek civilization had greatly modified (in the better minds, at least) the purely anthropomorphic conception of him: the lower human attributes being dropped and the higher ones transfigured. Similarly, if we contrast the Hebrew God described in primitive traditions, man-like in appearance, appetites, and emotions, with the Hebrew God as characterized by the prophets, there is shown a widening range of power along with a nature increasingly remote from that of man. And, on passing to the conceptions of him which are now entertained, we are made aware of an extreme transfiguration. By a convenient obliviousness, a deity who in early times is represented as hardening men's hearts so that they may commit punishable acts, and as employing a lying spirit to deceive them, comes to be mostly thought of as an embodiment of virtues transcending the highest we can imagine.

Thus, recognizing the fact that in the primitive human mind there exists neither religious idea nor religious sentiment, we find that, in the course of social evolution and the evolution of intelligence accompanying it, there are generated both the ideas and sentiments which we distinguish as religious, and that, through a process of causation clearly traceable, they traverse those stages which have brought them, among civilized races, to their present forms.

And now what may we infer will be the evolution of religious ideas and sentiments throughout the future? On the one hand, it is irrational to suppose that the changes which have brought the religious consciousness to its present form will suddenly cease. On the other hand, it is irrational to suppose that the religious consciousness, naturally generated as we have seen, will disappear and leave an unfilled gap. Manifestly it must undergo further changes; and, however much changed, it must continue to exist. What, then, are the transformations to be expected? If we reduce the process above delineated to its lowest terms, we shall see our way to an answer.

As pointed out in "First Principles," § 96, Evolution is throughout its course habitually modified by that Dissolution which eventually undoes it: the changes which become manifest being usually but the differential results of opposing tendencies toward integration and disintegration. Rightly to understand the genesis and decay of religious systems, and the probable future of those now existing, we must take this truth into account. During those earlier changes by which there is created a hierarchy of gods, demi-gods, manes-gods, and spirits of various kinds and ranks, Evolution goes on with but little qualification. The consolidated mythology produced, while growing in the mass of supernatural beings composing it, assumes increased definiteness in the arrangement of its parts and the attributes of its members. But the antagonist Dissolution eventually gains predominance. The spreading recognition of natural causation conflicts with this mythological evolution, and insensibly weakens those of its beliefs which are most at variance with advancing knowledge. Demons and the secondary divinities presiding over divisions of Nature become less thought of as the phenomena ascribed to them are more commonly observed to follow a constant order, and hence these minor components of the mythology slowly dissolve away. At the same time, with growing supremacy of the great god heading the hierarchy, there goes increasing ascription to him of actions which were before distributed among numerous supernatural beings: there is integration of power. While in proportion as there arises the consequent conception of an omnipotent and omnipresent deity, there is a gradual fading of his alleged human attributes: dissolution begins to affect the supreme personality in respect of ascribed form and nature.

Already, as we have seen, this process has in the more advanced societies, and especially among their higher members, gone to the extent of merging all minor supernatural powers in one supernatural power; and already this one supernatural power has, by what Mr. Fiske aptly calls deanthropomorphization, lost the grosser attributes of humanity. If things hereafter are to follow the same general course as heretofore, we must infer that this dropping of human attributes will continue. Let us ask what positive changes are hence to be expected.

Two factors must unite in producing them. There is the development of those higher sentiments which no longer tolerate the ascription of inferior sentiments to a divinity; and there is the intellectual development which causes dissatisfaction with the crude interpretations previously accepted. Of course, in pointing out the effects of these factors, I must name some which are familiar; but it is needful to glance at these along with others.

The cruelty of a Feejeean god, who, represented as devouring the souls of the dead, may be supposed to inflict torture during the process, is small compared with the cruelty of a god who condemns men to tortures which are eternal; and the ascription of this cruelty, though habitual in ecclesiastical formulas, occasionally occurring in sermons, and still sometimes pictorially illustrated, is becoming so intolerable to the better-natured that, while some theologians distinctly deny it, others quietly drop it out of their teachings. Clearly, this change can not cease until the beliefs in hell and damnation disappear. Disappearance of them will be aided by an increasing repugnance to injustice. The visiting on Adam's descendants, through hundreds of generations, dreadful penalties for a small transgression which they did not commit; the damning of all men who do not avail themselves of an alleged mode of obtaining forgiveness, which most men have never heard of; and the effecting a reconciliation by sacrifice of one who was perfectly innocent—are modes of action which, ascribed to a human ruler, would call forth expressions of abhorrence; and the ascription of them to the Ultimate Cause of things, even now felt to be full of difficulties, must become impossible. So, too, must die out the belief that a Power present in innumerable worlds throughout infinite space, and who during millions of years of the earth's earlier existence needed no honoring by its inhabitants, should be seized with a craving for praise, and, having created mankind, should be angry with them if they do not perpetually tell him how great he is. Men will by-and-by refuse to imply a trait of character which is the reverse of worshipful.

Similarly with the logical incongruities more and more conspicuous to growing intelligence. Passing over the familiar difficulties that sundry of the implied divine traits are in contradiction with the divine attributes otherwise ascribed—that a god who repents of what he has done must be lacking either in power or in foresight; that his anger presupposes an occurrence which has been contrary to intention, and so indicates defect of means—we come to the deeper difficulty that such emotions, in common with all emotions, can exist only in a consciousness which is limited. Every emotion has its antecedent ideas, and antecedent ideas are habitually supposed to occur in God: he is represented as seeing and hearing this or the other, and as being emotionally affected thereby. That is to say, the conception of a divinity possessing these traits of character necessarily continues anthropomorphic; not only in the sense that the emotions ascribed are like those of human beings, but also in the sense that they form parts of a consciousness which, like the human consciousness, is formed of successive states. And such a conception of the divine consciousness is irreconcilable both with the unchangeableness otherwise alleged and with the omniscience otherwise alleged. For a consciousness constituted of ideas and feelings caused by objects and occurrences can not be simultaneously occupied with all objects and all occurrences throughout the universe. To believe in a divine consciousness, men must refrain from thinking what is meant by consciousness—must stop short with verbal propositions; and propositions which they are debarred from rendering into thoughts will more and more fail to satisfy them. Of course, like difficulties present themselves when the will of God is spoken of. So long as we refrain from giving a definite meaning to the word will, we may say that it is possessed by the Cause of All Things, as readily as we may say that love of approbation is possessed by a circle; but, when from the words we pass to the thoughts they stand for, we find that we can no more unite in consciousness the terms of the one proposition than we can those of the other. Whoever conceives any other will than his own must do so in terms of his own will, which is the sole will directly known to him—all other wills being only inferred. But will, as each is conscious of it, presupposes a motive—a prompting desire of some kind: absolute indifference excludes the conception of will. Moreover, will, as implying a prompting desire, connotes some end contemplated as one to be achieved, and ceases with the achievement of it: some other will, referring so some other end, taking its place. That is to say, will, like emotion, necessarily supposes a series of states of consciousness. The conception of a divine will, derived from that of the human will, involves, like it, localization in space and time: the willing of each end, excluding from consciousness for an interval the willing of other ends, and therefore being inconsistent with that omnipresent activity which simultaneously works out an infinity of ends. It is the same with the ascription of intelligence. Not to dwell on the seriality and limitation implied as before, we may note that intelligence, as alone conceivable by us, presupposes existences independent of it and objective to it. It is carried on in terms of changes primarily wrought by alien activities—the impressions generated by things beyond consciousness, and the ideas derived from such impressions. To speak of an intelligence which exists in the absence of all such alien activities is to use a meaningless word. If, to the corollary that the First Cause, considered as intelligent, must be continually affected by independent objective activities, it is replied that these have become such by act of creation, and were previously included in the First Cause, then the reply is that in such case the First Cause could, before this creation, have had nothing to generate in it such changes as those constituting what we call intelligence, and must therefore have been unintelligent at the time when intelligence was most called for. Hence it is clear that the intelligence ascribed answers in no respect to that which we know by the name. It is intelligence out of which all the characters constituting it have vanished.

These and other difficulties, some of which are often discussed but never disposed of, must force men hereafter to drop the higher anthropomorphic characters given to the First Cause, as they have long since dropped the lower. The conception which has been enlarging from the beginning must go on enlarging, until, by disappearance of its limits, it becomes a consciousness which transcends the forms of distinct thought, though it forever remains a consciousness.

"But how can such a final consciousness of the Unknowable, thus tacitly alleged to be true, be reached by successive modifications of a conception which was utterly untrue? The ghost-theory of the savage is baseless. The material double of a dead man in which he believes never had any existence. And if by gradual dematerialization of this double was produced the conception of the supernatural agent in general—if the conception of a deity, formed by the dropping of some human attributes and transfiguration of others, resulted from continuance of this process—is not the developed and purified conception reached by pushing the process to its limit a fiction also? Surely, if the primitive belief was absolutely false, all derived beliefs must be absolutely false."

This objection looks fatal; and it would be fatal were its premise valid. Unexpected as it will be to most readers, the answer here to be made is that at the outset a germ of truth was contained in the primitive conception—the truth, namely, that the power which manifests itself in consciousness is but a differently-conditioned form of the power which manifests itself beyond consciousness.

Every voluntary act yields to the primitive man proof of a source of energy within him. Not that he thinks about his internal experiences; but in these experiences this notion lies latent. When producing motion in his limbs, and through them motion in other things, he is aware of the accompanying feeling of effort. And this sense of effort which is the antecedent of changes directly produced by him becomes the conceived antecedent of changes not produced by him—furnishes him with a term of thought by which to represent the genesis of these objective changes. At first this idea of muscular force as anteceding unusual events around him carries with it the whole assemblage of associated ideas. He thinks of the implied effort as an effort exercised by a being wholly like himself. In course of time these doubles of the dead, supposed to be workers of all but the most familiar changes, are modified in conception. Besides becoming less grossly material, some of them are developed into larger personalities presiding over classes of phenomena which, being comparatively regular in their order, foster the idea of beings who, while far more powerful than men, are less variable in their modes of action. So that the idea of force as exercised by such beings comes to be less associated with the idea of a human ghost. Further advances, by which minor supernatural agents become merged in one general agent, and by which the personality of this general agent is rendered vague while becoming widely extended, tend still further to dissociate the notion of objective force from the force known as such in consciousness; and the dissociation reaches its extreme in the thoughts of the man of science, who interprets in terms of force not only the visible changes of sensible bodies, but all physical changes whatever, even up to the undulations of the ethereal medium. Nevertheless, this force (be it force under that statical form by which matter resists, or under that dynamical form distinguished as energy) is to the last thought of in terms of that internal energy which he is conscious of as muscular effort. He is compelled to symbolize objective force in terms of subjective force, from lack of any other symbol.

See now the implications. That internal energy which in the experiences of the primitive man was always the immediate antecedent of changes wrought by him—that energy which, when interpreting external changes, he thought of along with those attributes of a human personality connected with it in himself—is the same energy which, freed from anthropomorphic accompaniments, is now figured as the cause of all external phenomena. The last stage reached is recognition of the truth that force as it exists beyond consciousness can not be like what we know as force within consciousness; and that yet, as either is capable of generating the other, they must be different modes of the same. Consequently, the final outcome of that speculation commenced by the primitive man is, that the Power manifested throughout the universe distinguished as material is the same Power which in ourselves wells up under the form of consciousness.

It is untrue, then, that the foregoing argument proposes to evolve a true belief from a belief which was wholly false. Contrariwise, the ultimate form of the religious consciousness is the final development of a consciousness which at the outset contained a germ of truth obscured by multitudinous errors.

Those who think that science is dissipating religious beliefs and sentiments seem unaware that whatever of mystery is taken from the old interpretation is added to the new. Or, rather, we may say that transference from the one to the other is accompanied by increase; since, for an explanation which has a seeming feasibility, it substitutes an explanation which, carrying us back only a certain distance, there leaves us in presence of the avowedly inexplicable.

Under one of its aspects scientific progress is a gradual transfiguration of Nature. Where ordinary perception saw perfect simplicity it reveals great complexity; where there seemed absolute inertness it discloses intense activity; and in what appears mere vacancy it finds a marvelous play of forces. Each generation of physicists discovers, in so-called "brute matter," powers which, but a few years before, the most instructed physicists would have thought incredible; as instance the ability of a mere iron plate to take up the complicated aërial vibrations produced by articulate speech, which, all translated into multitudinous and varied electric pulses, are retranslated a thousand miles off by another iron plate and again heard as articulate speech. When the explorer of Nature sees that, quiescent as they appear, surrounding solid bodies are thus sensitive to forces which are infinitesimal in their amounts—when the spectroscope proves to him that molecules on the earth pulsate in harmony with molecules in the stars—when there is forced on him the inference that every point in space thrills with an infinity of vibrations passing through it in all directions—the conception to which he tends is much less that of a universe of dead matter than that of a universe everywhere alive: alive, if not in the restricted sense, still in a general sense.

This transfiguration, which the inquiries of physicists continually increase, is aided by that other transfiguration resulting from metaphysical inquiries. Subjective analysis compels us to admit that our scientific interpretations of the phenomena which objects present are expressed in terms of our own variously-combined sensations and ideas—are expressed, that is, in elements belonging to consciousness, which are but symbols of the something beyond consciousness. Though analysis afterward reinstates our primitive beliefs, to the extent of showing that behind every group of phenomenal manifestations there is always a *nexus*, which is the reality that remains fixed amid appearances which are variable, yet we are shown that this *nexus* of reality is forever inaccessible to consciousness. And when, once more, we remember that the activities constituting consciousness, being rigorously bounded, can not bring in among themselves the activities beyond the bounds, which therefore seem unconscious, though production of either by the other seems to imply that they are of the same essential nature, this necessity we are under to think of the external energy in terms of the internal energy gives rather a spiritualistic than a materialistic aspect to the universe; further thought, however, obliging us to recognize the truth that a conception given in phenomenal manifestations of this ultimate energy can in no wise show us what it is.

While the beliefs to which analytic science thus leads are such as do not destroy the object-matter of religion, but simply transfigure it, science under its concrete forms enlarges the sphere for religious sentiment. From the very beginning the progress of knowledge has been accompanied by an increasing capacity for wonder. Among savages, the lowest are the least surprised when shown remarkable products of civilized art, astonishing the traveler by their indifference. And so little of the marvelous do they perceive in the grandest phenomena of Nature that any inquiries concerning them they regard as childish trifling. This contrast in mental attitude between the lowest human beings and the higher human beings around us is paralleled by the contrasts among the grades of these higher human beings themselves. It is not the rustic, nor the artisan, nor the trader, who sees something more than a mere matter of course in the hatching of a chick; but it is the biologist, who, pushing to the uttermost his analysis of vital phenomena, reaches his greatest perplexity when a speck of protoplasm under the microscope shows him life in its simplest form, and makes him feel that however he formulates its processes the actual play of forces remains unimaginable. Neither in the ordinary tourist nor in the deer-stalker climbing the mountains above him does a Highland glen rouse ideas beyond those of sport or of the picturesque; but it may, and often does, in the geologist. He, observing that the glacier-rounded rock he sits on has lost by weathering but half an inch of its surface since a time far more remote than the beginnings of human civilization, and then trying to conceive the slow denudation which has cut out the whole valley, has thoughts of time and of power to which they are strangers—thoughts which, already utterly inadequate to their objects, he feels to be still more futile on noting the contorted beds of gneiss around, which tell him of a time, immeasurably more remote, when far beneath the earth's surface they were in a half-melted state, and again tell him of a time, immensely exceeding this in remoteness, when their components were sand and mud on the shores of an ancient sea. Nor is it in the primitive peoples who supposed that the heavens rested on the mountain-tops, any more than in the modern inheritors of their cosmogony who repeat that "the heavens declare the glory of God," that we find the largest conceptions of the universe or the greatest amount of wonder excited by contemplation of it. Rather, it is in the astronomer, who sees in the sun a mass so vast that even into one of his spots our earth might be plunged without touching its edges; and who by every finer telescope is shown an increased multitude of such suns, many of them far larger.

Hereafter as heretofore, higher faculty and deeper insight will raise rather than lower this sentiment. At present the most powerful and most instructed intellect has neither the knowledge nor the capacity required for symbolizing in thought the totality of things. Occupied with one or other division of Nature, the man of science usually does not know enough of the other divisions even to rudely conceive the extent and complexity of their phenomena; and, supposing him to have adequate knowledge of each, yet he is unable to think of them as a whole. Wider and more complex intellect may hereafter help him to form a vague consciousness of them in their totality. We may say that just as an undeveloped musical faculty, able only to appreciate a simple melody, can not grasp the variously-entangled passages and harmonies of a symphony, which in the minds of composer and conductor are unified into involved musical effects awakening far greater feeling than is possible to the musically uncultured, so, by future more evolved intelligences, the course of things now apprehensible only in parts may be apprehensible all together, with an accompanying feeling as much beyond that of the present cultured man as his feeling is beyond that of the savage.

And this feeling is not likely to be decreased but increased by that analysis of knowledge which, while forcing him to agnosticism, yet continually prompts him to imagine some solution of the Great Enigma which he knows can not be solved. Especially must this be so when he remembers that the very notions, beginning and end, cause and purpose, are relative notions belonging to human thought, which are probably inapplicable to the ultimate reality transcending human thought, and when, though suspecting that explanation is a word without meaning when applied to this ultimate reality, he yet feels compelled to think there must be an explanation.

But, amid the mysteries which become the more mysterious the more they are thought about, there will remain the one absolute certainty, that he is ever in presence of an Infinite and Eternal Energy, from which all things proceed.

THE IGUANODON.

THE iguanodon was discovered by Dr. Mantell, in the Wealden of England, in 1822, and has since figured in geological books as one of the largest and most remarkable of the animals whose former existence is revealed in the fossil beds of past ages. It is described in the second edition of Dana's "Geology" as "an herbivorous dinosaur of the Wealden. It was thirty feet long, and of great bulk, and had the habit of a hippopotamus. The femur, or thigh-bone, in a large individual, was about thirty-three inches long, and the humerus nineteen inches. The teeth were flat, and had a serrated cutting edge like the teeth of the iguana ; and hence the name, signifying *iguana-like teeth ;* many of them, from old animals, are worn off short." Le Conte's "Geology" also says that "the animal takes its name from the form of its teeth, which are much like those of the iguana, a living herbivorous reptile, although in other respects there is little affinity." Figs. 1 and 2 show respectively the tooth of an iguanodon, and a section of the jaw of the iguana, for comparison.

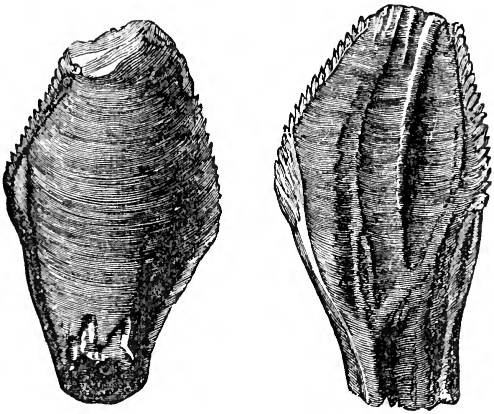

FIG. 1.—TOOTH OF AN IGUANODON.

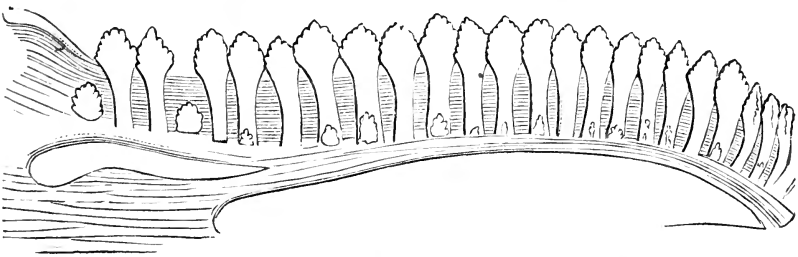

FIG. 2.—SECTION OF JAW OF AN IGUANA. (After Buckland.)

Le Conte adds : "But the difference in size between the living and the extinct reptile is enormous. The iguana is from four to six feet long ; the iguanodon was certainly thirty feet, perhaps fifty or sixty feet long, and of bulk several times greater than that of an elephant. A thigh-bone has been found fifty-six inches long, twenty-two inches in circumference at the shaft, and forty-two inches at the condyle. Its habits are supposed to have been something like those of a hippopotamus. Like this animal, it wallowed in the mud, and fed on the rank herbage of marshy grounds." The article "Iguanodon," in the "American Cyclopædia," in the course of its technical description of the bones of the animal that had been identified, suggests that the thighs "must have supported the heavy body in a manner like that of the large pachyderms," and states that the animal stood higher on its legs than any existing saurian, and was terrestrial in its habits. Dr. Mantell was of the opinion that the iguanodon had a nasal integumental horn. We reproduce in Fig. 3 a picture of the reptile restored, according to the ideas prevailing among geologists ten years ago, in contrast with a view of the actual skeleton set up in the museum at Brussels, as an illustration of the danger of making too hasty generalizations from too few or too imperfectly understood data.

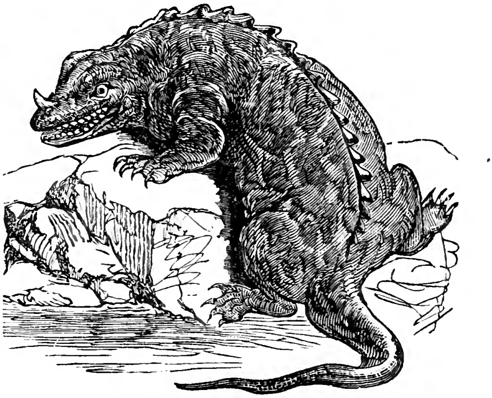

Fig. 3.—Iguanodon.

A new and very considerable deposit of remains of iguanodons, from one of the nearly complete skeletons of which the present reconstruction of the animal has been made, was discovered in 1878 at the coal-mines of Bernissart, between Mons and Tournay, in Belgium, close to the French frontier. They occur there, like the English fossils, in the Wealden or lower cretaceous strata, or *morts-terrains* (dead layers), as the workmen call them, that overlie the coal-beds, and which have to be penetrated for about twelve hundred feet before the coal is reached. The discovery was made by M. Fagès, director-general of the Bernissart Mining Company, and specimens of the bones were sent to Professor P. J. Van Beneden, who identified them as belonging to the iguanodon. The task of removing the fossils was attended with much difficulty, for they were charged with iron pyrites, the decomposition of which caused them to crumble as soon as they were exposed to the air. It was undertaken and accomplished successfully by M. Depauw, superintendent of the workshops of the museum at Brussels. He adopted the habits of the miners, and spent three years in the excavations, personally superintending the removal of every specimen. By subjecting them to a gelatine-bath and enveloping every piece, previous to removal, with a casing of plaster, he got them all out whole. The remains were then again examined by Professor Dupont, director of the museum, and again shown to be those of the iguanodon.

For the past two years the bones have been under the steady investigation of M. L. Dollo, a former pupil of Professor Giard, of Lille, who has published four papers giving accounts of his observations, and is expected, when he gets through with his work, to publish an exhaustive treatise on the subject. He thinks he has the skeletons, or parts of them, of twenty-three individuals, two of which belong to Mantell's species (*Iguanodon Mantelli*), and twenty-one to the species *Iguanodon Bernissartensis.* One of the specimens has been restored and mounted by M. Depauw, and set up in a glass chamber in the court of the museum. It is nearly complete, only a few phalanges and other minor details being wanting, while, on account of the impossibility of detaching the bones, most of them have been mounted still joined to one another, and fastened to the matrix as they were taken from the mine. The figure has, of course, for this reason a little stiffness, but not enough to attract the attention of the merely casual observer, and stands, in the natural attitude of progression of the animal on land, erect on its hind-limbs, with the top of its snout fourteen feet two inches from the ground, and covering, from the tip of the tail to a point immediately under the tip of the snout, a length of twenty-three feet nine inches.

The iguanodon belongs to the sub-class of dinosaurians and the order *Ornithopoda*, or bird-footed. Among the special characteristics of the family of the iguanodons are a single row of teeth, three functional digits on the foot, and two symmetrical sternal plates. The last, which Professor Marsh, from his studies of specimens in the British Museum, regarded as clavicles, and traced in them a point of structural resemblance with birds, are declared by M. Dollo, from specimens at Bernissart, in which they are preserved in their natural relations, to be sternal, while no clavicles are found. There are, however, says Mr. H. N. Moseley, in "Nature," abundance of other points in the skeleton of the iguanodon "in which the remarkable resemblances between the *Ornithopoda* and birds indicated by Professor Huxley, more than twelve years ago, are borne out in a most remarkable manner. . . . First of all, there seems to be little doubt possible that the iguanodons walked, as he pointed out, on their hind-limbs erect, like birds, in somewhat the attitude of the accompanying figure (see Fig. 4). Several different lines of coincidence, as M. Dollo points out, tend to prove this. Firstly, the remarkable resemblances between the structure of the pelvis and the posterior limbs of birds, and the corresponding parts in the iguanodons. The points of resemblance of the ilium and ischium, pointed out by Professor Huxley, are fully confirmed by the Bernissart specimens. . . . The actual pubis is very large in the iguanodon, as will be seen in the figure, and projects forward and outward, forming an obtuse angle with the post-pubis. . . . The post-pubis is long and slender, and directed backward alongside the ischium, as in birds, for a considerable distance beyond the ischial tuberosity. . . . M. Dollo is inclined to follow Professor Marsh in identifying the dinosaurian pubis with the pectineal process of birds, a conclusion which receives most interesting support in the valuable memoir recently published by Miss Alice Johnson, of Cambridge, on "The Development of the Pelvic Girdle in the Chick," in which it is shown that in the embryo fowl the cartilaginous representative of the pectineal process is at first much larger and more prominent in proportion to the dimensions of the pelvis than subsequently, and becomes gradually reduced as development proceeds. The peculiar form of the pelvis is, no doubt, directly connected with the muscular arrangements concerned in the erect posture, originated probably in the dinosaurians and transmitted to birds, in which it has been improved upon by the elimination, almost complete, of the original pubis through disuse."

The fore-limbs are considerably shorter than the hinder ones, and are massive and strong; and this difference in structure is cited as further though not conclusive evidence of the animal's having maintained an erect position. As further evidence in the same direction, and of the approach of the type of structure to that of birds, are mentioned the reduction of the volume of the head and thorax as compared with that of reptiles and the position of a large mass of the viscera behind the hip-joint, as in birds, whereby, with the aid of the long tail, the balancing of the head and fore-part of the body was more easily secured. The dorsal spines of the vertebræ are connected with a set of ossified ligaments binding the whole dorso-lumbar region into a rigid mass—another peculiarity in which the structure is strikingly like that of birds. The fore-limbs of the animal have five and the hind-limbs four claws, or toes, leaving a three-toed track. Here, again, is another and probably the most decisive proof that the iguanodon walked on its hind-limbs only. The feet have been compared by M. Dollo with the tridactyl Wealden foot-prints—which the iguanodon only among known Wealden dinosaurians could have made—and have been found to fit accurately. "If the animal had walked on all-fours," Mr. Moseley remarks, "it is impossible but that pentadactyl impressions should have occurred with the tridactyl, but such is not the case. Long series of the tridactyl prints are found without a trace of pentadactyl marks. The arrangement of the tridactyl tracks shows that the iguanodon walked on its hind-feet, and did not spring, like a kangaroo, with the aid of its tail. This merely dragged lightly behind, and has left no impression in connection with the foot-tracks." The first finger, or thumb, constitutes a large horny spur, the remains of which when first found were supposed to be the nose-horns of Mantell's ideal. According to M. Dollo's description, the head is relatively small, and very much compressed from side to side. The nostrils are spacious, and chambered in their anterior region; the orbits are of moderate size and elongated along the vertical. The temporal fossa is limited above and below by a bony arch, a disposition which is otherwise found among living lizards only in the *Hatteria*. The

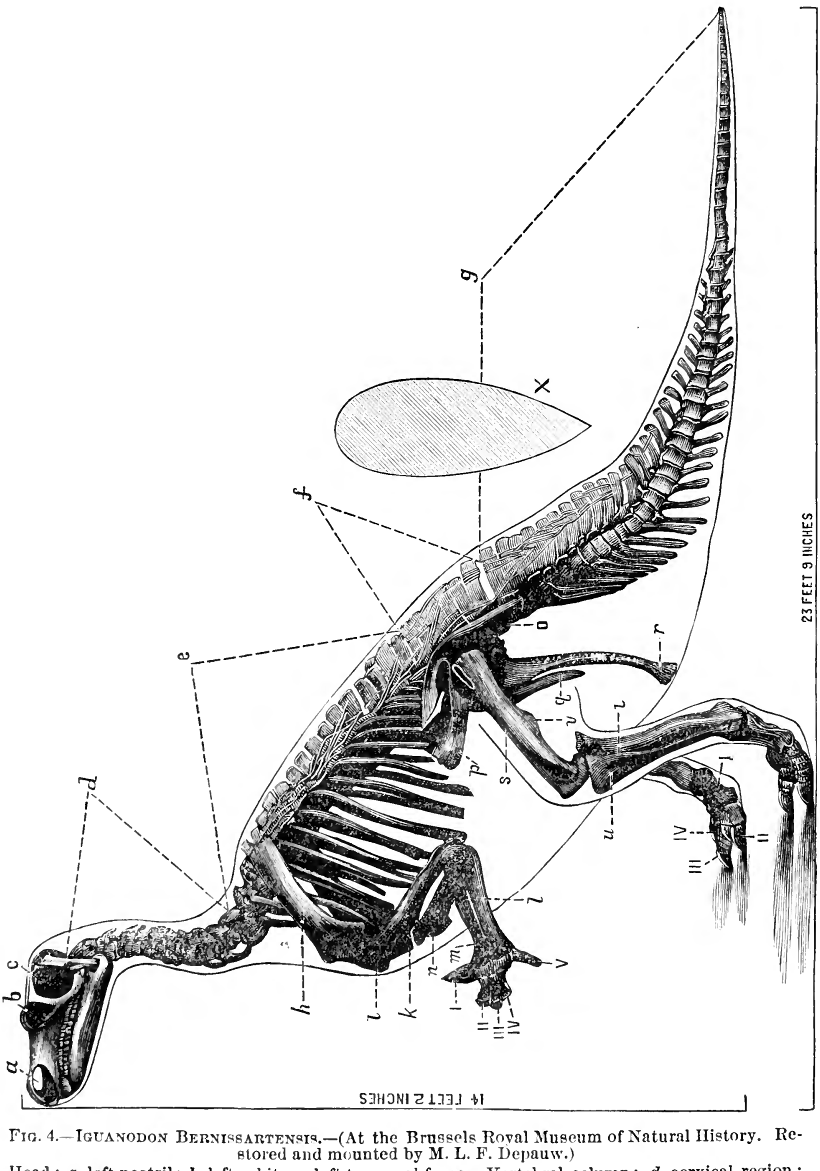

Fig. 4.—Iguanodon Bernissartensis.—(At the Brussels Royal Museum of Natural History. Restored and mounted by M. L. F. Depauw.)

Head: *a*, left nostril; *b*. left orbit; *c*, left temporal fossa. Vertebral column: *d*, cervical region; *e*. dorso-lumbar region; *f*, sacral region; *g*, caudal region; *h*, left scapula; *i*, left coracoid; *k*. left humerus; *l*, left ulna; *m*, left radius; *n*, sternum; *o*, left ilium; *p*, left pubis; *q*, left post-pubis; *r*, left ischium; *s*, left femur; *t*. left tibia; *u*. left fibula; *v*, third trochanter. I, II, III, IV, V, digits; X, diagrammatic transverse section of the body between the fore and hind limbs.

distal extremities of both jaws are without teeth; while there are ninety-two teeth in the hinder parts of the jaws, and these, as with other reptiles, were replaced by new ones as fast as they wore out. The skin was smooth, or covered only with epidermic scales. Some observers believe they have found in the foot-prints evidences that a slight web existed between the toes. M. Dollo has drawn a conjectural outline of the body of the iguanodon, which is represented in our large cut. Leaving out the long tail, its general shape is that of a duck. The sectional view, represented by X in the cut, indicates that the animal was relatively very narrow and sharp-keeled, like a clipper-ship. The tail, shaped like that of a crocodile, was probably a powerful swimming organ, like that of the duck. The neck was comparatively slender and capable of very free movements. The animal was an inhabitant of marshes—so far as is known, of fresh-water marshes only—and probably fed largely on ferns, abundance of which were found with the Bernissart specimens.

A multitude of other treasures besides the iguanodons were found at Bernissart, and are awaiting careful examination. Among them are crocodiles, in which two new genera have been defined; turtles, which have given one new genus; and "a vast quantity of fishes."

DEFECTIVE EYE-SIGHT.

By SAMUEL YORKE AT LEE.

DETERIORATION of the eye has been, for many years, a topic of complaint—not only in the United States, but in Europe. In Germany, after a careful examination of the pupils in a public school, a surgeon has reported that the proportion of normal-sighted children is gradually less as the ages of the subjects advance: being thirty-six per cent in the primary classes to ninety per cent in the highest classes. Another German investigator reports that, from an examination embracing ten thousand children, it was found that the number of short-sighted in the elementary classes was from five to eleven per cent; in the higher school for girls, the proportion was from ten to twenty-four per cent; in the *Realschulen*, it was between twenty and forty per cent; in the gymnasia, between thirty and fifty per cent; and in the highest classes of all, between thirty-five and eighty-eight per cent. In an examination of six hundred students of theology at Tübingen, it was found that seventy-nine per cent suffered from myopia.

Similar examinations made in the schools of France and of England exhibit similar results, showing that the organ of sight grows weaker as the term of study grows longer. In the United States, examination proves the same facts. In Philadelphia, a committee of physicians of the Medical Society examined, with the ophthalmoscope, the eyes of four thousand children in the public schools, and their report exhibits similar conclusions. In San Francisco, the Department Superintendent of the Public Schools asserts that, of the pupils who enter the public schools at the eighth grade, and work their way up to the high-school, fully forty per cent are afflicted with one or another form of myopia. Dr. Agnew shows, in a recent report on the progress of near-sightedness in this country, that "our school-rooms are the factors most directly influential in the gradual and increasing development of a race of spectacle-using people." Dr. Derby, Dr. Seguin, and many other scientific philanthropic gentlemen, have uttered similar opinions. Professor Calhoun, of the Atlanta Medical College, says, on this subject, that in the interior of the eye there is an elastic muscle, called the ciliary muscle (circumscribing that aperture through which light is conveyed to the retina), by which the sight is graduated to different distances. In a normal eye, the contractions and expansions of this muscle are not noticed by us ; but in a near-sighted or over-sighted eye these changes are violent and sometimes painful ; and, eventually, the action of this muscle is spasmodic and so weakened that the sight is permanently injured. Near-sightedness, he remarks, seldom begins until the sixth year, when children commence using the eye on school-books. There are records of the examinations of the eyes of forty-five thousand school-children, of all ages and grades, white and colored, and it has been proved that near-sightedness increases, from class to class, until, in the highest grades, it has actually been developed in as many as sixty or seventy per cent of all the scholars. I saw, lately, in the "Baltimore Sun," that a studious little girl in a public school in that city was struck with blindness at her desk, just after finishing her reading-lesson.

The causes to which this deterioration of eye-sight has been attributed are alleged to be cross-lights from opposite windows, light shining directly on the face, insufficient light, small types, and to the position of the desk, forcing the scholar to bend over and bring the eyes too close to the book or writing-paper, etc.

But, were all these defects remedied, the integrity of the eye would not be restored nor its deterioration prevented. The chief causes of the evil would still remain. These are the colors of the paper and ink. White paper and black ink are ruining the eye-sight of all reading nations. The "rays of the sun," says Lord Bacon, "are reflected by a white body, and are absorbed by a black one." No one dissents from this opinion ; but, despite these indications of nature and of philosophy, we print our books and write our letters in direct opposition to the suggestions of optical science.

When we read a book printed in the existing mode, we do not see the letters, which, being black, are non-reflective. The shapes reach the retina, but they are not received by a spontaneous, direct action of that organ. The white surface of the paper is reflected, but the letters are detected only by a discriminative effort of the optic nerves. This effort annoys the nerves, and, when long continued, exhausts their susceptibility. The human eye can not long sustain the broad glare of a white surface without injury. The author of "Spanish Vistas," in "Harper's Magazine," says of Cartagena that "blind people seem to be numerous there, a fact which may be owing to the excessive dazzle of the sunlight and the absence of verdure." Mr. Seward, in his tour around the world, observed that "in Egypt ophthalmia is universal," attributing it to the same "excessive dazzle" of the wide areas of white sand; and the British soldiers, in the late campaign in that country, exhibited symptoms of the same disease. In the Smithsonian Report for 1877 it is stated, in a paper on "Color-Blindness," that "M. Chevreul has produced 14,420 distinguishable tints of the elementary colors, from which the paper-manufacturers could select colors more agreeable to the eye than the dazzling white, so weakening and lacerating to the nerves of that delicate organ." We know, too, that the Esquimaux, wandering over their snowy plains, and the Arabs, roving over their sandy deserts, are afflicted with inflammation of the eyes, which often results in blindness. I once rode for hours over a Western snow-covered prairie, and experienced the wearisome and irritating glare; and, had my ride been continued longer, I might have found myself in the condition of the gentleman described in the "Cheyenne (Wyoming Territory) Leader," of April 17th ult., as follows: "Ex-Governor John W. Hoyt was brought home in yesterday's coach from the north suffering from snow-blindness. He left Cheyenne on Thursday, and on Friday traveled all day over the snow while the sun shone brightly upon it. The Governor suffered greatly from pain in the eyes in the evening, and at length became totally blind. He has not been able to use his eye-sight since. His physician, Dr. Gray, expresses the belief that the Governor will recover his sight, but must be kept in a dark room for a week." Lieutenant Danenhower, who lost the use of one of his eyes from the reflection of light from ice and snow in the Arctic Expedition of 1881, is a notable illustration of this subject.

From all these authorities and instances it does not seem unreasonable to substitute some other than the universal color of our paper. What color shall it be? Nature and science declare that it should be green. Green grass covers the ground, and green leaves are our canopy, and no color is so grateful to the eye. Plutarch said, in Demosthenes, "it is universally acknowledged that we are not to abandon the unhappy to their sorrows, but to endeavor to console them by rational discourses, or by turning their attention to more agreeable objects—in the same manner as we desire those who have weak eyes to turn them from bright or dazzling colors to green or to others of a softer kind."

And, in his life of Pericles, he says that "green is best suited to the eye by its beauty and agreeableness, and at the same time it refreshes and strengthens the sight." From an old anonymous volume entitled "The Gentleman and Lady instructed," published in London in 1759, I extract the following: "Some authors argue for a providence, from the earth being covered with green rather than with any other color, as being such a right mixture of light and shade that it comforts and strengthens instead of weakening or grieving the eye, and they explain it in this manner: All colors that are more luminous than green overpower and dissipate the animal spirits which are employed in the sight; whereas those that are more obscure do not sufficiently exercise the animal spirits; but the rays which produce in us the idea of green fall upon the eye in such a due proportion that they give the animal spirits their proper play, and, by keeping up the struggle in a just balance, excite a very pleasing and agreeable sensation. But," says the author, "be the cause what it will, we know that its effect is certain." Richerand, the celebrated French physiologist, says, in his chapter on "Sensations": "Green is the softest of colors, the most permanently grateful; that which least fatigues the eyes, and on which they will the longest and most willingly repose. Accordingly, Nature has been profuse of green in the coloring of all plants, and she has, in some sort, dyed of this color the greater part of the surface of the globe." Dr. Thomas Dick, in his work "On the Improvement of Society by the Diffusion of Knowledge," remarks, page 206, section 6: "As the eye is constructed of the most delicate substances, and is one of the most admirable pieces of mechanism connected with our frame, so the Creator has arranged the world in such a manner as to afford it the most varied and delightful gratification. By means of the solar light, which is exactly adapted to the structure of this organ, thousands of objects of diversified beauty and sublimity are presented to the view. It opens before us the mountains, the vales, the woods, the lawns, the brooks and rivers, the fertile plains and flowery fields, adorned with every hue, the expanse of ocean, and the glories of the firmament; and, as the eye would be dazzled were a deep *red* color or a brilliant *white* to be spread over the face of Nature, the Divine Goodness has clothed the heavens with *blue*, and the earth with *green*—the two colors which are the least fatiguing and the most pleasing to the organs of sight; and, at the same time, one of these colors is diversified by a thousand delicate shades, which produce a delightful *variety* on the landscape of the world."

Dr. Phene, in a paper read recently by him before a scientific society in Edinburgh, advised the planting of trees in cities; among the beneficial results of which he mentions "the relief to the optic nerve through the eye resting on objects of a green color, and that, as the power of sight is strengthened and sustained by green glasses, a similar advantage would be gained by the presence of the green foliage in the streets." And, finally, that profound philosopher, Swedenborg, says in his "True Christian Religion": "What would color be if only white were given and no black? The quality of the intermediate colors, from any other source, is but imperfect. What is sense without relation? and what is relation but things opposite? Is not the sight of the eye darkened by white alone, and enlivened by green, a color inwardly deriving something from black?"

These authorities and facts are entitled to serious consideration. They are all demonstrative of the positive injury, laceration, and destruction of the sight by the reflective dazzle of white; and to what else can we attribute the steadily increasing myopia of the children in our schools? Why not reform it altogether? Let our books be printed on green paper, and let our printers use red, yellow, or white ink for the noxious black. The reform would be revolutionary, and the interests of the trade would be at first hostile to the change. For thousands of years, from papyrus to superfine glittering note-paper, our eyes have been exposed to the deleterious influences of black and white. The change to green, yellow, and red, or to some other agreeable reflective tints, is eventually certain to take place. Science and common sense will compel it. The substitution can not, probably, be sudden nor immediate, for the stationery world must be turned upside down in the process: old school-books, blank-books, and writing-books and inks, must be displaced; and publishers and paper-manufacturers will have to adapt their measures to the new dispensation. But, when it is consummated, everybody will rejoice, except the spectacle-makers. The eyes of the scholar and of the student will no longer be wearied with the myopian contrast of black and white, but strengthened and refreshed by congenial colors; and to pore over the pages of a book would be no more fatiguing to the eyes than gazing on a verdant prairie decorated with variously tinted flowers.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XX.

IN my last I described generally the diffusion of liquids, and the actions to which the names of *endosmosis* and *exosmosis* have been given. It is easily seen that in extracting the juices of meat by immersion in water the work is done by these two agencies. This is the case, whether the extraction is effected by maceration (immersion in cold water) or by stewing.

Some of these juices, as already explained, exist between the fibers of the meat, others are within those fibers or cells, enveloped in the sheath or cell-membrane. It is evident that the loose or free juices will be extracted by simple diffusion; those enveloped in membranes by exosmosis through the membrane. The result must be the same in both cases: the meat will be permeated by the water, and the surrounding water will be permeated by the juices that originally existed within the meat. As the rate of diffusion—other conditions being equal—is proportionate to the extent of the surfaces of the diverse liquids that are exposed to each other, and, as the rate of osmosis is similarly proportioned to the exposure of membrane, it is evident that the cutting-up of the meat will assist the extraction of its juices by the creation of fresh surfaces; hence the well-known advantage of mincing in the making of beef-tea.

It is interesting to observe the condition of lean meat that has thus been minced and exposed for a few hours to these actions by immersion in cold water. On removing and straining such minced meat it will be found to have lost its color, and if it is now cooked it is insipid, and even nauseous if eaten in any quantity. It has been given to dogs and cats and pigs; these, after eating a little, refuse to take more, and, when supplied with this juiceless meat alone, they languish, become emaciated, and die of starvation if the experiment is continued. Experiments of this kind contributed to the fallacious conclusions described in No. 6 of this series. Although the meat from which the juices are thus completely extracted is quite worthless *alone*, and meat from which they are partially extracted is nearly worthless *alone*, either of them becomes valuable when eaten with the juices. The stewed beef of the Frenchman would deserve the contempt bestowed upon it by the prejudiced Englishman if it were eaten as the Englishman eats his roast beef; but when preceded by a *potage* containing the juices of the beef it is quite as nutritious as if roasted, and more easily digested.

Graham found that increase of temperature increased the rate of diffusion of liquids, and in accordance with this the extraction of the juices of meat is effected more rapidly by warm than by cold water, but there is a limit to this advantage, as will be easily understood by referring back to No. 3, in which are described the conditions of coagulation of one of these juices—viz., the albumen, which at the temperature of 134° Fahr. begins to show signs of losing its fluidity; at 160° becomes a semi-opaque jelly; and at the boiling-point of water is a rather tough solid, which, if kept at this temperature, shrinks, and becomes harder and harder, tougher and tougher, till it attains a consistence comparable to that of horn tempered with gutta-percha.

I have spoken of beef-tea, or *Extractum Carnis* (Liebig's Extract of Meat), as an extreme case of extracting the juices of meat, and must now explain the difference between this and the juices of an ordinary stew. Supposing the juices of the meat to be extracted by maceration in cold water, and the broth thus obtained to be heated in order to alter its raw flavor, a scum will be seen to rise upon the surface ; this is carefully removed in the manufacture of Liebig's extract or the preparation of beef-tea for an invalid, but in thus skimming we remove a highly-nutritious constituent—viz., the albumen which has coagulated during the heating. The pure beef-tea, or Extractum Carnis, contains only the creatine, creatinine, the soluble phosphates, the lactic acid, and other non-coagulable saline constituents, that are rather stimulating than nutritious, and which, properly speaking, are not digested at all—i. e., they are not converted into chyme in the stomach, do not pass through the pylorus into the duodenum, etc., but, instead of this, their dilute solution passes, like the water we drink, directly into the blood by endosmosis through the delicate membrane of that marvelous network of microscopic blood-vessels which is spread over the surface of every one of the myriads of little upstanding filaments which, by their aggregation, constitute the villous or velvet coat of the stomach. In some states of prostration, where the blood is insufficiently supplied with these juices, this endosmosis is like pouring new life into the body, but it is not what is required for the normal sustenance of the healthy body.

For ordinary food, all the nutritious constituents should be retained, either in the meat itself, or in its liquid surrounding. Regarding it theoretically, I should demand the retention of the albumen in the meat, and insist upon its remaining there in the condition of tender semi-solidity, corresponding to the white of an egg when perfectly cooked, as described in No. 4. Also that the gelatine and fibrine be softened by sufficient digestion in hot water, and that the saline juices (those constituting beef-tea) be *partially* extracted. I say "partially," because their complete extraction, as in the case of the macerated mince-meat, would too completely rob the meat of its sapidity. How, then, may these theoretical desiderata be attained ?

It is evident from the principles already expounded that cold extraction takes out the albumen, therefore this must be avoided ; also that boiling water will harden the albumen to leathery consistence. This may be shown experimentally by subjecting an ordinary beefsteak to the action of boiling water for about half an hour. It will come out in the abominable condition too often obtained by English cooks when they make an attempt at stewing—an unknown art to the majority of them. Such an ill-used morsel defies the efforts of ordinary human jaws, and is curiously curled and distorted. This toughening and curling is a result of the coagulation, hardening, and shrinkage of the albumen, as described in No. 3.

It is evident, therefore, that in stewing, neither cold water nor boiling water should be used, but water at the temperature at which albumen just begins to coagulate—i. e., about 134°, or between this and 160° as the extreme. But here we encounter a serious difficulty. How is the unscientific cook to determine and maintain this temperature? If you tell her that the water must not boil, she shifts her stew-pan to the side of the fire, where it shall only simmer, and she firmly believes that such simmering water has a lower temperature than water that is boiling violently over the fire. "It stands to reason" that it must be so, and, if the experimental philosopher appeals to fact and the evidence of the thermometer, he is a "theorist."

The French cook escapes this simmering delusion by her common use of the *bain-marie* or "water-bath," as we call it in the laboratory, where it is also largely used for "digesting" at temperatures below 212°. This is simply a vessel immersed in an outer vessel of water. The water in the outer vessel may boil, but that in the inner vessel can not, as its evaporation keeps it below the temperature of the water from which its heat is derived. A carpenter's glue-pot is a very good and compact form of water-bath, and I recommend the introduction of this apparatus into kitchens where a better apparatus is not obtainable. Some iron-mongers keep in stock a form of water-bath which they call a "milk-scalder." This resembles the glue-pot, but has an inner vessel of earthenware, which is, of course, a great improvement upon the carpenter's device, as it may be so easily cleaned.

One of the incidental advantages of the *bain-marie* is that the stewing may be performed in earthenware or even glass vessels, seeing that they are not directly exposed to the fire. Other forms of such double vessels are obtainable at the best iron-mongers'. I have lately seen a very neat apparatus of this kind, called "Dolby's Extractor." This consists of an earthenware vessel that rests on a ledge, and thus hangs in an outer tin-plate vessel; but, instead of water, there is an air-space surrounding the earthenware pot. A top screws over this, and the whole stands in an ordinary saucepan of water. The heat is thus very slowly and steadily communicated through an air-bath, and it makes excellent beef-tea; but, being closed, the evaporation does not keep down the temperature sufficiently to fulfill the above-named conditions for perfect stewing. At temperatures *below the boiling-point* evaporation proceeds superficially, and the rate of evaporation at a given temperature is proportionate to the surface exposed, irrespective of the total quantity of water; therefore, the shallower the inner vessel of the *bain-marie*, and the greater its upper outspread, the lower will be the temperature of its liquid contents when its sides and bottom are heated by boiling water. The water in a basin-shaped inner vessel will have a lower temperature than that in a vessel of similar depth, with upright sides, and exposing an equal water-surface. A good water-bath for stewing may be extemporized by using a common pudding-basin (I mean one with projecting rim, as used for tying down the pudding-cloth), and selecting a saucepan just big enough for this to drop into, and rest upon its rim. Put the meat, etc., to be stewed into the basin, pour hot water over them, and hot water into the saucepan, so that the basin shall be in a water-bath; then let this outer water simmer—very gently, so as not to jump the basin with its steam. Stew thus for about double the time usually prescribed in English cookery-books, and compare the result with similar materials stewed in boiling or "simmering" water.

XXI.

In my last I explained the hardening effect of boiling water on meat, and the consequent necessity of keeping down the temperature considerably below the boiling-point in order to obtain a tender and full-flavored stew. Some further explanation is necessary, as it is quite possible to obtain what commonly passes for tenderness by a very flagrant violation of the principles there expounded. This is done on a large scale and in extreme degree in the preparation of ordinary Australian tinned meat. A number of tins are filled with the meat, and soldered down close, all but a small pin-hole. They are then placed in a bath charged with a saline substance, such as chloride of zinc, which has a higher boiling-point than water. This is heated up to its boiling-point, and consequently the water which is in the tins with the meat boils vigorously, and a jet of steam mixed with air blows from the pin-hole. When all the air is expelled and the jet is of pure steam only (a difference detected at once by the trained expert), the tin is removed, and a little melted solder skillfully dropped on the hole to seal the tin hermetically. An examination of one of these tins will show this final soldering with—in some—a flap below to prevent any solder from falling in among the meat. The object of this is to exclude all air, for, if only a very small quantity remains, oxidation and putrefaction speedily ensue, as shown by a bulging of the tins instead of the partial collapse that should occur when the steam condenses, the display of which collapse is an indication of good quality of the contents.

By "good quality" I mean good of its kind; but, as everybody knows who has tried beef and mutton thus prepared, it is not satisfactory. The preservation from putrefactive decomposition is perfectly successful, and all the original constituents of the meat are there. It is *apparently* tender, but *practically* tough—i. e., it falls to pieces at a mere touch of the knife, but these fragments offer to the teeth a peculiar resistance to proper masticatory comminution. I may describe their condition as one of pertinacious fibrosity. The fibers separate, but there they are as stubborn fibers still.

This is a very serious matter, for, were it otherwise, the great problem of supplying our dense population with an abundance of cheap animal food would have been solved about twenty years ago. As it is, the plain tinned-meat enterprise has not developed to any important extent beyond affording a variation with salt junk on board ship.

What is the *rationale* of this defect? Beyond the general statement that the meat is "overdone," I have met with no attempt at explanation; but am not, therefore, disposed to give up the riddle without attempting a solution.

Reverting to what I have already said concerning the action of heat on the constituents of flesh, it is evident that in the first place the long exposure to the boiling-point must harden the albumen. *Syntonin*, or *muscle-fibrine*, the material of the ultimate contractile fibers of the muscle, is coagulated by boiling water, and further hardened by continuous boiling, in the same manner as albumen. Thus, the muscle-fibers themselves and the lubricating liquor* in which they are imbedded must be simultaneously toughened by the method above described, and this explains the pertinacious fibrosity of the result.

But how is the apparent tenderness, the facile separation of the fibers of the same meat, produced? A little further examination of the anatomy and chemistry of muscle will, I think, explain this quite satisfactorily. The ultimate fibers of the muscles are enveloped in a very delicate membrane; a bundle of these is again enveloped in a somewhat stronger membrane (*areolar tissue*); and a number of these bundles or *fasciculi* are further enveloped in a proportionally stronger sheath of similar membrane. All these binding membranes are mainly composed of gelatine, or the substance which (as explained in No. 5) produces gelatine when boiled. The boiling that is necessary to drive out all the air from the tins is sufficient to dissolve this, and effect that easy separability of the muscular fibers, or fasciculi of fibers, that gives to such overcooked meat its fictitious tenderness.

I have entered into these anatomical and chemical details because it is only by understanding them that the difference between true tenderness and spurious tenderness of stewed meat can be soundly understood, especially in this country, where stewed meats are despised because scientific stewing is practically and generally an unknown art. Ask an English cook the difference between boiled beef or mutton and stewed beef or mutton, and in ninety-nine cases out of a hundred her reply will be to the effect that stewed meat is that which has been boiled or simmered for a longer time than the boiled meat.

She proceeds, in accordance with this definition, when making an Irish stew or similar dish, by "simmering" at 212° until, by the coagulation and hardening of the albumen and syntonin, a leathery mass is obtained; then she continues the simmering until the gelatine of the areolar tissue is dissolved, and the toughened fibers separate or become readily separable. Having achieved this disintegration, she supposes the meat to be tender, the fact being that the fibers individually are tougher than they were at the leathery stage. The mischief is not limited to the destruction of the flavor of the meat, but includes the

* I have ventured to ascribe this lubricating function to the albumen which envelops the fibers, though doubtful whether it is quite orthodox to do so. Its identity in composition with the synovial liquor of the joints and the necessity for such lubricant justify this supposition. It may act as a nutrient fluid at the same time.

destruction of the nutritive value of its solid portion by rendering it all indigestible, with the exception of the gelatine which is dissolved in the gravy. This exception should be duly noted, inasmuch as it is the one redeeming feature of such proceeding that renders it fairly well adapted for the cookery of such meat as cow-heels, sheep's trotters, calves'-heads, shins of beef, knuckles of veal, and other viands which consist mainly of membranous, tendinous, or integumentary matter composed of gelatine. To treat the prime parts of good beef or mutton in this manner is to perpetrate a domestic atrocity.

I am not yet able to record the result of stewing a sirloin of beef in accordance with the scientific principles expounded in my last. Have no hopes of being able to do so until I can spare time to stand by the kitchen fire with thermometer in hand from beginning to end of the process, or have constructed a stewing-pot, big enough for the purpose, so arranged that its contents can not possibly by any effort of ingenious perversity be raised above 180°. The domestic superstition concerning simmering is so wide-spread and inveterate that every normally-constituted cook stubbornly believes that simmering water is of much lower temperature than boiling water, and therefore any amount of instruction or injunctions for the maintenance of a heat below boiling will be stubbornly translated into an order for "gentle simmering," a quarter of an hour of which would spoil the sirloin.

I may, however, mention an experiment that I have made lately. I killed a superannuated hen—more than six years old, but otherwise in very good condition. Cooked in the ordinary way she would have been uneatably tough. Instead of being thus cooked, she was gently stewed about four hours. I can not guarantee to the maintenance of the theoretical temperature, having suspicion of *some* simmering. After this she was left in the water until it cooled, and on the following day was roasted in the usual manner, i. e., in a roasting-oven. The result was excellent ; as tender as a full-grown chicken roasted in the ordinary way, and of quite equal flavor, in spite of the very good broth obtained by the preliminary stewing. This surprised me. I anticipated the softening of the tendons and ligaments, but supposed that the extraction of the juices would have spoiled the flavor. It must have diluted it, and that so much remained was probably due to the fact that an old fowl is more fully flavored than a young chicken. The usual farmhouse method of cooking old hens is to stew them simply ; the rule in the midlands being one hour in the pot for every year of age. The feature of the above experiment was the supplementary roasting. As the laying season is now coming to an end, old hens will soon be a drug in the market, and those among my readers who have not a hen-roost of their own will oblige their poulterers by ordering a hen that is warranted to be four years old or upward. If he deals fairly he will supply a specimen upon which they may repeat my experiment, very cheaply. It offers the double economy of utilizing a nearly waste product and obtaining chicken-broth and roast fowl simultaneously.

One of the great advantages of stewing is that it affords a means of obtaining a savory and very wholesome dish at a minimum of cost. A small piece of meat may be stewed with a large quantity of vegetables, the juice of the meat savoring the whole. Besides this, it costs far less fuel than roasting.

The wife of the French or Swiss landed proprietor, i. e., the peasant, cooks the family dinner with less than a tenth of the expenditure of fuel used in England for the preparation of an inferior meal. A little charcoal under her *bain-marie* does it all. The economy of time corresponds to the economy of fuel, for the mixture of viands required for the stew once put into the pot is left to itself until dinner-time, or at most an occasional stirring of fresh charcoal into the embers is all that is demanded.—*Knowledge.*

CATCHING COLD.

By C. E. PAGE, M. D.

"She caught her death o' cold, taking gruel out of a damp basin."—*Old Story.*

THERE has always been more or less of mystery connected with the disorder popularly called "a cold." A close observer, in studying this question, will find:

1. That, while persons of all ages, sexes, occupations, social positions, and in all conditions of general health—from the delicate infant and the frail consumptive to the most robust man—have colds, say to-day, from the slightest causes, often enough, indeed, when utterly at a loss to account for the attack; next month, or next week, perhaps, the same individuals—the frail and delicate ones, even—may pass through severe exposures to wet and cold, even to the point of being chilled through and through, without producing a symptom of this disorder.

2. Every day throughout the year we see evidences of the disease; to the last individual in any community none escape altogether, a large proportion are affected several times, and individuals there are who rarely pass an entire month without some of the symptoms; while others, notably children and infants who are fed every hour or two, are almost constant sufferers from nasal catarrh, difficult breathing ("snuffles"), and general *malaise*, and are peculiarly subject to acute attacks.

3. Whenever it happens that an unusually large proportion of the people are attacked at about the same time, the disease is popularly

attributed to the influence of an "influenza-wave"; but this theory seems to me utterly untenable, else a still larger proportion would be thus affected, and the disease would, in general, be confined to such periods; whereas very many escape at such times, only, alas! to fall victims to the disorder during the finest season of the year, when the weather is the mildest and most charming and the temperature most uniform. Indeed, some of the severest "attacks" are observed at such times, and the disease is far more prevalent during a season of steady hot weather in summer than during a period of steady cold weather in winter! But it is during a *warm spell* in midwinter, after the world has for quite a period of intense cold been *confined within-doors*, that "everybody has a cold"!

4. While the disease under consideration is no respecter of persons, but is as universal as the dietetic habits of the people are uniform, there is one class, viz., vegetarians, who are very much less subject to it, often passing the entire year without an attack, or, if attacked, are less seriously affected, and recover more speedily than others about them. Individuals, indeed, there are, living still more abstemiously, and paying proper regard to the ventilation of their dwellings, who *never* have a cold, though half the town may be sick with the disease: the "wave" never touches even the hem of their garments.

5. Members of this class, however, upon resuming their former practices as to diet, returning to the "mixed" diet and three meals a day, also resume the habit of "catching cold"; indeed, a visit of a few weeks, in a family of "good livers," especially if the latter are "air-haters" also, will often produce an attack.

Personally, though a life-long sufferer from the disease in various forms, from the "snuffles" of infancy to the "hay-fever" of adult age, together with occasional attacks of neuralgia, rheumatism, throat and lung affections, etc., I now find it impossible to excite any of the "well-known symptoms," or, in fact, any form of disease, though subjecting myself to what many would consider the most suicidal practices in the matter of exposure to the elements, so long as I live upon a frugal diet, chiefly cereals and fruit, served plainly—nominally two meals a day; holding myself ready, however, to "skip" a meal when necessary, i. e., whenever any of the symptoms of indigestion, as acid stomach, flatulence, pressure in the region of the lungs or stomach, etc., warn me of having carried the pleasures of the table a trifle beyond the needs of the organism.

I have, in my efforts to "catch" cold, submitted myself to exposures that to the minds of most people would appear of a suicidal character, wearing low shoes and walking in snow and slop until both socks and shoes were saturated, sitting an hour in that condition and going to bed without warming my feet; removing flannel under-garments in midwinter on the approach of *colder weather*, and attending to out-door affairs without the overcoat habitually worn; sleeping with a current of air blowing directly on my head and shoulders; sitting entirely naked in a draught, on a very cold, damp night in the fall, for fifteen minutes before getting into bed; wearing cotton night-shirt and sleeping under light bed-covers on the night following the use of flannel gown and heavy-weight bedclothes; rising from bed on a cold, rainy morning, and sitting naked for an hour, writing, and then putting on shirt and trousers only, the shirt almost saturated with rain and the trousers quite damp, from hanging by the window—these and similar experiments I have tried repeatedly, but without catching cold: I become cold, and become warm again, that is all.*

On the other hand, changing the nature of my experiments, going back to my old habits as to diet—the indulgence of what we call a "generous" diet—the universal mixed diet of the people, viz., fish, flesh, fowl, with the hot, stimulating, and greasy condiments almost invariably associated with this class of food, together with pastry, puddings, and sauces, coffee, etc.—I have found no difficulty in accumulating a "cold," and within a reasonable length of time—the time depending upon the degree of my over-indulgence as to frequency and amount—although, now, a part of the programme consisted in taking the most extreme care to avoid everything in the way of "exposures," as this term is commonly applied—keeping the feet dry and warm, paying the utmost attention to wraps, etc., etc. Indeed, my own experience and observation satisfy me of the truth, and furnish ample explanation for it, of the oft-expressed opinion that those people who wrap the most and take the most care in such respects are the greatest sufferers from "colds"; and, theoretically, this would be the logical deduction from a consideration of the simple facts taught even in the primary text-books on physiology: certainly, the less clothing one wears and the more he is exposed to cold, the nearer he is carried, metaphorically speaking, to the polar regions, where *surfeit-fever* is unknown! Said an observing friend to me, "I am apt to catch cold when I put on my winter flannels—why is it?" My explanation was satisfactory to him, for he was a bright man; but, in general, it is difficult for people to comprehend the fact or the principle involved therein.†

* Accidents often cause worse exposures than any I have enumerated above, without exciting this disorder: for example, upon the occasion of a shipwreck on a bleak, Northern coast, in winter, not one of the stranded mariners or passengers would have "a cold" in consequence. Indeed, a sufficient degree of exposure to hunger and cold would tend to "cure" every case of this disorder that previously existed on shipboard; and if the exposure should not extend beyond measure—beyond the power of endurance of an individual or the entire group—no sickness of any sort would result.

† For the past two winters the writer has worn no under-flannels. He removed them in midwinter (1881–'82) as a part of the treatment for "a cold!" The balance of the curative regimen consisted in a quick sponge-bath, succeeded by an air-bath with friction for fifteen minutes in a cool room, abstaining from food for the entire day, though the appetite was craving, engaging in active exercise in the open air. By night the feverish symptoms had disappeared, the oppressed lungs were relieved, hoarseness scarcely noticeable—in a word, convalescence established.

In the course of my experiments, whenever I have fed my cold as far as I wished or dared to go, I have, in every instance, banished the disease by entirely abstaining from food for a time ; I have never known this remedy (if applied at the very onset) to fail of "breaking up" a common cold in twenty-four to forty-eight hours, whatever the age, sex, or occupation of the patient. However we may differ as to the origin of the disorder, whenever I can prevail upon a sufferer to try this remedy, we come to be of one opinion as to what will most surely and speedily "cure" it.

Of course the size of the "dose" must bear some relation to the severity of the case :* On the first appearance of the disease—the symptoms of a slight cold, so familiar to all—skipping a single meal, in the case of a person who takes but two meals a day habitually, or two meals, in the case of a three-mealer, will sometimes suffice, if the succeeding meals be very moderate ones. I have usually, in my experimentation, been satisfied to "turn" at the "one-meal buoy," not often being obliged to abstain longer than twenty-four hours. When, however, I have chosen to prolong the experiment by continuing to eat heartily, as is the custom with people in general at such times, I have found my experience identical with theirs : the symptoms would increase in severity, and to nasal catarrh, headache, slight feverishness, and languor, would be added sore-throat, perhaps, with pressure at the lungs, hoarseness, increased fever, and entire indisposition for exertion. In this case, two, perhaps three days' fasting would be required, with a little extra sponging of the skin, to completely restore the balance. Out-door air is desirable, and—when not demanding too great effort—exercise. *Air-baths*, when there is much feverishness of the skin, are comforting and curative. The practice of *holding down* the bedclothes, in case of fever and delirium, lest the burning body "catch cold," and of stinting the supply of fresh air for the same reason, is no less irrational than to withhold water or to offer food.

Years of study and observation have forced me to the conclusion that the disease which manifests the symptoms popularly supposed to indicate that a cold has been caught is to all intents and purposes a

* In the "Boston Journal of Chemistry," February, 1882, I reported a case of consumption (the patient, seventy years old, had been declining for three years, and was helpless in bed) cured by a forty-three days' fast. He had been a great sufferer; but his cough and pains gradually disappeared during the first two weeks. Within four months thereafter, on a fruit-and-bread diet, he had regained his normal weight and strength.

A bad case of malarial fever, the past summer, yielded to a twelve days' fast, *and nothing else.* Another patient suffering from rheumatism, with night-sweats, fasted thirteen days, obtaining great relief. His night-sweats ceased the fourth day.

Dr. Wood, Professor of Chemistry in Bishop's College, Montreal, reports for the Canada "Medical Record" forty-seven cases of acute articular rheumatism cured by fasting—time required, from four to eight days—and a recent letter assures me that this remedy is still successful with him. He consequently has come to regard rheumatism as "a phase of indigestion."

filth-disease, arises largely from indigestion, and forms the basis, so to say, or is in fact the *first stage of all* the so-called filth-diseases. Whatever interferes with digestion or depuration, or depraves the vital organism in any manner, produces an impure condition of the body—a condition of disease; and a continuance of disease-producing habits must inevitably result in periodical or occasional "eruptions," the severity of which will depend upon the degree of one's transgression. Among the causes of this impure bodily condition are (1) impure food,* (2) excess in diet, and (3) impure air. Our homes, offices, shops, halls, court-houses, churches, and, with rare exceptions, all living-rooms, private or public, are insufficiently or not at all ventilated; and, except while in the open air, a very large proportion of our people, in all the walks of life, habitually breathe an atmosphere vitiated by being breathed over and over again; they are starving for want of oxygen, and are being poisoned by carbonic acid. In default of sufficient oxygen the best of food can not be transformed into pure blood—there will always be a corresponding indigestion; nor can the carbonic acid be eliminated freely in an impure atmosphere. We have, then, serious "interference with digestion and depuration," whenever we remain even for a single hour of the twenty-four in an "in-door" atmosphere, i. e., an atmosphere that is not in tolerably free communication with the great body of air without. The only offset for restriction in oxygen is restriction in diet and exercise; but a combination of this character would produce enfeeblement of the system, though if a proper balance were maintained there would arise no febrile symptoms such as we are considering. We have plenty of people living in unventilated rooms who, so far as *exercise* is concerned, live a well-balanced life; but seldom do these, any more than the robust and active, practice any sort of voluntary restriction as to quality or quantity of food—nausea and lack of appetite being the only safeguards. Persons of this class are great sufferers from colds.

Impure air, although a prevailing source of disease, is not absolutely essential in provoking this disorder; an unwholesome diet alone being sufficient. In none of my own experiments have I suffered any restriction in the matter of pure air. But for this depraved condition—this chronic state of impurity—that I have undertaken to describe

* Under this head I am led to class all foods eaten unnaturally, as (1) farinaceous dishes (the mushes, soft bread, etc.), that on account of their mode of preparation and dressing can not be insalivated; and (2) flesh-food that is "well masticated" or taken in the form of hash. It has been demonstrated (by experiments on dogs) that carnivorous animals fed on hashed meat suffer from indigestion, while, if they are allowed to swallow their meat as they like, in chunks, it is all digested. In repeated experiments upon myself, I find that a moderate ration of meat, swallowed in pieces of convenient size, occasions no disturbance, while the same quantity chewed fine, or taken in the form of hash, is not well borne. The point is, that while minced meat passes out of the stomach before being dissolved by the gastric juice, large pieces remain to be gradually dissolved. There is no demand for the chemical action of saliva on this class of foods.

and account for, such sicknesses as croup, diphtheria, pneumonia, measles, scarlet, typhus, typhoid,* rheumatic, "malarial," and other fevers.

I have already remarked that the condition of disease produced by an unhygienic mode of living, relating chiefly to food and air, and whose occasional ebullitions are observed in the "well-known symptoms of cold," forms the basis of most sicknesses by whatever name they are known. "I catched cold in the first place, and kept adding to it, some way, I couldn't tell how, and finally it settled on my kidneys" (or lungs, throat, face, limbs, or whatever organ or locality seems especially affected). As the nearest to a panacea for all the physical ills of life, I would offer this : Take care of the colds and the fevers will take care of themselves. Whatever may be the origin of disease, or whatever may give rise to its manifestations, whenever these manifestations or symptoms are said to indicate a cold, the condition, as every intelligent physician well knows, is that of *fever:* the thermometer placed under the tongue shows at once that the temperature is above the normal. The patient may, usually does, have periods of chilliness ; his first noticeable symptom is, very likely, a chill ; and if at such a moment he happens to feel a puff of fresh air on his cheek he thinks *that* was the moment when he caught his cold ! Possibly he might have been feeling a little too warm, and that "draught" † did the business for him ! Chills and fever, speaking in popular phrase (in reality it is *all* fever), indicate blood-poison, always. In its earliest stage, the patient, being perhaps wholly unaware of his condition, feels "too warm," and throws off coat or shawl ; pretty soon he feels the reaction—the chill—and, thinking he has done a careless thing in removing the garment, replaces it ; too late, alas ! he has already caught cold !

"It is noteworthy as a curious yet easily explicable fact," says the "Lancet," "that few persons take cold who are not either self-consciously careful or fearful of the consequences of exposure." ‡ It is

* It is held by some that typhoid fever and some other diseases depend upon the introduction of germs of the disease from without the organism. "No seed, no crop," remarks a friend, and adds: "These germs do not always lodge, or, if they do, may not grow; but they may. Not all the thistle-seeds take root and grow." To which I reply, that neither thistles nor any other undesirable weeds ever "get the start" of a good gardener; and that, of all antagonists to obnoxious or undesirable "weeds," the vital organism, under the influence of rational personal hygiene, is the most alert and efficient.
—none of these, or at least but seldom, could get a foothold.

† Whenever a patient comes to me with "a cold," complaining of a draught, I usually ask, "A 'draught' of what—pure air or impure food?" The answer, in the absence of certain physiological knowledge, is sure to be a blank stare of helpless ignorance as to my meaning.

‡ Former patients comfort me with such remarks as these: "Your colds-theory has given me a new lease of life;" "How thankful I am for being rid of my old fear of cold air!" "I date my first real improvement from the hour when you induced me to throw off my dread of cold," etc. "Now that I know what it is," writes a bright Southern lady,

not, however, that these over-careful people catch cold from fear, but rather that their cowardice keeps them in-doors too much, or incites them to "muffling" themselves when they do go out—they quake from fear of "night-air," "draughts," and so cheat themselves of health-producing influences. Lacking active exercise and fresh air, or sweltering with an excess of clothing, they must suffer from indigestion. That is, though they may *eat* as much, or more, they can not *digest* as much as the fearless person who dresses light, pays no heed to the weather, spends considerable time out-doors every day, and, because of this, can not and will not remain in "stuffy" rooms.

The "fresh-air idiot" seldom takes cold. "That may be," says the timid, blood-poisoned, chilly man, "but he causes every one else to, with the open doors and windows." There is a grain of truth, if not of sense, in this assertion; for the pure air in contact with the skin, and in the lungs, of those who are most in need of it—who are filled up, so to say, with the impurities of indigestion and deficient depuration—the constipated air-haters—gives the needed stimulus, or, rather, so augments the vital powers that "the reconstructive process is initiated, and thus apparently the disease itself, but there is a wide difference between a proximate and an original cause. A man may be too *tired* to sleep and too *weak* to be sick. Bleeding, for the time being, may 'break up' an inflammatory disease—the system has to regain some little strength before it can resume the work of reconstruction. The vital energy of a person breathing the stagnant air of an unventilated stove-room is often inadequate to the task of undertaking a restorative process—though the respiratory organs, clogged with phlegm and all kinds of impurities, may be sadly in need of relief. But, during a sleigh-ride, or a few hours' sleep before a window left open by accident, the bracing influence of the fresh air revives the drooping vitality, and Nature avails herself of the chance to begin repairs—the lungs reveal their diseased condition, i. e., they proceed to rid themselves of the accumulated impurities.

"For," continues Oswald,* "rightly interpreted, the external symptoms of disease constitute a restorative process that can not be brought to a satisfactory issue till the cause of the evil is removed. So that, in fact, the air-hater confounds the cause of his *recovery* with the cause of his *disease*. Benjamin Franklin, "whose wisdom was of that rare kind which does not grow old," expressed his conviction of the fact that "the causes of 'colds' are totally independent of wet and even of cold."† Dr. Herring remarks of a family of friends, "They all invariably had 'colds in the head' the next day after dining on roast goose!"

"I seldom catch cold, and, when I do, it gets away again right soon!" I am compelled to admit that all this is more profitable for patients than for the practitioner.

* "Physical Education," by F. L. Oswald, M. D.; New York, D. Appleton & Co.

† "Essays," p. 216.

"The immediate effects of a displacement of blood from the surface, and its determination to the internal organs, are not," says the "Lancet," "as was once supposed, sufficient to produce the sort of congestion that issues in inflammations. If it were so, an inflammatory condition would be the common characteristic of our bodily state. When the vascular system is healthy, and that part of the nervous apparatus by which the caliber of the vessels is controlled performs its proper functions normally, any disturbance of equilibrium in the circulatory system which may have been produced by external cold will be quickly adjusted. Most of the sensations of cold or heat," continues the "Lancet," "which are experienced by the hypersensitive have no external cause." They have, however, an internal cause which I have endeavored to point out and account for, as well as indicate the natural remedy. A "chilly" person is a sick person, and is in a state predisposing him to an "attack"—a natural kill-or-cure sickness—whenever external conditions are favorable. But no amount of transient cold, or wet, or draughts, can *alone* originate the symptoms of "a cold"; the predisposing cause must of necessity exist, or the effects will be of a wholly different character: temporary discomfort—suffering, perhaps—and, at the worst (if the exposure be of a severe nature, as in the case of a feeble person), a lowering of the general health. Short of the point of freezing to death, or of exposure so severe as to render reaction impossible, the person will get cold and—get warm again, that is all.

There is a maxim worthy of all acceptation: "If you stuff a cold you will have to starve a fever." Unfortunately abbreviated to "stuff a cold and starve a fever," and utterly misinterpreted, a deal of mischief has been done, for which the only compensation evident to my mind is this: those who have accepted the first division of the command have gorged themselves *conscientiously!* They have taken allopathic doses of a homœopathic remedy—*similia similibus curantur*—with a vengeance! But when the incipient fever became well established did these superobedient children of Nature obey the second injunction? No, and with good reason, apparently—the first prescription proving a failure (?), they did not dare to try the second! Now and then, however, it has been tried, either because of the courage or exceptional intelligence on the part of the patient or his physician, and with uniform good results. Where the "fasting-cure" is applied *in extenso*, with appropriate water and air baths, sunshine, and perfect ventilation, the worst forms of fever rarely have a "run" of ten days—three or four days will often suffice to insure convalescence; whereas, under the milk-and-brandy, beef-tea, and tonic treatment, and "eating little and often," the flames are fed until the patients are *burned to skeletons*, and a large percentage fatally.

I think I should be justified, in the estimation of most people, in saying that mankind are by nature, or at least from custom, if not gourmands, certainly prone to over-indulgence in diet. I find, in conversing with rational people—and most people are rational to this degree—that they are quite willing to subscribe to this much: "Without doubt we eat too much, and indulge in many dishes of an unwholesome nature." There are, to be sure, many persons who call themselves small eaters, and who do, in fact, eat very little food; such would be inclined to take issue, and upon apparently good grounds, with the assertion that *their* colds could spring from overeating. But we must bear in mind that "excess in diet" is a relative phrase; the quantity of food, if we regard a physiological diet, must be proportioned to—1. The amount of labor performed, or exercise taken; 2. The degree of cold endured; 3. The amount of oxygen taken into the blood; i. e., the purity of the air habitually breathed, since all these circumstances affect the needs of the organism for nutriment, and therefore the amount of the digestive fluids that can possibly be secreted from the blood by the appropriate glands of the stomach, liver, pancreas, and intestines. Moreover, it must relate to the present physical condition of the individual: for example, the man who has recently been purified by a "cold," may carry off, without experiencing serious indisposition, a dinner of a dozen courses (*curses*, as Dr. Abernethy used to call them), either one of which would alone suffice to produce a violent "attack" of indigestion in the case of his neighbor who might be approaching, or already standing on, the "dead-line"; but a succession of such indulgences, or continuance of the prevailing mode of living, will ere long again bring him to the end of his tether, so to say—to the brink of the surfeit-precipice upon which so many habitually live—to that condition of the system wherein a single dish of the most wholesome food constitutes an excess. In such a case the form of the disorder will depend upon various circumstances, as the constitution, temperament, or "diathesis" of the individual, the kind of food eaten, amount, etc.—headache, nausea, colic "cramps," or cholera-morbus (in the South, during the heated term, genuine cholera or yellow fever); or it may excite the symptoms of that *initial fever* popularly called a cold. Many people eat little, simply because it is physically impossible for them to eat much. Nausea or lack of appetite prevents them, not from overeating, but from eating a large amount. Such people habitually overeat. Even the small quantity swallowed, in face of Nature's protest, lack of relish, is relatively a greater excess than the huge dinner eaten by a "good feeder" when in condition. Hence, their frequent efforts to eat (every five or six hours, or oftener), especially in view of the kind of food necessary to "tempt the appetite," prevent a ready return to a normal condition—prohibit a natural appetite, i. e., a relish for plain food. For all such patients I would direct, first, a rest for the stomach (and thus a respite for all the viscera concerned in digestion, and relief for the excretories as well), and then attention to the due nutrition of the body, not the tickling of the palate merely or mainly. "Fasting, fresh air, and exercise, is Nature's panacea," says Dr. Oswald ; and so, in practice, I have found it for a wide range of "diseases" that nothing else can reach. If we agree that *disease* results, mainly, from the breathing of impure air, the use of unnatural food or excess, and often deficient exercise, then it would seem to follow that *ease* must depend upon a reform in these particulars. In all my experience with sick people I have never known of the restoration of a single patient to fairly robust health in the absence of such reform. I have rarely known a person to become sick except as the direct result of some degree of fear of pure air, and fearlessness regarding the influence of impure food. Whatever else may have contributed to the production of his disease, it is seldom, indeed, that these may not be truly regarded as the principal causes. Nature's preventive and curative agents may be summed up thus : Pure air, appropriate food, exercise (active or passive as the case may require), skin-cleanliness, with proper ventilation of the surface of the body, i. e., through the use of non-sweltering garments, supplemented by rational exposure of the entire surface of the body to the air, by means of air-baths, sunshine in the home and "sunshine in the heart"—with these, and only these, all curable cases will go on to certain recovery. Without them no medication will avail.

THE SOURCE OF MUSCULAR ENERGY.

By J. M. STILLMAN, Ph. B.

NEW and valuable scientific discoveries and inventions are not slow at the present time in making their way from the closets and laboratories of the investigators or discoverers to popular recognition. It is somewhat otherwise with the gradual development of knowledge on subjects once thought to have been tolerably clearly understood and of no immediate practical value. The gradual modifications which take place in generally accepted theories by the slowly accumulating results of the labor of many investigators are, to be sure, appreciated by the special student in the particular department of knowledge concerned, but are slower in meeting with public recognition. It thus happens that teachers and books, not dealing as a specialty with the subject involved, often adopt and repeat as authoritative views and theories which, by the specialists in those branches, have either been abandoned or brought seriously into question. Nor is it to be otherwise expected. Chroniclers are quick to seize upon and distribute the news of brilliant or startling discoveries or inventions, but those are fewer who will track patiently the slowly accumulating evidence of many workers, appreciate the bearing of their work, and produce it in a form in which it can be appreciated by those non-specialists most interested in the subject involved.

It is thus, to a certain extent, with the subject of the source of muscular power in the animal organism. It is needless to specify in this particular. Text-books and popular articles touching on the subject are continually asserting, as apparently unquestioned, theories which at the present time are either exploded or very much in doubt. It would seem, therefore, not without value to attempt, as far as practicable in a popular or semi-popular article, a general statement of the present condition of the theories on the source of muscular power, and of the main points of the evidence which tends to support these theories.

The general acceptance of the law of the conservation and correlation of physical forces had at once an important influence in directing attention to the source of muscular force. The idea was readily taken up that this form of force is at the expense of heat, which is produced by the oxidation of carbon and hydrogen in the body, the necessary oxygen being conveyed by the arterial blood to the muscular tissue. In other words, the somewhat trite comparison of the human body and the muscular system to an engine, which consumes just so much fuel to produce so much force, has pretty clearly formulated the idea as generally accepted. And so far as it goes the comparison is not bad.

When, however, we pass beyond this somewhat vague simile to an examination of the more intimate nature of these various processes, we find the questions raised are not so generally understood. Accepting that the muscular force is produced by the ultimate oxidation of carbon and hydrogen to carbonic-acid gas and water respectively, the next questions that suggest themselves are: "What is the immediate source of this carbon and hydrogen—the fuel material for muscular force?" and "What is the real nature of these processes which we call briefly oxidation?" The endeavors to answer these questions have given rise to many discussions and disputes, which are, even at the present day, by no means concluded.

Before taking up the discussion of the theories advanced to answer these questions, it will not be out of place to review very briefly the composition of the muscles and their general relations to the circulation—only in so far, however, as is necessary for a clear comprehension of the evidence and arguments involved in the discussion.

A muscle is essentially a collection of lengthened cells held together by a connective tissue. Each cell consists of a delicate cell-wall or membrane containing a fluid or semi-fluid mass of living (protoplasmic) matter. This gelatinous substance possesses the power of contraction under the stimulus of excitations of various kinds—nervous impulse, electricity, heat—and the cell becomes thereby shortened. This process, taking place simultaneously in all the cells of a given muscle under the influence of the same exciting cause, is what exerts the power of the contracting muscle. The intensity of this shortening or contracting power has been approximately measured—e. g., by ascertaining experimentally the weight necessary to prevent a muscle from contracting under excitation.* The muscles are supplied with blood by the fine ramifications of the arteries, and the blood is conducted away again by the ramifications of the veins, the arterial blood losing oxygen and taking up carbonic acid during its passage, as is the case in the other tissues also.

Regarding the composition of the muscular tissue, it may be simply noted that the tissue itself is composed mainly of albuminoid material (cell-contents) and of the substance of the connective tissue, which is, like the albuminoids, composed mainly of carbon, hydrogen, oxygen, and nitrogen, and in much the same proportions. Besides this, the blood and lymph permeate the muscular tissue throughout, and certain non-nitrogenous substances, mainly glycogen, a substance resembling starch or dextrine in composition and properties, are stored up in the muscular tissue, and always found to be present. Certain other simple compounds containing nitrogen are also present, and are considered to be decomposition products of the more complex albuminoids. When the muscular contraction takes place, mechanical force may be exerted which is produced at the expense of the force stored up as potential chemical energy in the materials which serve as the fuel material. This potential energy is set free or rendered active by the chemical processes which there take place, and appears as work, as sensible heat, or as electrical disturbances.

Before we inquire as to the nature of these chemical processes, it will be of advantage to glance briefly at the results of important investigations which have been made on this subject, as these form the only safe data by which we may judge of the tenability of any theory. It would be out of place here to attempt a full reference to the mass of investigations and experiments which have been published, and which bear on the topic under discussion.† We shall therefore simply notice the principal facts which have been established as the results of those investigations, and which are most pertinent to the matter in hand.

The experimental researches on this subject may be classified under four heads: 1. The examination of the muscular tissue itself before

* This value has been found in man at about 6,000 to 8,000 grammes per square centimetre of cross-section of muscle (85 to 114 pounds per square inch) for the maximum for voluntary contraction. It is of course evident that the intensity of the force exerted varies with the kind and degree of excitation, so that too much dependence must not be placed on any particular values thus obtained. They simply give an approximate value for ordinary muscular activity.

† Quite full references may be found in the excellent and quite recent text-books of F. Hoppe-Seyler, "Physiologische Chemie," and of A. Gamgee, "Physiological Chemistry of the Animal Body."

and after muscular action. 2. The examination and comparison of the blood coming to the muscle, and that leaving it, during rest and exertion. 3. The examination of the gases given off or absorbed by the active muscle after excision from the animal, and under the influence of artificial irritation. 4. The influence of continuous muscular exertion on the respired gases and on the waste products of excretion.

1. With regard to the changes in the muscular tissue, it has been noticed that the proportion of water in the muscles is increased or the proportion of solids diminished by work, the amount of substances soluble in water is diminished and the amount soluble in alcohol increased; and particularly that glycogen disappears and sugar is increased (the latter probably as a product of fermentation at the expense of the glycogen).

2. Changes produced in the blood are for the most part difficult to trace with certainty; but, it has been observed that the blood coming from the active muscle contains more carbonic acid and less oxygen than that coming from the resting muscle; and, further, that the carbonic acid is increased in greater proportion than the oxygen is diminished. We shall recur to this later.

3. Investigations into the changes which occur in gaseous atmospheres surrounding an excised muscle made to contract under the influence of electricity are interesting and instructive. G. Liebig found that the excised muscle gave off carbonic acid and took up oxygen, but that muscular contraction took place also when the surrounding atmos phere contained no oxygen, carbonic acid being given off, however, in this latter case also. Later observers confirmed these observations, and Matteucci considered, from his experiments in the same direction, that the carbonic acid was not produced at the expense of the oxygen of the surrounding atmosphere, but from oxygen held in some form of combination in the muscular tissue itself. Herrmann found that a portion even of the oxygen absorbed from the air was absorbed in consequence of incipient putrefactions.

4. Investigations under the fourth head, as to the effect of muscular exertion on the general relations of respiration and excretion, have been very elaborate and very numerous. Pettenkofer and Voit, Ludwig and Sczelkow, and others, have investigated the relations of carbonic acid and water given off to food and oxygen consumed as influenced by muscular exertion. Their investigations have shown that the oxygen consumed and carbonic acid and water given off are largely increased by muscular exertion. This had been noticed as a general fact by Lavoisier a half-century or so earlier, but the experiments of the above-named investigators were carried on with a care and thoroughness which left little to be wished for in that direction.

Whether the subject of the experiment be kept on a constant diet during both work and repose, or whether it be allowed to eat and drink according to desire, or even if no food be permitted during the experiment, the general fact remains the same, that the quantities of carbonic acid and water eliminated during work are much greater than during rest, in many cases the ratio being as high as two to one. It is also found that the oxygen taken up, though increased during muscular exercise, is not increased in proportion to the carbonic acid eliminated. The result is, that the ratio of the volume of oxygen consumed to the volume of carbonic acid eliminated, which is normally somewhat less than unity, tends to approach unity during muscular work. It should be here remarked that investigations dealing with total respired gases, although doubtless in the main reliable, are not without certain defects. If we could be certain that muscular exercise left all other organic functions unaffected, we could safely attribute the observed changes to the muscular contraction alone. But such is probably not the case. The functions of organs are influenced by the activity of others, and hence the changes noticed in products of elimination or in the consumption of oxygen can not with safety be attributed solely to the muscular work performed, as these substances are consumed or produced by the combined activity of all the living tissues of the organism. Hence the value of the corroborative testimony of the other methods of investigation noticed above.

The influence of muscular exertion on the elimination of nitrogen has also received much attention, inasmuch as the nitrogen eliminated (mainly in the form of urea by the kidneys) may be taken as a measure of the amount of nitrogenous food or tissue decomposed in the organism. The influence, then, of muscular exertion on the excretion of nitrogen is of importance as showing also its influence on the decomposition of albuminoids (foods or tissues). The results of the numerous investigations on this subject have been somewhat at variance. Many have found no material increase in the elimination of nitrogen during muscular exertion; others find a slight increase, but not sufficient to indicate any immediate relation of the nitrogen eliminated to the work performed. Passing over the work of earlier investigators, we will consider briefly the results of some of the later investigators. Voit was one of the first to make careful and exact experiments extending over a considerable period of time, and he determined that the increase in elimination of nitrogen during muscular exertion is very slight; *that it bears no constant relation to the work done*, and is more influenced by diet than by work. Fick and Wislicenus made an ascent of the Faulhorn in the Alps, with the purpose of determining the possibility or impossibility of albuminoids being the fuel-material for muscular power. They estimated the mechanical work necessary to raise their own bodies through the vertical distance to which they ascended. They then calculated the amount of albuminoids necessary to produce so much force by its combustion. They determined experimentally the amount of nitrogen in their excreta during the period of the ascent, and, having taken no nitrogenous food during that period, they were enabled to estimate what relation the albuminoid decomposition bore to the amount necessary to supply the power for the ascent. By this method they demonstrated that the whole amount of albuminoid material decomposed during the ascent, even if completely oxidized to carbonic acid, water, and nitrogen (instead of yielding its nitrogen in the form of urea, as is actually the case), would produce less than half the force necessary to raise their bodies through the vertical height to which they ascended. Thus it is shown that the amount of force represented by the actual decomposition of albuminoids during work is by no means adequate to account for the work done, even supposing that all the nitrogenous material decomposed in the body went for that purpose, and that no other muscular work were performed during the ascent than the mere lifting of such a weight to the given height. Both these suppositions are evidently incorrect, as the nitrogen is eliminated in almost equal quantities when no voluntary muscular action is exerted, and the muscular work, voluntary and involuntary (lungs, heart, etc.), on such a trip, would evidently far exceed that necessary for the simple elevation of a dead weight to a specified height.

Experiments conducted by Dr. Parkes on two soldiers proved that a small increase of nitrogen elimination was produced, and also, that this increased elimination of nitrogen may extend for many days after the exercise has ceased.

Dr. Austin Flint, Jr., in an elaborate and thorough investigation on the pedestrian Weston, found a decided increase in the nitrogen eliminated during work; also, a decided increase in the ratio of nitrogen eliminated to that taken in with the food. The value of his results is somewhat impaired for our present purpose, in so far as they relate to the influence of muscular exertion simply, because the condition of the subject during the working period was not such as was favorable for a fair test. His appetite fell off; he slept poorly; was extremely nervous and irritable much of the time; became at times much exhausted and prostrated even to nausea. When the influence of the nervous state and of an exhausted condition on the functions is taken into account, it will be evident that deductions as to the effect of muscular exertion alone would in this instance be open to doubt. Dr. Pavy's experiments on the same pedestrian indicated also an increase in the nitrogen elimination, but only a slight increase as compared with Dr. Flint's results.

What, then, seems tolerably certain is, that muscular exertion increases the nitrogen elimination but slightly, and perhaps only very slightly, so long as the muscular system is *moderately exercised* and not *overtaxed*. And, indeed, the pertinent question here would seem to be, "Is the normal muscular action accompanied with any elimination of nitrogen showing a decided relation of the work done to the nitrogen eliminated?" and not "Is the excessive and exhaustive exertion of the muscles accompanied with any increase of nitrogen elimination?"

Having thus glanced at some of the more important experimental results bearing on this subject, let us return to the consideration of the two questions previously enunciated. First, then, "What is the fuel-material for muscular force? is it albuminoid and nitrogenous, or is it non-nitrogenous?" That it is not essentially nitrogenous will appear from the experiments last described, for if such were the case we should find nitrogen eliminated in much greater quantities during muscular work than during rest, which is not the case. The material which supplies the force by its decomposition must, then, be mainly non-nitrogenous. Here, again, are various possibilities. Fats, sugars, glycogen, are all non-nitrogenous, and we have next to inquire whether the fuel-material be fats, sugars, or glycogen. The facts above stated of the constant occurrence of glycogen in the muscular tissues, and its disappearance in part during muscular exercise, suggest at once the possibility of this substance being a fuel-material. We shall obtain light on this question from the facts regarding the influence of muscular exertion on the ratio of the volume of carbonic acid expired to that of the oxygen taken up. The three principal classes of foods consumed in the animal body are the fats, carbohydrates (starch, sugars, glycogen, etc.), and nitrogenous substances. For the present purpose it may be considered that the fats and carbohydrates are ultimately converted into carbonic acid and water, and that the nitrogenous substances are ultimately converted into carbonic acid, water, and urea. The nitrogenous foods are usually subdivided into albuminoids proper, and substances not albuminoids. All these nitrogenous substances are composed mainly of carbon, hydrogen, oxygen, and nitrogen, and usually also sulphur, in proportions which vary with different substances, but within very narrow limits. For the sake of simplicity, therefore, it will be permissible to take a certain average composition to represent the entire class, and the deductions will apply with sufficient accuracy to the nitrogenous foods as a body. For the sake of easy comparison we may also represent this average composition by a formula which may be considered as representative of the class; e. g., $C_{143}H_{226}N_{38}O_{46}S$. If we now consider this to be oxidized to carbonic acid, water, and urea (and the sulphur to be oxidized to SO_3, as would be the case in the formation of a sulphate), we might represent the process by the following equation:

$$\underset{\text{Albuminoids, etc.}}{C_{143}H_{226}N_{38}O_{46}S} \div 299O = 124CO_2 + 75H_2O + \underset{\text{Urea.}}{19CON_2H_4} + SO_3.$$

This would give 248 volumes CO_2 produced for 299 volumes of oxygen taken up, or a ratio of $\frac{248}{299} = 0{\cdot}83$.

If we consider the fats, and take stearine as a fair example of this class, we should have for such an equation—

$$\underset{\text{Stearine.}}{C_{57}H_{110}O_6} + 163O = 57CO_2 + 55H_2O.$$

or the ratio of volumes of carbonic acid and oxygen would be $\frac{114}{163}$

= 0·70. Other natural fats would give results differing little from this ratio.

The carbohydrates, on the other hand, contain relatively more oxygen than the other classes of foods, and contain hydrogen and oxygen in just such proportions as exist in water. Hence by their oxidation just enough oxygen must be consumed to convert the carbon to carbonic-acid gas, e. g.:

$$C_6H_{10}O_6 + 12O = 6CO_2 + 5H_2O.$$

Glycogen.

$$C_6H_{12}O_6 + 12O = 6C_2O + 5H_2O.$$

Grape-sugar.

The ratio is hence 1 for all this class, since the carbonic acid formed is equal to the volume of the additional oxygen consumed. It follows, then, that the oxidation in the organism of carbohydrates would tend to cause the ratio $\frac{CO_2}{O_2}$ to approach unity. The extensive investigations of Regnault and Reiset on small animals have shown that with carbohydrate food the ratio does approach unity, sometimes almost attaining it, though of course it is impossible to eliminate entirely the decomposition of fats and albuminoids in the organism, and hence the ratio is kept below that figure.

So, also, as we have seen above, the tendency of muscular exertion is to increase this ratio and cause it to approach unity. The evidence, then, seems to point with tolerable conclusiveness to the fact that the *immediate* fuel-material is mainly non-nitrogenous and carbohydrate in its character.* To what extent this supply of carbohydrates is derived from the glycogen of the muscles, to what extent from sugars absorbed from digestion, or produced from the glycogen of the liver, is not yet established with sufficient accuracy, though the participation of the muscle-glycogen is hard to doubt.

We have said the *immediate* fuel-material is apparently carbohydrates, for the possibility still remains that this carbohydrate material may itself be in part derived from albuminoids. It is certain that the liver-glycogen is in great part, possibly entirely, derived from albuminoids. Parke's experiments, above mentioned, showing a continuous elimination of increased quantities of nitrogen in the form of urea

* It will, I think, be evident that the widely entertained theory of Herrmann, regarding the chemical processes taking place during muscular action, is not contradicted by the considerations here advanced. According to this theory, a complex nitrogenous substance of the muscular tissue is decomposed during muscular activity with evolution of carbonic acid, and other non-nitrogenous residues, together with a simpler nitrogenous substance which is supposed again to unite with other (non-nitrogenous) matter to form the original compound, which may be again decomposed during contraction. This still leaves the non-nitrogenous matter the fuel-material, but assumes it to be stored up in the form of a combination with a complex nitrogenous substance which then yields it again in the form of carbonic acid and water. This theory lies too far in the field of speculation for its discussion to come within the scope of the present article.

for days after continued muscular exertion, would be in harmony with such an origin, as they might indicate a gradual replacement of glycogen consumed, at the expense of albuminoid material with elimination of urea as a a waste product. Sugars (grape-sugar and maltose) absorbed from digestion or formed from liver-glycogen, are doubtless consumed in the tissues and organs and assist in producing animal heat. Whether muscular tissue consumes these sugars in greater quantity than other tissues it is difficult to say with certainty.

We come now to the second question as to the nature of this decomposition to which we have alluded as oxidation. This question is still contested. The older theory is that the oxygen, taken up by the blood, is given up in the form of active oxygen, or ozone, and by its energetic oxidizing power burns up or oxidizes the carbon and hydrogen of the fuel-material, with formation of carbonic acid and water.

The newer theory is that the decomposition processes are essentially fermentative in their character; that under the influence of appropriate ferments the substances combine with water, splitting up into simpler and simpler products with evolution of heat or force, as is the case with all fermentative changes. The oxygen present in the arterial blood gives these processes the character of fermentative changes in the presence of oxygen; secondary oxidation takes place, as in putrefaction in presence of air, the final products being mainly carbonic acid and water, as also is the case in putrefactive processes.

Some of the objections raised to the older theory are that we know of no similar changes produced by ozone in watery solutions, such as exist in the animal organism; that the oxygen obtained from the arterial blood under the air-pump contains no ozone. Also certain compounds are found in the blood and tissues which are essentially deoxidized products, which could not be supposed to exist in the presence of ozone, but the presence of which accords with the supposed fermentative character of the processes (Hoppe-Seyler). The fact that the evolution of carbonic acid from the contracting muscle is in great part independent of the presence of oxygen at the time would harmonize also with such a fermentative character of the changes, as carbonic acid is the product of many fermentative changes out of the presence of oxygen, as, for example, of the alcoholic fermentation of sugar. Matteucci's supposed storing up of oxygen in some form of combination in the tissues would then be interpreted rather as the storing up of fermentable substances (like glycogen) rich in oxygen. The combustion theory, on the other hand, would seem to demand that the evolution of carbonic acid and consumption of oxygen should be simultaneous, which is apparently contradicted by the experiments of G. Liebig, Matteucci, and others above mentioned. It would exceed our limits to enter more fully into a discussion of these two opposing theories. The conflict between them is still in progress, and new evidence is constantly accumulating. Both theories agree in this, that the material which by its decomposition produces the force for muscular work is finally decomposed, with evolution mainly of carbonic acid and water. They differ in their views of the nature of the process and the steps by which these ultimate products are obtained.

We have here endeavored to show briefly what has been gained in comparatively recent times by the growth of knowledge in regard to the source of muscular power. Let us attempt a brief summary of the main points brought forward in the preceding discussion: 1. The source of muscular energy is in the chemical decomposition of certain substances, which is accompanied with a release of energy. 2. The muscular contraction produces a greatly increased production of carbonic acid and water, and an increased consumption of oxygen, in the general respiration. To what extent this is due to the mere muscular contraction, to what extent to the influence of muscular exercise on other functions, is difficult to estimate with certainty. 3. The excised muscle, when caused to contract, gives off carbonic acid, and this action is in great part independent of a simultaneous absorption of oxygen. 4. The blood coming from the contracting muscle contains more carbonic acid and less oxygen than that coming from the resting muscle, and less oxygen than that coming to the contracting muscle. 5. The ratio of carbonic acid given off to oxygen taken up is increased by muscular exertion. 6. The nitrogen elimination is but slightly increased during muscular exertion. No considerable amount of nitrogenous muscular tissue is consumed. 7. The *immediate* fuel-material is mainly non-nitrogenous and carbohydrate in its character, probably in part at least derived from the muscle-glycogen, and perhaps from some other substances stored in some manner in the muscular tissue, possibly also to some extent from sugars conveyed to the tissues by the blood. 8. It is not certain to what extent this glycogen or other non-nitrogenous fuel-material is derived from nitrogenous or albuminoid material during rest or repose of the muscles, but such an origin, for a portion at least of the fuel-material, has some evidence in its favor. 9. The nature of the decomposition of this fuel-material is as yet an unsettled matter. The older theory of direct oxidation has been to a great extent replaced by the more modern theory of fermentative decomposition, i. e., splitting up by combination with water into simpler products with an accompanying release of energy, and this process followed by secondary oxidations exerted by the oxygen of the blood. Satisfactory experimental evidence for deciding with respect to these theories as yet fails us.

In conclusion, it is well, however, to recollect that at best the questions touched upon are but secondary to the more fundamental question upon which no investigation has as yet thrown even the most dim and feeble light, viz., "What is muscular force?" It seems impossible to conceive how a collection of cells with thin, elastic walls, and filled with a fluid or semi-fluid mass, can contract in such a way as to manifest the power familiar to us as muscular force. We are here brought face to face with the same difficulties that meet us whenever we attempt to explore the mysterious physics and chemistry of living matter. The attempts which have been made to account for the peculiar selective power of the living cells of the rootlets of plants, to explain the selective action of the gland-cells of the kidneys which act partly according to laws of transudation and diffusion, and partly in opposition to those laws, have given us no satisfaction on those points. And it is the same with regard to the essential functions of other living tissues—all are carried on under the influence of the peculiar and uncomprehended properties of living matter.

We have gained, and are constantly gaining, valuable knowledge as to very many of the processes taking place in the living body, but as to the processes which take place in the truly living cells of gland, muscle, brain, or nerve, we are in almost complete darkness. At the doors of these most refined and mysterious of Nature's laboratories, we must lay down our rude tools and methods, and confess to ourselves that "thus far and no farther" may we hope to press our eager search for truth.

IDIOSYNCRASY.

By Professor GRANT ALLEN

EVERY man is, in the true Greek sense of the term, an idiosyncrasy. He is a *syncrasis*, because he derives all his attributes, physical or mental, from two parents, or four grandparents, or eight great-grandparents, and so forth. But at the same time he is an *idiosyncrasis*, because that particular mixture is eminently unlikely ever to have occurred before, or ever to occur again, even in his own brothers or sisters. That he is and can be at birth nothing more than such a *crasis*, that he can not conceivably contain anything more, on the mental side at least, than was contained in his antecedents, is the thesis which this paper sets out to maintain.

Take a thousand red beans and a thousand white beans; shake them all up in a bag together for five minutes, and then pour them out in a square space on a billiard-table just big enough to contain them in a layer one deep. Each time you do so, your product will be the same in general outline and appearance: it will be a quadrangular figure composed of beans, having throughout the same approximate thickness. But it will be a mixture of red beans and white in a certain order; and the chances against the same order occurring twice will be very great indeed. Make the beans ten thousand of each so as to cover the table ten deep, and the chance of getting the same order twice decreases proportionately. Make them a hundred thousand each, and it becomes infinitesimal. You have practically each time not only a *syncrasis* but an *idio-syncrasis* as well.

Now, a human being is the product of innumerable elements, derived directly from two parents, and indirectly from an infinity of earlier ancestors ; elements not of two orders only, but of infinite orders ; combined together, apparently, not on the principle of both contributing equally to each part, but of a sort of struggle between the two for the mastery in each part. Here, elements derived from the father's side seem to carry the day ; there, again, elements derived from the mother's side gain the victory ; and yonder, once more, a compromise has been arrived at between the two, so that the offspring in that particular part is a mean of his paternal and maternal antecedents. Under such circumstances, absolute equality of result in any two cases is almost inconceivable. It would imply absolute equality of conditions between myriads of jarring and adverse elements, such as we never actually find in nature, and such as we can hardly believe possible under any actual concrete circumstances.

The case of twins comes nearer to such exact equality of conditions than any other with which we are acquainted. Here, the varying health and vigor of the two parents, or the difference between their respective functional activities at two given times, are reduced to a minimum ; and we get in many instances a very close similarity indeed. Yet even among twins, the offspring of the same father and mother, produced at the same moment of time, there are always at least some differences, mental and physical ; while the differences are occasionally very great. A competent observer, who knew the Siamese twins, informed me that differences of disposition were quite marked in their case, where training and after-circumstances could have had little or nothing to do with them, inasmuch as both must have been subjected to all but absolutely identical conditions of life throughout. One was described as taciturn and morose, the other as lively and good-humored. Whether anything of the same sort has been noticed in the pair of negro girls called the Two-headed Nightingale, I do not know, but, to judge from their photographs, there would seem to be some distinct physical diversities in height and feature. We can only account for these diversities in twins generally by supposing that in that intimate intermixture of elements derived from one or other parent, which we have learned from Darwin, Spencer, and Galton, takes place in every impregnation of an ovum, slightly different results have occurred in one case and in the other. To use Darwin's phraseology, some gemmules of the paternal side have here ousted some gemmules of the maternal side, or *vice versa ;* to use Mr. Spencer's (which to my judgment seems preferable), the polarities of one physiological unit have here carried the day over those of another.

But why under such nearly identical conditions should there be such diversity of result? Let us answer the question by another:

Why, with a thousand red and a thousand white balls, shaken together with an equal energy by a machine (if you will), and poured out on our billiard-table, should there be a similar diversity? The fact is, you can not get absolute identity of conditions in any two cases. Imagine yourself mixing two fluids together with a spoon, as regularly as you choose; can you possibly make the currents in the two exactly alike twice running? And here in the case of humanity you have not to deal with simple red beans or with simple fluids, but with very complex gemmules or very complex physiological units.

If even in twins we can not expect perfect similarity, still less can we expect it in mere ordinary brothers and sisters. Here, innumerable minor physiological conditions of either parent may affect the result in infinite ways. Not, indeed, that there is any sufficient reason for supposing passing states of health and so forth directly to impress themselves upon the heredity of the offspring; but one can readily understand that, in a process which is essentially a mixture of elements, small varieties of external circumstances may vastly alter the nature of the result. Shake the bag of beans once, and you get one arrangement; shake it once more, and you get another and very different one. To this extent, and to this extent only, as it seems to me, chance in the true sense enters into the composition of an individuality. The possible elements which may go to make up the mental constitution of any person are (as I shall try to show) strictly limited to all those elements, actual or latent, which exist in the two persons of his parents; but the particular mixture of those elements which will come out in him—the number to be selected and the number to be rejected out of all the possible combinations—will depend upon that minute interaction of small physical causes, working unseen, which we properly designate by the convenient name of chance. In this sense, it is not a chance that William Jones, the son of two English parents, is born an Englishman in physique and mental peculiarities, rather than a Chinese or a negro; nor is it a chance that he is born essentially a compound of his ancestors on the Jones side and on the Brown side, but it is a chance that he is born a boy rather than a girl; and it is a chance that he is born himself rather than his brother John or his brother Thomas. If we knew all, we could point out exactly why this result and not any other result occurred just there and then; but, as we do not know all, we fairly say that the result is in so far a chance one. And, even if we knew all, we should still be justified in using the same language, for it marks a real difference in causation. William Jones is an Englishman and a Jones-Brown strictly in virtue of his being the son of Henry Jones and Mary Brown; but so are all his brothers and (*mutatis mutandis*) his sisters too. He is himself, and not one of his brothers or his sisters, in virtue of certain minute molecular arrangements, occurring between certain elements for the most part essentially identical with the elements which went to make up the other members of his family. To be metaphorical once more, one may say that a Robinson differs from a Jones because he is a mixture of brown peas and white peas; whereas one Jones differs from another in being a particular mixture of red beans and black beans, differently arranged in each case.

Next after the similarity between brothers and sisters or other blood-relations, we may expect to find the similarity between the offspring of the same class in the same community, similarly situated: and this the more so in proportion to the average identity of their several lives. For example, one would naturally expect that our own agricultural laborers, all engaged in much the same sort of work and surrounded by much the same sort of objects, would produce by intermarriage very similar children. Still more would this be the case among very homogeneous savages, such as the Esquimaux or the South American Indians. And where the identity of pursuits is very great on both sides, and in all individuals, as among the Fuegians, the Veddahs, the Andamanese, we should expect to find a great likeness of physique and character between all the offspring.

Conversely, where marriages take place between persons of different races, or very differently situated, we may look for great differences between the offspring, especially when compared with those of marriages between relatively homogeneous persons. Under such circumstances, the children tend more or less, though very irregularly, to present a mean between the two parents. Thus, to take the most obvious instance, the average mulatto is half-way as a rule between the negro and the European, physically at least, though, for various reasons to be considered hereafter, it often happens that he is more than the equal in intelligence of the average white. But even in the same family of mulattoes great differences exist between the children. Some will be darker, others lighter; some will be curlier-headed, others straighter-haired; some will have prognathous faces and depressed noses, others will have more regular features and more prominent noses. So far as my observation goes, too, it does not always happen that the most European physical type has the most European mind: on the contrary, high intelligence often accompanies a very African physique, while English features may be concomitant with a truly negro incapacity for logical reasoning, generalization, or elementary mathematical ideas. It seems as though in each part there was a struggle for supremacy between the two types: and the one type may apparently carry the day in certain external peculiarities, while the other type carries the day in the more intimate arrangements of the nervous system. At the same time, I can not myself doubt that there must be a very intimate connection between every one of the sense-organs and the brain; and I can hardly believe that prognathism and other like physical peculiarities do not imply various correlated nervous facts of great psychological importance. Though, in the resulting compromise between the two diverse heredities, the one seems largely to prevail over the other in certain parts, yet it is difficult to suppose that there is not a minute interrelation between all the parts: and perhaps the significant fact that every mulatto, though darker or lighter, is at least brown, not purely black or purely white, gives us the best key to the true nature of the situation.

So far, I have been tacitly but intentionally taking for granted the very principle which I set out to prove, in order fully to put the reader in possession of the required point of view. The question now arises, Where in this series of events is there room for any fresh element to come in? Can any man ever be anything other than what some of his ancestors have been before him? And, if not, how is progress or mental improvement possible? That men have as a matter of fact risen from a lower to a higher intellectual position is patent. That some races have outstripped other races is equally clear. And that some individual men have surpassed their fellows of the same race and time is also obvious. How are we to account for these facts without admitting that new elements do at sundry times creep in by chance, in the false and unphilosophical sense of the word? How can we get advance unless we admit that exceptional children may be born from time to time with brains of exceptional functional value, wholly uncaused by antecedents in any way?

The answer to this question is really one of the most important in the whole history of mankind. For on the solution of the apparent paradox thus propounded depend two or three most fundamental questions. It is by this means alone that we can account, first, for the existence of great races like the Greeks or the Jews. It is by this means alone that we can account, secondly, for genius in individuals. And it is by this means alone that we can account, thirdly, for the possibility of general progress in the race. It is surprising, therefore, that the question has so little engaged the attention of evolutionary psychologists at the present day.

There are only two conceivable ways in which any increment of brain-power can ever have arisen in any individual. The one is the Darwinian way, by "spontaneous variation"—that is to say, by variations due to minute physical circumstances affecting the individual in the germ. The other is the Spencerian way, by functional increment—that is to say, by the effect of increased use and constant exposure to varying circumstances during conscious life. I venture to think that the first way, if we look it clearly in the face, will be seen to be practically unthinkable: and that we have therefore no alternative but to accept the second. Deeply as I feel the general importance of Darwin's theory of "spontaneous variation" (using the words in the sense in which he always used them), it seems to me that that theory can not properly be applied to the genesis of a nervous system, or of any part of a nervous system, and that in this case we must rather come back to the genesis worked out by Mr. Herbert Spencer in the part of his "Principles of Psychology" entitled "Physical Synthesis."

For let us for a moment try to imagine a nervous system being produced, or increased in value, by natural selection of spontaneous variations alone, without the aid of functional variations at all. It is easy to see that an animal or a plant may vary indefinitely here or there in color, or in hardness of skin, or in woodiness of tissues, and so forth; and it is easy to see that among these truly "accidental" variations* some may be better adapted to their particular environment than others. But can we imagine, say, an eye to be produced by a series of such individual accidents? I do not say a human eye, but a simple pigment cell, with a nerve given off from it to a ganglion as in the case of the *Amphioxus?* And if we can imagine this (which I can not), can we imagine a child being born into the world, gifted, I do not say with innumerable faculties never possessed by his ancestors, but with a single nerve-cell or nerve-fiber more than they possessed? Just let us look at what a palpable absurdity this notion implies.

Here is William Jones's head, containing an average human brain, developed on the same pattern as his father's brain (or as his father's in part and his mother's in part): and here in a particular spot in a particular convolution of it, by a combination of mere physical circumstances, has arisen a totally new and hitherto non-existent nerve-cell. Clearly, this is an acquisition to the race, by way of spontaneous variation. But what is the functional use of this new nerve-cell? What physical circumstance decides whether it is to answer to a new movement in the left little finger, or to a single creative element in the composition of a future fugue? Let us grant a little more: let us suppose the surrounding cells are all concerned in the appreciation of color, or in the manipulation of numbers. Will the new cell in the first case answer to a new and hitherto undiscovered color or to a further æsthetic pleasure in an existent color, or to a higher synthesis into which colors enter as elements; or what in the second case will be its mathematical value? Again, what good will it be without a whole network of connecting fibers which will link it to percipient structures in the eye on the one hand, and to all the various higher layers in the stratified hierarchy of color-thought elements or number-dealing elements on the other hand? Granted that one man in a hundred was born with one such new cell in his brain, and (setting aside the question how the cell comes to have any function at all) what are the

* It is a great pity that to this day one is always obliged to employ this useful term with a caution in the way of quotation-marks, in order to avoid a supposed philosophical scholar's-mate from sixth-form critics. "Accidental" in biology means, of course, "produced by causes lying outside the previous vital history of the race"; in a word, "individual." Among such accidental variations survival of the fittest preserves a few. But it is annoying that one can never use so transparent a phrase without being informed magisterially by a lofty reviewer that the word accidental is unphilosophical, and that nothing ever happens in nature without a cause.

chances that that cell would be so connected with other cells elsewhere as to make any part of an organized brain? Can we imagine a new cell so imported, connected in rational manners with hundreds of other cells, in any other way than by a miracle? Which is only a different form of saying, can we imagine it at all?

But here, again, is something more than William Jones's head; here is, let us say, a great poet's, or a great philosopher's, or a great mathematician's head; and here are the upholders of spontaneous variation asking us to believe, not that one cell within it thus spontaneously varied in the right direction, but that a vast number of cells and fibers all varied simultaneously and symmetrically, so as to produce a harmonious and working whole, capable of giving us Othello, or the Evolution Theory, or the Differential Calculus. Why, the thing is clearly impossible—impossible, that is to say, as a result of "accidental" physical causes. We might just conceivably imagine one or two fibers made to connect one or two hitherto unconnected nerve-cells, though even here the probability that the nerve-cells so connected were of heterogeneous orders would be far greater than the probability that they were of homogeneous orders; we could much more readily imagine such connections resulting in a potentiality for believing that a lobster's tail was a blue hope of raspberry watches than in a potentiality for believing that water was composed of hydrogen and oxygen, or that propositions in A were not convertible. But we certainly can not imagine a whole network of such fibers to spring up by spontaneous variation in a human brain, and yet to produce an organized result. If spontaneous variation ever works in this way, its product must surely be either an idiot or a raving madman. To believe the opposite is too much like believing in Mr. Crosse's electrical *Acari*, which were developed *de novo*, out of inorganic material, in a dirty galvanic battery, and yet possessed all the limbs and organs of degenerate spiders. It is asking us once more to accept a still greater miracle than the first.

But such miracles, it is urged, do take place elsewhere in nature. For example, an almond-tree, let us say, once produced a peach-bearing branch by bud-variation. Hence it has been inferred that the peach is a spontaneous variation on the central almond theme. Yet peaches are in color, fleshiness, sweetness, and perfume, true fruits, adapted to the fruity method of dispersion, by means of attracting birds; whereas the almond is a nut, with the usual nutty peculiarities of green and brown color, dryness, absence of sweet juice, and so forth. In this case, then, it would seem that bud-variation immediately produced a variety adapted to a different environment in ever so many distinct ways. Well, I have introduced this case, just because it illustrates the very impossibility of such a supposition. For it seems pretty clear that if peaches have grown at one act from almonds, then this must really be a case of reversion; the almond must itself be a dried-up form of a still earlier peach; and this will be equally true even if all the existing peaches can be shown to be descended from nut-like almonds. For the almond is a plum by family; and all the other plums have juicy fruits; while one of them, the apricot, closely approaches the almond-peach group in most of its characters. Seeing, then, that the almond must almost certainly be descended from juicy fruit-bearing ancestors, nothing is more natural than that under altered circumstances it should revert, *per saltum*, to a juicy peach. But to suppose that the peach type was originally developed *per saltum* from an almond is to suppose that it varied at once in several separate ways, all equally and correlatively adapted to a particular mode of dispersion. It is to suppose that accident could do in a minute what we have every reason to believe can only be done by infinitesimal variations and infinite selection.

But if the naturalist can not imagine the production of a peach *de novo* out of an almond at a single jump, how can he imagine the production of a new thinking element in a human brain? How can he suppose that the accidental introduction of one more little bit of matter into that vast organized labyrinth—a mighty maze, but not without a very definite and regular plan—can have any kind of intelligible relation to the complicated system of cross-connections and superimposed directive departments which make it up? And if it be objected that the view taken above of the constitution of the brain is wooden and mechanical, I would answer that it is certainly absurdly diagrammatic and inadequate, but that it is so far right in that it insists upon making believers in spontaneous variation try to realize their own unthinkable attitude. As to materialism, surely it is more profoundly materialistic to suppose that mere physical causes, operating on the germ, can determine minute physical and material changes in the brain, which will in turn make the individuality what it is to be, than to suppose that all brains are what they are in virtue of antecedent function. The one creed makes the man depend mainly upon the accidents of molecular physics in a colliding germ-cell and sperm-cell; the other creed makes him depend mainly upon the doings and gains of his ancestors, as modified and altered by himself.

And now let us look at this second creed, in order to see how far it surpasses its rival in comprehensibility, concinnity, and power of explaining all the phenomena. If it be true that all nerve-increment and especially all brain-increment is functionally produced, we can easily understand why each new cell or fiber should stand in its true and due relation to all the rest. It will have been evolved in the course of doing its own work, and it will be necessarily adapted to it because the act of working has brought it into being. There will be no doubt whether the new cell governs the peculiar action of the left little finger in performing that amusing conjuring trick, or is, on the contrary, connected with the perception of orange-red, because the cell was actually differentiated (say out of pre-existing neuroglia, though that is a hypothetical matter of detail) in the very act of performing the trick in question. There will be no doubt whether the new fibers are related to the arithmetical faculty or to the Sanskrit verbs, because they were actually rendered possible as nervous tracks in the act of learning decimal fractions. It is true, we may admit to the utmost the intense complexity of the existing brain, and the vast number of its elements involved in even the simplest muscular adjustment or the simplest visual perception. Nobody feels the necessity for admitting such complexity more fully than myself. One may allow with M. Ribot that every act of thought must be conceived rather as a vast dynamical tremor, affecting a wide plexus of very diverse nerve-elements, than as a single function in a single cell or fiber. One may acknowledge that what one ought really to picture to one's self (at the present stage of human evolution) is not so much the genesis of a new cell for governing the little finger, or of a new fiber for understanding a fact in decimal fractions, as the habituating an immense series of cells and fibers, perhaps in various parts of the brain, to thrill together in unison on the occurrence of a single cue. But let us thus purify and dematerialize our conception as far as we like, we must nevertheless come back at last to the fact that every gain implies a modification in structure, and that this modification in structure, if it is to have any functional meaning and value whatsoever, must be functionally brought about.

That such functional modifications are forever taking place in all of us is a matter of common observation, as evidenced by psychological facts. We are always seeing something which adds to our total stock of memories ; we are always learning and doing something new. The vast majority of these experiences are similar in kind to those already passed through by our ancestors ; they add nothing to the inheritance of the race. To use a familiar phrase in a slightly new and narrower sense, they do not help to build up "forms of thought" ; though they leave physical traces on the individual, they do not so far affect the underlying organization of the brain as to make the development of after-brains somewhat different from previous ones. But there are certain functional activities which do tend so to alter the development of after-brains ; certain novel or sustained activities which apparently result in the production of new correlated brain-elements or brain-connections, hereditarily transmissible as increased potentialities of similar activity in the offspring. If this is not so, then there is no meaning at all in the facts collected by Mr. Galton, or, indeed, for the matter of that, in the common facts of human experience as to hereditary transmission of faculties for acquired pursuits of any sort. If the children of acrobats make the best tumblers, if the descendants of musical families make the best singers and composers, if a great thinker or a great painter is usually produced by the convergence of two lines of thinkers or artists, then the general truth of this principle is abundantly clear.

Supposing such small functionally-produced modifications to be always taking place, it will be obvious that they must take place most in the most differentiated societies, and least in the least differentiated. A race of hunting savages will perform a certain number of routine acts, which will be for the most part the same for all members of the tribe, and will remain pretty much the same from generation to generation. In the particular direction of hunting and fishing, the cleverness at last attained will be very remarkable; but in most other directions there will be little excellence and still less variety. On the other hand, in a tribe which is also made a trading and navigating one by the accident of a maritime position, a new set of activities will be specially cultivated, and will give rise to new functional modifications in a different direction. Suppose some of the tribe, in this latter case, to be mainly inland cultivators and hunters, while others of the tribe are mainly seaboard traders or pirates, then each of these sections will tend to develop certain special hereditary brain-modifications of its own. But if a man of the inland section marries a woman of the maritime section, or *vice versa*, then the offspring will tend to reproduce more or less the structural peculiarities of both parents. And here comes in an important corollary. For though, under such circumstances, the children may none of them fully reproduce all the brain-gains of their father's line, nor all the brain-gains of their mother's line, they will yet on the average reproduce a fair share of the former and a fair share of the latter. Accordingly, they will usually turn out, on the whole, persons of higher general brain-power than either ancestral series; they will partially unite the strong points of both.

It seems to me that this principle is one of very great importance. From it we can deduce the conclusion that in any complex society many children represent directly a convergence of two unlike lines of descent, and indirectly a convergence of innumerable unlike lines, with corresponding gain to the species. Two parents, possessing distinct points of advantage of their own, produce children, some of whom resemble rather the one, and some the other; but many of whom will at least tend to resemble both in their stronger points. Of course, one must allow much for the *idiosyncrasis* as well as for the *crasis*. This child may fall below both its parents in most things; that child may reproduce the weakest elements of both; yonder other child may attain the average or may surpass them in everything. But, on the whole, the principle of convergence seems to imply that in a fairly complex society there will always be an average of mental improvement from generation to generation, due to the constant intercrossing of brains specially improved in particular directions. This improvement will, it need hardly be said, be increased and favored by natural selection; but it will itself form the basis of favorable variations without which natural selection can do nothing. It seems to me easy to understand how survival of the fittest may result in progress, starting from such functionally-produced gains: but impossible to understand how it could result in progress if it had to start from mere accidental structural increments due to spontaneous variation alone.

Thus it becomes clear why certain countries have by mere geographical position necessarily produced certain high types of human intelligence, while in certain other countries the race has never progressed beyond a very low level. There are places like Central Africa, where the physical conditions do not tend to produce any great diversity of occupation; and here the general average of intelligence does not tend to rise high. On the other hand, there are places, like Greece, Italy, the West European peninsulas and islands, where the physical conditions tend to differentiate the population into many groups, agricultural, mercantile, sea-faring, military, naval, and professional; and here the general average of intelligence tends to rise very high indeed. Of course, one must allow much influence to the time-element; for every such increase in differentiation involves yet further increases in the sequel, and brings the social organism, or parts of it, into contact with new environments. The Ægæan is not now of the same importance in this respect as during the days when coasting voyages from island to island were the utmost possible stretch of navigation: the science acquired there has widened the sphere of navigation itself, first to the entire Mediterranean, then to the open Atlantic, finally to all the oceans of the whole earth. But in principle it has always seemed to me (as against the really accidental view advocated by Mr. Bagehot) that the "philosophy of history," the general stream of human development, could be traced throughout to perfectly definite physical causes of this sort. Mr. Bagehot, basing himself on the pure Darwinian theory of spontaneous variations, believed that the differences between races of men were due to mere minute physical sports in their nervous constitution: it appears to me rather that they are due to the action of a definite environment, thus effecting a differentiation of circumstances, and in many cases calling into constant functional activity the highest existing faculties of the various social units in the most diverse ways. We may not thus (though *vide post*) be able to account for the particular character and genius of a Pericles, an Aristotle, a Hannibal, a Cæsar, a Newton, or a Goethe; but we can thus at least account for the general average of intelligence which made Greece, or Carthage, or Rome, or England, or Germany, capable of producing such an individual, as a slight variation on the common type, due to the convergence of separately rich and varied lines of descent. The real illuminating point is this—that such men do arise from time to time among the most intelligent nations, and that they do not arise among the Australian black-fellows, the Digger Indians, or the Andaman-Islanders.

And now, how far can we account on these principles for the existence of the individual genius? Well, here we must begin by clearing the ground of a great initial fallacy. Genius, as a rule, has made quite too much of itself. Having had the field all to itself, it has never been tired of drawing a hard and fast line between itself and mere talent. Nevertheless, from the psychological point of view, nothing is plainer than the fact that genius differs from mere talent only by the very slightest excess of natural gifts in a special direction. True, that small amount of superiority makes all the difference in our judgment of the finished work: we say, this is a great poem, while that is a pretty trifle; this is a grand scientific generalization, while that is a painstaking piece of laboratory analysis; this is a magnificent work of art, while that is a very creditable little bit of landscape-painting. But, in the brain and hands of the performer, what infinitely minute structural modifications must underlie these seemingly vast differences of effect! And even in ourselves, the critics, how minute are the shades of feeling which make us give the palm to the one work and withhold it from the other! How many people are really competent to judge in any way of the differences between this poem and that, between this oratorio and that, between this picture and that? And what is this but to say that the differences are in themselves extremely small and almost elusive?

Now, in a country like Italy, say, where for many ages many men have continually painted pictures of the nymphs and the satyrs, or of the Madonna and of St. Sebastian; where little chapels have studded the land, from age to age, with votive tablets to Venus Genitrix or to Our Lady of the Sea; where countless generations of workmen have decorated the walls of Pompeii or covered the vulgarest ceilings of Florence and Genoa with hasty frescoes—in such a country there is developed among all the people a general high average of artistic execution, utterly impossible in a country like Scotland, where there has hardly ever been any indigenous spontaneous art at all to speak of. And when an Italian man of an artistic family, having inherited from his ancestors certain relatively high artistic endowments, marries an Italian woman of another artistic family, similarly but perhaps somewhat differently endowed, there is at least a possibility, not to say a probability, that their children, or some or one of them, will develop great artistic power. True, we can not follow the minute working of the *crasis*: we can not say why Paolo is an artist of the highest type, while Luigi is merely a fair colorist, and Gianbattista is a respectable copyist of the old masters. But at least we can say that all three are painters after a fashion, in virtue of their common artistic descent; and that Paolo is a great painter because he unites in himself, more than either of the others, the respective merits of the two ancestral lines. After all, we common mortals, if we practiced all our lifetime, could not turn out as good a sketch as Gianbattista's first water-color.

In the same way, in a Greece where every god had his temple, every temple its statue, every house its shrine, and every shrine its little deities—in a Greece where marble was what brick is in London, and where artistic stone-cutters were as common as carpenters here—we can understand why a Phidias was a possible product, and why a Phidias-admiring public was a foregone conclusion. So, too, we can understand why among ourselves so many artists should come from the only real native schools of decorative handicraft—the workshops of Birmingham, Manchester, and London. We can see why musical talent should arise most in Germany and Italy, or among the Jews, or in our own case among the Welsh and in the cathedral towns. We can see why a Watt is not born in the Tyrol; why a Stephenson does not come from Dolgelly; why America produces more Edisons, and Bells, and Morses, and Fultons than she produces Schillers, or Mozarts, or Michael Angelos. The convergences which go to produce a great mechanician are more frequent in countries where mechanics are much practiced than they are in the Western Hebrides or in the British West Indies. The Quakers do not turn out many great generals, and the kings of Dahomey are not likely to beget distinguished philanthropists.

Of course, there are some hard cases to understand—hard for the most part, I believe, because we do not know enough about the various convergent lines which have gone to produce the particular phenomenon. Here and there, a great man seems to spring suddenly and unexpectedly from the dead level of absolute mediocrity. But then, we do not know how much mediocrity in different lines may have gone to make up his complex individuality; and we do not know how much of what seems mediocrity may really have been fairly high talent. So many men are never discovered. Let me take a few slight examples from our own time, which may help to illustrate the slightness of the chances that make all the difference in our superficial judgments; and, if I take them from very recent cases, I think the readers of "Mind" will not misunderstand my object; for it is almost impossible to recover the facts from remoter periods.

Carlyle, in spite of his spleen, was no bad judge of intelligence; and Carlyle thought Erasmus Darwin, the younger, an abler man than his brother Charles, the author of "The Origin of Species." Probably nobody else would agree with Carlyle; people seldom do; but at any rate it is clear that Erasmus Darwin must have been a man very high above the average in intellect, doubtless inheriting the same general tendencies which are inherent in the whole of that distinguished family. Yet, if it had not been for his brother, probably the world at large would never have heard of him. Again, supposing he had had no brother, but had married and had children, all of whom achieved celebrity, we might have inquired in vain whence these children came by their ability. Once more, take Charles Darwin himself. He was nearly if not quite fifty before he published "The Origin of Species." It was a mere chance that with his feeble health he lived on to complete that great work. Suppose he had died at forty, how would he have been remembered? Chiefly as the author of a clever book of scientific travels, and of a monograph on the fossil acorn-barnacles. In a world of such mere accidents as these, who shall say that an apparently negative instance proves anything?

Take another and somewhat different case—the Tennyson family. Here we have three brothers, all with more or less poetical temperament, and all marked by much the same minute peculiarities in cast of thought and turn of expression. Only two, however, I believe, have published or at least have acknowledged their verses; and of these two alone—Alfred Tennyson and Charles Tennyson Turner—has one a right to speak publicly. When the "Poems by Two Brothers" appeared, who could have said which of the two was destined to turn out a great poet? And in the after-event, who can say what little difference of circumstances may have made the one into a clergyman and the other into a professional versifier? If Charles Turner had cultivated his muse as assiduously as the laureate, would he have produced equal results? What little twist set the one, with Tennysonian love of form carried to the length of a passion, upon the writing of exquisite sonnets alone, while it set the other upon "In Memoriam," and "Maud," and "The Princess," and the "Morte d'Arthur"? What little extra encouragement on the part of a reviewer may have impelled the more successful poet to fresh efforts; what professional distractions or religious scruples may have held back the less illustrious parson? And yet, who can read Charles Tennyson Turner's sonnets without feeling that though the *idiosyncrasis* is not exactly the same, the *crasis* itself is at bottom identical? Compare the sonnets with the work of any one among the imitators—the men who "all can raise the flower now, for all have got the seed," and what a difference! The imitator is all servile copyism in form, with no real underlying identity of matter; the brother is only half a Tennyson in mere externals, but is still own brother in the most intimate turns of thought and feeling.

After such cases as these, do we need any explanation of the sudden apparition of a Carlyle, a Burns, a Shakespeare, a Dickens, from out the ranks of the people themselves? To me it seems not. Are there not pithiness and sternness and ability enough in the Lowland peasantry to account for the occasional production, out of thousands of casts at the dice, of such a convergence as that which gave us the old man at Ecclefechan who "had sic names for things and bodies," and his two able sons, of whom the more strangely compounded was Thomas Carlyle? Is there not in another type of Scotch peasant enough of pathos and literary power and *bonhomie* to account for an occasional convergence which will give us either the old popular-song-writers, or Burns himself, or on a slightly lower level such a woman as Janet Hamilton? Again, the case of Dickens looks at first sight somewhat more difficult; but then one may remember that, as far as general mental power went, Dickens was nowhere. He was a pure artist in a special and very restricted line; he possessed a peculiar faculty for describing queer and original people in a queer and original way. Doubtless this faculty was in him so fully developed that it rose to the rank of genius in its own line; but the line was by no means an exalted one. In such a case, who can say what quaint little combinations of ordinary elements went to make up the power that amused and delighted us so much? Are there not thousands of people in our midst who possess just the same faculty in a less degree—people who, without depth or brilliancy in other respects, can raise a laugh, by their clever caricatures of the habits and conversation of their friends? Throw in the merest side-twist of comical exaggeration and a grain of plot-forming capacity into such a *raconteur*, and you get the framework for the genius of Dickens. Of genius of that sort, indeed, more than of any other, one may fairly say that it differs only by a hair's breadth from humorous mediocrity. It is otherwise, I believe, with really deep philosophical or scientific power. Grasp, insight, luminousness, breadth; the capacity for dealing with the abstract ideas of mathematics, of logic, of metaphysics; the power of seeing or formulating great generalizations—these things, if I read the lives of thinkers aright, come only from a convergence of able and powerful stocks. It takes three generations, they say, to make a gentleman; surely it takes many generations of trained intelligence on both sides to make a philosopher.

At the same time, it must be remembered that a convergence even of two mediocre strains may produce comparatively high results, provided the endowments of the two strains be complementary or supplementary to one another. To this cause may perhaps be attributed the general high level of intelligence displayed by half-breeds—even half-breeds with a lower race. I have already alluded to the intellectual superiority of mulattoes, a large proportion of whom appear to me (and to some other observers) considerably above the average of either Europeans or negroes. And this is not surprising when we recollect that the negro brain, though relatively inferior, must almost necessarily be highly cultivated in some particular directions, where the European brain is comparatively deficient. If, then, a mulatto child inherits in fair degrees the quick perceptive faculties and intuitions of his mother, and the higher reasoning faculties and forethought of his father, he is likely on the average to be better equipped in inherited potentialities than either.* Similarly, one may take it for granted

* Darwin has somewhere noted that half-breeds with lower races appear to be on the whole often morally inferior to either parent race; and he has suggested that this inferiority

that each great European nationality has some strong points not equally shared by the others; and it is a trite observation that intermarriages between members of such nationalities tend to produce an unusually high level of general intelligence. In Ireland, the mixed French families, sprung from intermarriages with refugees, have long been noticed in this respect; at Norwich and throughout the eastern counties, the mixed descendants of the Huguenots (such as the Martineaus and others) have been equally distinguished. Perhaps one might even point out an exceptional amount of intellectual power in the more mixed Celtic and Teutonic regions of Britain—the borderlands of the two races—notably at Aberdeen and in Devonshire. But the most remarkable and least dubious instance is that of the mixed offspring of Jews and Christians. Here we start with a pure race of unusual intellectual vigor and power, the Jews long thrown by circumstances into an environment which has brought out many of their faculties in a very high degree. They are the oldest civilized race now remaining on the earth; they are artistic, musical, literary, exceptionally philosophic, and hereditarily cultivated. Even by marriage among themselves they naturally produce a very large proportion of remarkable men. But when they marry out with Christian women—in other words, with women of the European race—the special Aryan traits seem to blend with the Semitic in a very notable and powerful mixture. I have not space to give illustrations, but the list that can be compiled of distinguished persons of half-Jewish blood is something simply extraordinary, especially when one remembers the comparatively small sum-total of such intermarriages. Indeed, the difficulty would probably be to find a single person of mixed Jewish race who was not at least above the average in intellect and in plasticity of thought.

Finally, it seems to me that unless we accept the view here contended for, that all increments of brain-power are functionally produced, the whole history of human development ought to present the appearance of a continuous chaos. Granted this principle, we can understand why a Phidias appeared in Greece, a Raffaelle in Italy, a Watt in Britain; without it, we can not understand why they should not all have appeared in Iceland or in New Guinea just as well. If mere physical circumstances affecting germs and sperm-cells can pro-

may be due to reversion to an earlier and still more savage type of humanity. Without expressing any opinion on the question of fact (a delicate one to decide), I fancy another explanation fits more simply: namely, that as morals are a comparatively recent and unstable acquisition even in the best and highest, they do not crop up in the half-breed; and the union of relatively high European intelligence with relatively low savage ethics may easily produce what seems at least to be a very brutal and diabolical nature. Surely there can be nothing worse in any savage than such abnormal products of our own civilization as Peace the murderer, or as the man Thomasson who attempted to blow up an Atlantic steamer by a piece of dynamite clock-work for the sake of obtaining the insurance.

duce miraculous and really uncaused new developments of structure and function—can make a genius spring from nobodies, and a philosopher grow at one leap out of two common strains, of the earth, earthy—then we can see no reason why there should not be great families, great epochs, great outbursts in any one place as well as another. But if all increments are functionally acquired, then we can understand why this environment produces races of sculptors, that environment races of poets, yonder environment races of traders, or thinkers, or soldiers, or mechanicians. The first hypothesis is one that throws no light at all upon any of the facts; the second hypothesis is one that explains them all with transparent lucidity.—*Mind.*

ÉTIENNE GEOFFROY SAINT-HILAIRE.

THE name of ÉTIENNE GEOFFROY SAINT-HILAIRE is most intimately associated with the establishment of the doctrine of the unity of the organic plan of the animal kingdom. This great naturalist was born at Étampes, France, April 15, 1772, and died in Paris, June 9, 1844. He came of an honorable family, of only a moderate fortune, another branch of which had given three members to the Academy of Sciences. His father, Jean Gérard Geoffroy, an attorney and magistrate, designed him for the ecclesiastical profession. So, after having taken his primary studies at home, he obtained a bursarship in the college of Navarre, and, about 1788, a canonry and a benefice at Étampes. Everything thus promised well for his ecclesiastical advancement; but he felt drawn toward the natural sciences by an irresistible taste, which the experimental lessons in physics of Brisson had contributed to develop. On leaving the college, he asked permission of his father to remain in Paris, to attend the courses of the *Collège de France* and the *Jardin des Plantes.* The father consented, and toward the end of 1790 the young man became a bachelor-in-law. He went no further in this profession, but sought in medicine a calling more congenial to his tastes, without remaining faithful to that. He entered the college of Cardinal-Lemoine as a *pensionnaire*, where he attracted the notice of Lhomond and Haüy, who were teaching there. Daubenton, whose lectures in the *Jardin des Plantes* he was attending, remarked him among his pupils, invited him to his house, charged him with commissions relative to the lectures, and intrusted to him the determination of some of the objects in the collections of the *Jardin.*

The French Revolution was now (1792) raging furiously, and all the professors in the college were arrested on the 13th of August for the crime of being priests. Haüy was released on the next day, through the most active exertions of Geoffroy, and Lhomond was delivered by one of his former pupils. The other priests were detained in the prison of Saint-Firmin, near Geoffroy's residence; and he, on the 2d of September, getting access to the prison under a disguise, signified to them that he intended to help them escape. "No," said the Abbé de Keranran, "we will not leave our brethren, for that would only make their destruction more certain." Geoffroy, however, got a ladder, and took it after nightfall to the corner of the prison-wall which he had designated, and waited for eight hours before the first priest appeared. One of the prisoners hurt his foot in jumping, and our hero carried him in his arms to a neighboring yard. Twelve of the priests had been rescued, when one of the guards fired a gun, the shot from which went through Geoffroy's clothes, and aroused him to the fact, which he had not noticed, that the sun had risen. He then returned home; but, though he had arranged to meet the priests afterward, he was not destined to see them again; and, when he went to the appointed rendezvous, he found himself alone. Exhausted by his efforts, Geoffroy hurried home to Étampes, where he fell dangerously ill, but was brought back to health under the salubrious influence of the fresh country air. Haüy's letters to him at this time attest the affection which existed between the master and his pupil. In one of them the great mineralogist wrote (October 6, 1792): "Your letter reached me just as I was going out to dinner; it was like a delicate dessert, of which I immediately gave a part to M. Lhomond; we were never so happy at the table except when you were really with us"—and then he advises Geoffroy to suspend for a while, for the sake of the restoration of his health, the hard study of crystallography, and attach himself to plants, "which present themselves under a more graceful mien and speak a more intelligible language. A course in botany is all pure hygiene." Geoffroy resumed his studies in Paris in November, and in March following, at the request of Daubenton and on the nomination of Bernardin de Saint-Pierre, he was appointed sub-keeper and assistant demonstrator in the Natural History cabinet of the *Jardin des Plantes*. On the reorganization of the *Jardin des Plantes* as the Museum of Natural History, in June, 1793, he was named to the chair of Zoölogy of Vertebrated Animals. He hesitated to accept the position because his studies had been in mineralogy, but Daubenton persuaded him to do so. Immediately after his installation, he began the foundation of the menagerie of the *Jardin des Plantes*, beginning with three itinerant collections of animals that had been confiscated by the police and taken to the museum. Of what he accomplished in this department he has written: "When I began to direct my studies to the natural history of animals, that science had not been encouraged at Paris. It had never been made a branch of instruction, and I did not expect that I should shortly be made the first one to treat it in a public course. Established in the year II (1793–94) as Professor of the Natural History of Mammalia and Birds, I became also an administrator in the museums of the collections of these classes. There were then only a few quadrupeds in the national collection. My duty was to try to increase the number. I entered into correspondence with the principal naturalists, I was powerfully seconded by their zeal, and the collection of viviparous quadrupeds or mammals is now the richest of that class in existence. I have likewise greatly enriched the collection of birds. Finally, I have made the collections useful to young naturalists by making rigorous determinations of the animals intrusted to my administration."

The course was opened in May, 1794, and in the following December Geoffroy read to the Society of Natural History an essay on the aye-aye, in the introduction to which, criticising the views of Bonnet on the scale of beings, he attacked a theory that was but slightly different from the one which he himself afterward adopted.

In 1795 the Abbé Tessier had found in Normandy a youth who was strongly interested in natural history, and gave an account of him to Geoffroy, to which the young man added a communication describing some of his researches. Geoffroy wrote back to the youth: "Come to Paris without delay; come, assume the place of another Linnæus, and become another founder of natural history." The youth came, and thus was opened the career of the illustrious Georges Cuvier. He and Geoffroy became fast friends, and together composed five memoirs, of which one, on the classification of mammalia, contained the theory of the subordination of characters, fundamental to Cuvier's system. In a memoir on the Makis, or Madagascar monkeys, published a year afterward by Geoffroy alone, appears the principle of unity of composition, to which the author afterward related all comparative anatomy. The minds of the two friends had already begun to diverge toward opposite systems.

In 1798 Cuvier and Geoffroy Saint-Hilaire were invited to accompany Bonaparte on his expedition to Egypt. Cuvier declined, Geoffroy went. There he was one of the members of the scientific commission that explored the Delta, and of the Commission of Seven for the organization of the Institute of Egypt, which distinguished itself by its archæological labors. He made in succession journeys through the Delta, to Upper Egypt, and to the Red Sea. After his return from the Cataracts, at the end of 1799, he established himself at Suez, and began a collection of the fishes of the Red Sea.

On the evacuation of Egypt by the French, the scientific party were confined to Alexandria, where, amid all the perils of the siege, Geoffroy continued his scientific investigations and his examinations of the electrical fishes of the Nile. When the city was given up, no reservation was made of the collections, but Geoffroy managed to save them. General Hutchinson demanded a strict execution of the terms of surrender, and sent Hamilton to enforce them upon Geoffroy's treasures. "No," said Geoffroy, "we shall not obey the orders; your army can not get in here for two days: we will take that time to burn our cabinets, and then you can do with our persons as you please. Yes," he added, to the astonished officer, "we shall do it. You are seeking for fame. Depend upon it, history will give it to you, for you also will have burned an Alexandrian library." These bold words were reported to Hutchinson, and he rescinded the order for seizing the collections.

Returning to France in 1802 with the magnificent zoölogical and zoötomical collections thus literally saved from the fire, Geoffroy proceeded to classify them and prepare the description of them for the grand work on the expedition to Egypt, and began the series of monographs that served as the point of departure and as supports for his system of natural philosophy. He was already outlining his theory of unity of composition, in memoirs which, aside from novelty and elevation of ideas, contained, according to Cuvier, "facts very curious and generally new, and added much to the knowledge of naturalists and anatomists on the interior organization of fishes." These memoirs secured the author's admission to the Academy of Sciences in September, 1807.

In 1808 Geoffroy Saint-Hilaire was charged with a scientific mission to Portugal, then occupied by a French army under Junot. He was exposed to many perils in passing through Spain, where the people were restive against the French invasion, and was held a prisoner for several months at Merida. He used his influence with Junot, an old comrade of his in Egypt, to make the condition of the Portuguese more easy under military rule, and took away from the country many cases of mineralogical specimens, plants, and animals, including Brazilian ones, but in turn enriched the museum at Lisbon with a valuable cabinet of minerals from Paris, and set in order the collections there, which had hitherto been only the object of an unintelligent curiosity; and, by his tact and reputation for a general benevolent disposition, he managed to keep what he had acquired from Portugal when the French were obliged to give up everything else they had taken from foreign nations.

In 1809 Geoffroy was appointed Professor of Zoölogy in the Faculty of Sciences at Paris, and toward the end of the year he began a course of instruction which was destined to have a great influence upon his hearers and on himself. "From this moment," says M. Dumas, "his thought, sustained by the respectful attention of distinguished pupils, and particularly by their philosophical studies, sprang more freely into the fields of abstraction, and succeeded in fixing those laws of organization to which his name will continue to be always attached, and which he had long perceived. Till then anatomical philosophy, as he conceived it, had no existence; it was with us and for us that he founded that doctrine, endeavoring every year to overcome new difficulties, fortifying his convictions with new proofs, and confirming himself in his views by their success, even while they were yet new." Sickness in 1812, and the disasters of the country in 1813–'14, interrupted his scientific work. In 1815 he was chosen a representative by the electors of Étampes, and performed the functions of his office with credit, till the Restoration put an end to them. Restored to science, he expounded his system in a work entitled "Philosophie Anatomique" ("Anatomical Philosophy"), the first volume of which, treating of the respiratory organs and skeletons of vertebrates, appeared in 1818. The second volume, devoted to researches on human monstrosities, was published in 1822. The dominant feature of these two volumes was the principle of unity of composition. This principle was not entirely new to science. It had been glanced at by Aristotle, Pierre Belon, Newton, Buffon, and Vicq-d'Azyr; but it remained for Geoffroy Saint-Hilaire to create a theory embodying the views which they had only mentioned sporadically.

Previous to him, naturalists, giving more particular attention to human anatomy, recognizing only forms, and regarding each new form as a new organ, had multiplied details infinitely without discovering any general law. "The first step toward rising to the ideal type of a vertebrate animal," says M. Flourens, in his eulogy before the Academy, "was to get free from every preconception in favor of human anatomy, as the only means of being able to regard the organs under their more general conditions, aside from the merely relative considerations of form, volume, and use." Geoffroy was convinced that identities can bear only upon relations, and had in this rule, which he called the *principle of connections*, an infallible guide through all metamorphoses, capable of unmasking the most strangely disguised affinities. Thus, whenever two parts agreed in having similar relations and dependencies, they were analogous. With this precept, Geoffroy was able to declare that the materials found in one family exist in all the others, and to proclaim his law of unity as a law of nature. In his second volume he extended the application of his principle to the formations called monstrosities, which he declared were not original anomalies, but simply cases of abnormal or of incomplete development of some particular part.

As long as the principle of unity was applied simply to vertebrates it was incontestable, and excited no contradiction; but when Geoffroy Saint-Hilaire began to extend it to invertebrates he encountered a vigorous adversary in Cuvier, whose work it had been to emphasize the distinctions between the groups which his former patron was trying to reduce to unity. When Geoffroy, in 1820, brought the articulates under his general type, Cuvier uttered words of impatience and disapproval; but, when in 1830 he proposed to include the mollusks, the long latent contention broke out. "Never," says M. Flourens, "did a more vital controversy divide adversaries more resolute, more firm, or who had by long preparation provided themselves with more resources for the combat, and (if I may say it) more learnedly prepared not to agree."

The division spread and extended to all countries where any thought was given to the subjects under debate. Geoffroy was highly applauded by Goethe, who declared the discussion a very important one for science, and made it the subject of the last lines he ever wrote. The controversy was resumed in 1832, and terminated only with the death of Cuvier. Geoffroy sometimes appeared overcome by the ability and brilliancy of his antagonist, but he never gave up, and time has rendered its verdict that, on the essential points, he was not in the wrong.

The Revolution of July occurred in the midst of the discussions in the Academy, and Geoffroy, who sympathized with the popular movement, again distinguished himself, as he had done in the previous Revolution, by an act of hospitality to the clergy, in giving shelter to the Archbishop of Paris, who was in danger of violence.

When Cuvier died, every one hastened to sound the praises of the genius of the great anatomist. Geoffroy ventured upon a criticism of his views on fossil remains and regarding the revolutions of the globe, and was accused of attacking the fame of his late antagonist. Deeply wounded at so unjust an imputation, he gave up the work that had provoked it, saying: "It would perhaps be best to have courage or wisdom enough to pay no attention to such objections. But the question now concerns one of the glories of France, the first zoölogist of our age. It is for posterity, if it deigns to concern itself with the strifes of this period, to do justice to my adversaries and myself." He was stricken with blindness in July, 1840, and with paralysis a few months afterward. He endured the infirmities of old age with great resignation, and preserved to the last the serenity of a good man and a great mind—or, as Edgar Quinet remarks of him, "he approached unveiled truth with a cheerful face, and descended without fear into eternal knowledge."

The list of the works of Geoffroy Saint-Hilaire would be a very full one if all were included. Besides the larger works which he composed, or in the composition of which he was associated, the catalogue of the principal only of the papers he presented to learned societies occupies a full page in the "Biographie Générale." His most important publications are the "Philosophie Anatomique" (2 vols., 1818–1820), which contains the exposition of his theory; "Principles de la Philosophie Zoölogique" ("Principles of Zoölogical Philosophy," 1830), which gives a synopsis of his discussions with Cuvier; "Études Progressives d'un Naturalist" ("Progressive Studies of a Naturalist," 1835); "Notions de Philosophie Naturelle" ("Ideas of Natural Philosophy," 1835); and, in conjunction with Frédéric Cuvier, "Histoire Naturel des Mammifères," ("Natural History of Mammals," 3 vols., 1820–1842). Among the best works about him are the "Life," by his son Isidore; the "Eulogy," by M. Flourens; and a sketch in the appendix to De Quatrefages's "Rambles of a Naturalist."

CORRESPONDENCE.

SCIENCE IN CLASSICAL SCHOOLS.

Messrs. Editors:

PROFESSOR COOKE, in his remarks on "The Greek Question," does injustice to the best classical schools in express terms, and his statements ought not to pass unchallenged. Classical culture as preparatory for any of the "learned" professions, literary or scientific, needs no defense. But Professor Cooke, if he knew the facts, should not have held up foreign universities as wholly successful in the change he proposes. He should not have said that "among others the University of Berlin, which stands in the very front rank, has already conceded, to what we may call the new culture, all that can reasonably be asked." Is it not true that these concessions were made against the unanimous protest of all the faculties; that, after earnest comparison of the progress of scholars from the Realschulen and the Gymnasia, the scientific professors are unanimous in their demand that classical training shall be restored even for those intending to enter scientific professions?

Professor Cooke, mentioning by name certain well-known classical schools, tells us that "the attempt to introduce some science requisitions into the admission examinations has been an utter failure"; that "the science requisitions have been simply crammed, and the result has been worse than useless"; that "it has, in most cases, given a distaste for the whole subject"; that "true science-teaching is utterly foreign to all their methods"; that "the small amount of study of natural science which we have forced upon them has proved to be a wretched failure, and the sooner this hindrance is got out of their way the better"; that it is hopeless to look for any change in the classical schools. These are heavy charges, if true; but do they represent the facts?

Harvard College was among the first to shake off old methods, and to introduce a system of examinations which should distinguish between those applicants who had been crammed and those who had been taught. Her professors have showed themselves able to set papers in all branches, which proved those admitted worthy to join her classes. Professor Cooke would probably not admit that his colleagues in the scientific departments have been behind their classical associates in this respect. What, then, has been the record of the Roxbury Latin School in the six years that boys have been presented in Physics? Though every boy has been allowed to try the examinations in Physics, even if we judged him deficient, only two have been rejected out of above eighty presented. In one year, out of fifteen boys presented, sixteen honors were taken in subjects purely scientific, viz., seven in Prescribed Mathematics, two in Prescribed Physics, one in Prescribed and Elective Physics, and six in French.

It is certain that many of those eighty boys have not been crammed, and that few of them have gained "a distaste for the whole subject." For, though the time for the subject has been limited, and the apparatus meager, I have seen them eagerly making apparatus to illustrate their lessons, and discussing, at every opportunity, disputed points. In one instance three boys worked for weeks on a machine to prove their teacher in the wrong, while nearly the whole class enthusiastically supported their mates with sincere but mistaken conviction.

Perhaps one ought to speak modestly about true science-teaching being foreign to all his methods, but I will say that the trustees, taking advantage of a slight change made necessary by the rejection of Arnott as a standard of preparation, and of a fine addition to our building, have fitted up a working laboratory for our physics, and have furnished suitable apparatus. Then every boy of my present class, aided only by a paper giving directions for manipulation, is performing every experiment for himself, is putting his questions to Nature, recording and interpreting the phenomena observed.

We do not regard the study of science as forced upon us. For years before any science was required a good portion of two years was given, and still is given, to the study of botany, though our boys are not presented in that subject. And the authorities of this school are so thoroughly in sympathy with the advancement of science that, whether physics shall be required by Harvard or not, more and not less time is likely to be given to its study in the future.

With centuries of testimony for the "old classical culture," testimony unshaken by repeated assaults, of course the social prestige of our classical schools and universities holds its own. Of course, parents wish their sons fitted for and trained by classical colleges. Of course, "nine, at least, out of every ten, offer maximums in classics," and continue as they have begun.

But, when Harvard is ready to remove Greek from the list of prescribed subjects, I believe that many classical schools will be found liberal enough to give pupils every opportunity to replace its study with German, mathematics, and science, taught by men both competent and sincere.

George F. Forbes,
Master in Roxbury Latin School.

Roxbury, Mass., *November* 14, 1883.

THE HOME-MADE TELESCOPE.

Messrs. Editors:

While reading the very useful article in the November issue of the "Monthly," by Dr. George Pyburn, on "A Home-made Telescope," it occurred to me that my own experience in that direction, not covered by Dr. Pyburn's article, might prove acceptable to some of your readers. In constructing my telescope I made the tube of paper and paste substantially as described by Dr. Pyburn, finishing with shellac-varnish as a protection against moisture. The three-inch object-glass cost about twenty-five dollars, which is nearly the total outlay for the instrument, as I use for eye-pieces those belonging to my microscope. As these range from a two-inch to a four-inch, I get a fair astronomical telescope with powers from twenty-five to two hundred diameters, affording satisfactory views of the more interesting celestial objects. For viewing the sun, a light box open on one side is attached to the tube, containing a sheet of white paper on which the image of the sun is received at a distance of nine or ten inches from the eye-piece. The stand is unskillfully constructed of wood, but, as the instrument is supported at two points, it is steady. It is of convenient height for an observer in a sitting posture, the object-end of the telescope being made to swing. When in use the telescope is strapped in a kind of long trough made by nailing two strips of boards together. This support is bolted at the end next the observer to an axle having a vertical motion. It has a horizontal motion on the bolt. The end of the support toward the object is given a vertical motion from horizontal to perpendicular by a lever running through a mortice in the stand, and working on a pin in the mortice. A rod jointed on the lower end of the lever is always in reach of the observer with which to manipulate it. The top of the lever is fitted with a long horizontal roller, on which a roller placed under the telescope-support rests at right angles. The rollers crossing each other at right angles, smooth and steady motion is had both vertically and horizontally. Such a stand may be made in a day.

George W. Morehouse.

Wayland, New York, *October* 29, 1883.

INSECTS AS CARRIERS OF DISEASE.

Messrs. Editors:

Although not prepared to accept entirely the theory so ably presented by Dr. King, in the September number of your magazine, as to the mosquital *origin* of malaria, I believe in the power of insects to transmit and disseminate infectious diseases. The active agency of mosquitoes and other insects in the spread of yellow fever has never been fully appreciated, and it is to be hoped that the attention of the boards of health in the localities liable to this terrible scourge will be directed to this source of danger, and that they will establish cordons of fires as well as men around infected districts. However, my object in writing this is merely to add further testimony as to the fact of insects carrying disease.

The interior counties of the Southern States are infested by a minute fly, a little larger than the sand-fly of the coast, but without the sting of the latter. They are called gnats or black gnats, and are exceedingly troublesome, from their habit of flying into the ears and eyes of both men and animals. They also gather upon any running sore or abrasion of the skin, and, though they do not bite or sting, they are very irritating. When they get into the eye they cause a very sharp pain, and, though immediately killed by the secretions, the eye feels the effects for some hours after. It has been observed that during the seasons when these gnats are most plentiful the disease known as sore-eyes is most common and severe.

Not being a physician, I do not know the name of the disease, but it is very contagious, and usually affects an entire family when once introduced into it. The lids of the eye become irritated and swollen, and the entire ball is red and inflamed. Some persons have lost the sight of one or both eyes from it, and its effects are felt for months after recovery. The intimate relation existing between this disease and the gnats is so well recognized that the negroes say it is caused by the gnats laying their eggs in the eye. This, of course, is improbable, but points clearly to them as the real cause in some way. I do not think the irritation arising from their getting into the eye is the origin of the trouble, because the disease does not always or even generally follow as a matter of course; but I do think that the germs are carried upon the legs or wings of the gnats, and that, when one so charged touches or gets into the eye, the germ or bacteria is deposited, and from that the disease is developed.

Of course, there are other ways of transmitting the disease, but the most active agent is undoubtedly the gnat, since after it disappears the disease ceases to spread, and gradually loses its character as an epidemic. If through your published articles intelligent observation is directed toward the dangers inherent in our insect pests, and means are discovered to avert them, you will deserve the undying gratitude of suffering humanity.

Respectfully, A. G. BOARDMAN.

MACON, GEORGIA, *September* 22, 1883.

TIDAL ANOMALIES.

Messrs. Editors:

PROFESSOR R. W. MCFARLAND ("Popular Science Monthly," volume xii, page 106), after demonstrating, as a result of Professor Schneider's theory, a great inequality in the daily range of the tides, confidently asks, "Do your New York tides play such tricks?"

However it may be with the New York tides I will not undertake to say, but there are numerous localities upon the globe where the tides do play such or at least similar "tricks," seemingly at variance with established theories, and in some places these "tricks" appear to be contrary to all our preconceived notions of hydrodynamics. Thus, at the entrances of the various United States ports in the Gulf of Mexico, the tides either exhibit a great inequality in their daily range, or but one flood and ebb tide occurs in the course of the twenty-five hours usually occupied by the two tides. The one-tide phenomenon is again met with among the Philippine Islands; while tides exhibiting considerable daily inequality in their range are met with in numerous other places.

That part of the St. George's Channel called the Irish Sea included between the fifty-third and fifty-fifth parallel of latitude contains a body of water covering an area of about ten thousand square miles, inclosed on all sides, except at the two entrances, north and south of Ireland. Throughout this entire body of water the time of high water is nearly simultaneous, the difference nowhere exceeding an hour. Here the average mean range of the tides is not less, probably, than twenty feet. The water to supply and exhaust this broad area of unusually large range of tides has to pass in and out at the two entrances simultaneously with the rise and fall of the water in the Irish Sea.

Now, the puzzling thing about these tides is, owing to the time of high water at the two entrances being about five hours earlier than in the Irish Sea, at least two thirds of all this water passing in and out of the St. George's Channel has the appearance of running from a lower to a higher level. Here the tides exhibit another curious freak in the distribution of their range. On the east coast of Ireland, between Wexford and Wicklow Head, for some distance there are no rise and fall to the tides; while directly on the opposite side of the channel, on the coast of Wales, the mean range is not less than fifteen feet.

But this anomaly of the water apparently running up-hill, as exhibited by the tides, will be found more clearly marked at the Strait of Gibraltar, where the motion of the tidal wave is easterly, and the easterly tidal stream begins at high water, and the westerly tidal stream begins at low water. The same phenomenon is met with again at the Strait of San Bernardino, Philippine Islands, and also on our own coast, in Martha's Vineyard Sound, where the motion of the tidal wave is westerly, and the westerly tidal stream begins at high water. At Cook's Strait, New Zealand, the motion of the tidal wave is westerly, and the westerly stream begins at half flood.

These are only a few of the more clearly marked of the many anomalies that have come under my observation while endeavoring, as a navigator, to make myself acquainted with the concrete phenomena of the tides.

In the absence of a better explanation of these anomalies, I offer the following hypothesis: *That the established theory of the tides is substantially correct; but, that the primary tidal wave is in the liquid portion of the earth beneath the solid (though to a greater or less extent flexible) crust; and that the tidal phenomenon as it reveals itself to us is a secondary tidal, undulatory motion, deriving its impulse from, and is complicated by, the variable flexibility of the solid crust between the two liquid portions of the earth.*

GEORGE W. GRIM (Bark Coryphene).

YOKOHAMA, JAPAN.

ELEPHANTS' TRICKS.

Messrs. Editors:

THE following extract from an old edition of the "Arabian Nights" (Edinburgh, 1772), may be of interest, showing as it does that at an early date elephants were trained to perform tricks which excite the curiosity if not the wonder of the spectators in the modern shows. It is from the story of "Prince Ahmed and the Fairy Pari-Banou":

"But what the Prince Houssain most of all admired was the ingenious address and invention of some Indians, to make a large elephant stand with his four feet on a post which was fixed into the earth, and stood out of it above two feet, and beat time with his trunk to the music. Beside this there was another elephant as big as this and no less surprising; which being set upon a board which was laid across a strong rail about ten feet high, with a great weight at the other end which balanced him, kept time by the motions of his body and trunk as well as the other elephant, and both in the presence of the king and his whole court."

When this story was written I do not know, as this edition gives no notes as to the original sources of the stories.

Respectfully, DAVIS L. JAMES.

CINCINNATI, *October* 6, 1883.

EDITOR'S TABLE.

"CHURCH-AND-STATE" FUNCTION OF DEAD LANGUAGES.

THE partisans of classical studies had a Godsend a couple of years ago, in the shape of a report emanating from the professors of the University of Berlin, and corroborated by the action of other universities, which it was claimed ended the controversy on the question of modern against classical studies. It was represented that the Germans had tried out the issue in the fairest way, and on an extensive scale. They had two systems of schools which prepared young men for the universities—one the gymnasiums, devoted mainly to classical studies; and the other the real schools, modern in origin, and devoted chiefly to modern and scientific studies: and it was said that, after an ample trial of the two modes of mental preparation, the unanimous verdict of the faculty, including the scientific professors, was in favor of the classical preparation as superior to the scientific preparation of the young men. The statement as it appeared was very telling. The New York "Evening Post" gave an account of the report soon after its appearance, and said: "It will hardly fail to be regarded as the most powerful plea ever made in behalf of classical studies," and Mr. Charles Francis Adams, Jr., has been reproached from all the classical quarters for venturing to open his mouth in criticism of our dead-language studies after the German universities had given to the world their conclusive judgment upon the question.

We confess to having had no little distrust of the case as it was thus presented. It was sufficiently obvious at the time that we were not in possession of all the facts necessary to form an intelligent opinion on its merits. We know enough of the spirit and tactics of the classical party, in this country and in England, to justify some suspicion of the impartiality of their proceedings in Germany, and we accordingly deferred any discussion of the Berlin report until more information should become available for the purpose. Many questions arose of decisive significance to which answers could not be obtained, and it seemed futile to debate a question while in the dark regarding its most important conditions.

But the information wanted is now forthcoming, and it well pays for waiting. An American gentleman, both interested in the subject and very competent to investigate it, himself a cultivated classical scholar and educated in Germany, has made the subject a matter of special and careful inquiry, and gives the result in the opening article of the present "Monthly." He has been in Germany during the past year, expressly to study certain aspects of its university system, and has visited a large number of its great educational institutions, and conversed with many of the professors in relation to the nature and actual significance of the real-school controversy, and the action that has been taken upon the subject. The Berlin report is also itself published in English by Ginn & Heath, of Boston, so that both sides of the case are now open to all who care about the question. Those who read the paper of Professor James—and none can afford to pass it by—will find that the uses to which that report has been put in this country are entirely unjustifiable. It turns out, as we suspected, that there is a good deal more to be taken into consideration than has been represented, and that the German document is a thoroughly one-sided affair.

We have to remember, in the first place, that partisanship on this question runs very high in Germany, and that the reports against the real schools were all written by prejudiced classical extremists. It turns out, moreover, that the whole question was decided upon in advance, and with the greatest emphasis, before the experiment had been tried to test the preparation of the real-school graduates, and that from the outset the problem was not that of the progressive principles of higher education, as we understand it in this country, but a question of national politics in relation to the policy of the universities. The historic ascendency of dead languages, as against the rising claims of science, is to be maintained in Germany for state reasons. This is no mere inference, but the bluntly declared position. When the matter was first broached, in 1869, of admitting the real-school graduates to the universities, the Philosophical Faculty of the Berlin University protested vehemently against the contemplated action on the grounds here stated. They said: "While the university has no reason to withhold its advantages, it must not, in its desire to make the higher education accessible to the greatest possible number, forget its peculiar purpose and its historical task. Its duty is to fit the youth for the service of state and church." Again: "The faculty are compelled . . . to utter a warning against the surrender of that which has been till now the common basis of training of all the higher public functionaries, and which, if it be once given up, can never be regained." And still further: "The Philosophical Faculty can not give their consent to such a movement. They are convinced that no sufficient compensation is given in the real-schule for the lack of classical education. They fear that so decided a lowering of standards would be accompanied by weighty consequences, especially in such a state as Prussia." And finally, "The faculty, therefore, believe they owe it to the university and to the state to declare themselves in the most positive manner against a more extensive admission of Realschüler."

These statements give us the key of the celebrated "Berlin Report." A despotic paternal government has church-and-state reasons for maintaining a dead-language culture as a national policy. The whole vast machinery of education in that empire is run in subordination to the ideal of government—a military despotism, and, to discipline a community into thorough subjection to this ideal, centuries of history prove that there is nothing equal to the dead languages and classical studies. Hence the traditions must be maintained in their full rigor, the existing faculties must not be divided, science must not be suffered to take a coequal place with the other faculties, or to become an independent power in the universities; in short, no rival system of organized higher education, based upon modern ideas, must be tolerated.

The whole question was thus prejudged and predetermined, and no experiment that could possibly be made under the Bismarckian *régime* would be allowed to disturb the foregone church-and-state conclusion of the Berlin Philosophical Faculty. The real-school graduates were, however, admitted to the university, and after ten years it was, of course, reported by the same faculty that the policy pronounced bad at the outset was bad at the end. The real-school graduates were declared failures, as they must have been failures by the church-and-state standards assumed, whatever their proficiency. That the teaching in the real schools was inferior to that in the gymnasiums was allowed no weight; that the gymnasiums were pets of the Government and the real schools neglected was of no importance, that the brightest youths and the best stock of Germany crowded into the gymnasiums, leaving the lower grades to the real schools, amounted to nothing; and that the system of study in the real schools had not been shaped as a preparation for higher university work, as was the fact with the gymnasiums, counted for naught. It was only said that the graduates of the gymnasiums beat the graduates of the real schools, when tested side by side in the university.

We venture to think that "the most powerful plea ever made in behalf of classical studies," when viewed in the light of Professor James's exposition, will be seen to disclose the customary weakness of all the defenses of the classical superstition, besides being for imperative considerations wholly inapplicable in this country.

LEARNING ONE LANGUAGE BY STUDYING OTHERS.

That fine classical scholar, and accomplished master of both prose and poetic English, Walter Savage Landor, in his "Letters to an Author," observed, "If we wish to write well, we must keep our Greek and Latin out of sight." We shall not undertake to say what or how much Landor meant by this remark, but he could not have signified less than that the influence of those dead languages may be bad upon an author who strives to attain a high standard in his native tongue. The implication is that the vernacular must be itself and independently cultivated without interference from foreign influences. Obviously skill and perfection in any art can only come from careful study and patient practice of that art, and not by studying any other art. The acquirement of a language for its highest purposes, to become a powerful and perfect instrument for the expression of thought in any of the nobler forms of literature, is the most transcendent of the arts, and the utmost excellence in it is not to be achieved through the study of another language. Genius, perseverance, and an everlasting apprenticeship are required to develop even partially the resources of any vernacular tongue, and, by the laws of all human effort and human success, there must be undivided concentration upon the instrument to be mastered. The Greeks, as we have before had occasion to state, were shut up to this condition, and, by not scattering their efforts upon other languages, carried their own to a high degree of perfection. But in these times, when there is such a passion to become familiar with many languages, there is a corresponding neglect of the vernacular, and no end of crude, incompetent writing is the result. We are told perpetually that perfection in English is to be achieved through familiarity with the ancient classical models; or, in other words, to get the completest command of our own speech, it is necessary first to know the Greek and Latin languages. This stereotyped dictum is equally a violation of common sense, out of harmony with the open facts, and in the teeth of weighty authority. It is simply notorious that a great number of the finest masters of English in different departments of literature knew little or nothing of Greek and Latin, and acquired their proficiency in English by the direct cultivation of it. And that competent classical scholars may be, and often are, incompetent in English, is strongly affirmed by many who have the best opportunities of knowing. An able English scholar, Mr. Dasent, who had large experience as an examiner of classical students, says: "I have known young men who write very good Latin prose indeed, and very good Latin verse. I know what good Latin prose and Latin verse is, and I have known the same young men utterly incapable of writing a letter or a decent essay in their own language." And, again: "I think I know good writing when I see it, and I must say that some who had great classical reputation have been the worst English writers I have known. I have observed this over and over again. I have known men recommended solely in consequence of their university reputation, and I have found that they have been signal failures in English writing—splendid scholars, but utterly incapable of expressing themselves in their own tongue. They have no choice of words, and very often have a heavy, cumbrous way of expressing themselves."

But the most striking exemplification of this principle on a grand scale is probably now to be found in Germany. From the article of Professor James we gather that the dead-language superstition holds on in that country with the greatest inveteracy. Dead languages are the center and pivot of the national system of education, maintained with unrelenting tenacity in all the favorite government institutions of culture, the trade-mark of social position, and the gateways to all honor and emolument. In the official preparatory schools, the gymnasia, twice as much time and labor are given to Latin and Greek as in our own colleges. Certainly here, if anywhere, we should observe the general reflex advantages upon the vernacular speech of life-long intercourse of the cultivated German mind with the classical masterpieces. If the study of dead languages can perfect a living language, then surely the German language should have become the world's model in every desirable attribute, and German books should be taken as the world's standards of the finest lingual achievement. If the virtues of grinding in Latin and Greek are so great as they are alleged to be, German writing should be the type of lucidity, elegance, conciseness, and force of expression. But such are not the characters for which the German writers are usually distinguished. They are the worst expositors in the world, and the national habit is so careless and slovenly that it is recognized even by some German writers themselves as a national reproach. Professor Helmholtz translated a series of works into German, among other reasons for the avowed purpose of doing something to raise the standard of clearness and simplicity in the use of the German language. These works, offered as exemplars, were not from the treasures of Latin and Greek, but were from a living language, the English, and by a writer, Professor Tyndall, who had attained his remarkable mastery of the native tongue by the critical study of it, and not by the study of dead languages. The following extract from an editorial in "Science" of October 5th sufficiently illustrates the literary habits and general state of mind of a people trained beyond any other people in the old languages of Greece and Rome:

In German scientific writings the excellence of the matter usually contrasts vividly with the defective style and presentation. Indeed, the Germans, despite the superiority of their modern literature, are awkward writers, and too often slovenly in literary composition. Conciseness and clearness are good qualities, which may assuredly be attained by the expenditure of thought and pains; but these the German investigator seems unwilling, in many cases, to bestow upon his pen-work, but follows the easier plan of great diffuseness. Besides this, another defect is not uncommon—the ill-considered arrangement of the matter. This occurs in all degrees, from a well-nigh incredible confusion (to be sometimes found even in elaborate and important essays) to a slightly illogical order. In this regard, a curious and not infrequent variety of this fault deserves mention. According to the headings of the chapters or sections, the division of topics is perfect; but under each head the matters are tumbled together as if a clerk was contented to stuff his papers in anyhow, if only he crammed them into the right pigeon-hole. Speaking broadly, the German mind lacks conspicuously the habits of clearness and order. There have been celebrated exceptions, but they were individual. The nation regards itself as having a decidedly philosophical bent, meaning a facility at taking broad and profound views of the known. We venture to contradict this opinion, doing it advisedly. Their profundity is mysticism, their breadth vagueness, yet a good philosopher must think clearly. It is a remarkable but little-heeded fact, that Germany has not contributed her share to the generalizations of science; she has produced no Linné, Darwin, Lyell, Lavoisier, or Descartes, each of whom bequeathed to posterity a new realm of knowledge, although she has given to the world grand results by the accumulated achievements of her investigators. The German's imperfect sense of humor is another obstacle which besets him on every path. He is cut off from the perception of some absurdity, like that of Kant's neumenon, for instance. One can not explain this to him; it were easier to explain a shadow to the sun, who always sees the lighted side. To state the whole epigrammatically, German science is the professional investigation of detail, slowly attaining generalization.

LITERARY NOTICES.

The Law of Heredity. A Study of the Cause of Variation, and the Origin of Living Organisms. By W. K. Brooks, Associate in Biology, Johns Hopkins University. Baltimore: John Murphy & Co. Pp. 336.

This work combines in a very unusual degree the two traits that are so rarely found to coexist in scientific books: it is both original and independent in its views, and is at the same time a most lucid and popular presentation of its subject. While the work is as far as possible from being a compilation, and will be sure to take its place as a valuable contribution to philosophic biology, the author has, nevertheless, given us such a survey of the general subject as will prove interesting and instructive to all readers. We needed a good exposition of the nature and present condition of the fundamental problems of heredity, and we here have it by one who has labored systematically and effectively in the direction of their solution; and what is perhaps still more to the purpose, we have it in the light of a new and advanced theory of the subject of extreme interest, and which will probably prove a permanent and valuable contribution to the inquiry.

Dr. Brooks devotes his first chapter to the question, "What is heredity?"—and he gives his readers a vivid idea of the marvels which it involves. Of course, people who have no real or accurate knowledge on the subject of life are but ill prepared to appreciate its subtilties, and our author observes that such people are apt to "regard an adult animal with feelings similar to those with which an intelligent savage might regard a telephone or a steamboat. . . . A dog with all the powers and faculties which enable him to fill his place as man's companion is a wonder almost beyond our powers of expression; but we find in his body the machinery of muscles and brains, digestive, respiratory, and circulatory organs, eyes, ears, etc., which adapts him to his place; and study has taught us enough about the action of this machinery to assure us that greater knowledge would show us in the structure of the dog an explanation of all that fits the dog for this life—an explanation as satisfactory as that which a savage might reach in the case of the steamboat by studying its anatomy. . . . Let our savage find, however, while studying an iron steamboat, that small masses of iron without structure, so far as the means at his command allow him to examine and decide, are from time to time broken off and thrown overboard, and that each of these contains in itself the power to build up all the machinery and appliances of a perfect steamboat. The wonderful thing now is, not the adaptation of wonderful machinery to produce wonderful results, but the production of wonderful results without any discoverable mechanism; and this is, in outline, the problem which is brought before the mind of the naturalist by the word heredity. . . . In the mind of the naturalist the word calls up the greatest of all the wonders of the material universe: the existence in a simple, unorganized egg, of a power to produce a definite adult animal with all its characteristics, even down to the slightest accidental peculiarity of its parents—a power to reproduce in it all their habits and instincts, and even the slightest trick of speech or action."

Dr. Brooks then proceeds to state various other striking and subtile phenomena involved in heredity, and then intimates that, notwithstanding their refinement and obscurity, they are unquestionably capable of being cleared up so as to be as fully understood as other scientific laws. He says: "We may not be able as yet to penetrate its secrets to their utmost depths, but I hope to show that observation and reflection do enable us to discover some of the laws upon which heredity depends, and do furnish us with at least a partial solution of the problem; that we have every reason to hope that in time its hidden causes will all be made clear, and that its only mystery is that which it shares with all the phenomena of the universe."

Chapter II, on the "History of the Theory of Heredity," is of extreme interest. He traces the most notable speculations upon the subject that have been made in past times, and points out their inadequacy both from defective knowledge and from erroneous views of the nature of life, and shows that no explanations of the phenomena could be at all satisfactory until biology had fully accepted and broadly planted itself upon the evolution hypothesis. Dr. Brooks's summary in this chapter of the fundamental facts that have been established in this field of inquiry, and which he presents as requisites of a theory of heredity, is very discriminating and helpful in the prosecution of the inquiry. In Chapter III the same line of historic analysis is pursued more closely, and the author is here brought to the consideration of Darwin's theory of pangenesis, one of the latest forms of the explanation of hereditary phenomena. Dr. Brooks finds the hypothesis of Darwin to be unsatisfactory, in that it does not recognize such a difference in the functions of the reproductive elements of the opposite sexes as the facts require and now seem to warrant. And, after his review of the various theories that have been thus far offered, our author then proceeds to the main thesis of his work, which is the establishment of a new theory of heredity based upon the different powers and functions of the respective reproductive elements.

It will not be possible here to give any full or satisfactory account of Dr. Brooks's theory as elaborated and illustrated in the volume before us, nor will it be so necessary to the readers of the "Monthly," as Vol. XV of this magazine contains two articles upon the subject by the author representing his views, and exemplifying some of their higher applications. It may be stated, however, that while Darwin holds that male and female give equal elements in their combined offspring, Dr. Brooks maintains that they are not only different, but that the difference rises to the import of a general law. While the function of the female is conservative, or to preserve and hand on all the parts that belong to the race—all that has been acquired, with little or no tendency to vary from the race type—on the other hand, the male, leading a more varied and adventurous life, stamps the tendency to variation, the impulses to higher development, upon the common product of organization. There is more than plausibility, more even than probability, in this idea, and those who look critically into the evidence adduced by the author can hardly fail to recognize that he has seized upon an important principle in this field of investigation.

The English Grammar of William Cobbett. Carefully revised and annotated by Alfred Ayres. New York: D. Appleton & Co. Pp. 254.

"'Cobbett's Grammar,'" says the editor of this edition, "is probably the most readable grammar ever written. For the purposes of self-education it is unrivaled." This is probably because it is not strictly a grammar according to the common ideas of a grammatical text-book, but is rather a series of familiar, practical letters on the use of the English language. Technicalities are absent, and paradigms are rare, and given only in illustration of the discussions of the text. The editor's work has been chiefly to call attention to the points in which Cobbett's teachings differ from what is now considered the best usage, a matter in which changes may have occurred or more strict distinctions have been established since the first edition of the "Grammar" was published in 1818; to note the few errors of diction to be found in the letters; and to emphasize a more discriminating use of the relative pronouns than is customary in English literature. The last is a point on which the editor appears to set much store. The rule he announces on the subject is that "who and which are properly the co-ordinating relative pronouns, and that is properly the restrictive relative pronoun. Whenever a clause restricts, limits, defines, qualifies the antecedent—i. e., whenever it is adjectival—explanatory in its functions—it should be introduced with the relative pronoun that, and not with which, nor with who or whom. . . . Who and which are the proper co-ordinating relatives to use when the antecedent is completely expressed without the help of the clause introduced by the relative." The rule seems to be a useful one, other things being equal; but as we read the thats which the editor has inserted in brackets after Cobbett's who's and which's wherever he judges the change should be made in accordance with his rule, and as we observe in other places, we find it will not do to establish the maxim as obligatory, but that it must be made very often to yield in favor of euphony or considerations of grace in style. One of the most commendable features in the present edition is its complete and excellently arranged index.

Das Studium der Staatswissenschaften in Amerika (The Study of the Political Sciences in America). By Dr. E. J. James. Jena: Gustav Fischer. Pp. 26.

The substance of this publication was originally contributed by the author, a professor in the University of Pennsylvania, to the "Jahrbücher für Nationalökonomie und Statistik." It comprises a clear review of the present condition of the teaching of political economy and other branches relating to public polity and administration in the colleges of the United States, with specific notices of the courses in those institutions in which more particular attention is given to it.

Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories. By F. V. Hayden. Washington: Government Printing-Office. Part I. Pp. 809, with 154 Plates. Part II. Pp. 503, with 80 Plates and 17 Maps.

These volumes and the accompanying portfolio constitute the final report of the Hayden Survey, and cover the work done in 1878 and until the close of the existence of the survey, June 30, 1879. The first part includes the reports of Dr. C. A. White on Geology and Paleontology, and of Professor A. S. Packard, Jr., and R. W. Schufeldt on Zoölogy. The second part relates to the Yellowstone National Park, and comprises the "Geology" of that region, by W. H. Holmes; "The Thermal Springs," by Dr. A. C. Peale; and the "Topography," by Henry Gannett, E. M.

Sea-Sickness: Its Cause, Nature, and Prevention without Medicine or Change in Diet. By William H. Hudson. Boston: S. E. Cassino. Pp. 147. Price, $1.25.

Sea-sickness is regarded in this treatise as the result of offenses against gravity, aggravated by attempts to resist them. The irregular motions of the ship are constantly displacing the center and the direction of gravity of the body and its parts, while the muscular efforts made to counteract those efforts produce other shocks. Consequently, the system becomes thoroughly disorganized. The remedy recommended is to submit to the conditions. Secure a complete relaxation of the muscles, and there will be, it is asserted, no trouble.

Cumulative Method for learning German. By Adolphe Dreyspring. New York: D. Appleton & Co. Pp. 253. $1.50.

The theory on which Mr. Dreyspring has worked is that of repetition. His aim is to teach the student German by the same kind of process as that by which a native learns it, and so to drill him that he shall know when a phrase is formed aright, not by having to go through the painful process of a grammatical analysis, but simply because it "sounds right." The method is then generally oral and conversational. The first stumbling-block the student in German has to meet is the "chaos," as the author well styles it, of genders. Mr. Dreyspring meets it by drilling the pupil in series of exercises on single words in connection with the articles and pronouns and some adjectives. By the time he has pronounced the word in a dozen or twenty recurrences with the adjectival terminations, *er*, *e*, or *es*, that may be appropriate to the so-called gender of the word marking as many adjectives, he will be very apt to have gained the power of detecting a wrong use at once by its sounding wrong. Drills governed by this idea are supplemented by exercises and reading-lessons, with a stock of words that is considered ample for the practical wants of every-day life and conversation; and when, the author believes, "by constant and ever-varying repetitions, these words are fully mastered, the student will possess a thorough knowledge of the practical framework of the language."

Questões Hygienicas (Hygienic Questions). By Dr. João Pires Farinha. Rio de Janeiro: Typographia Nacional. Pp. 54.

Dr. Farinha is physician to the houses of detention and correction in Rio de Janeiro. The pamphlet before us is a collection of articles which he has contributed to the "Uniao Medica" and the "Jornal do Commercio" of that city, on such subjects as "Animal Emanations," "The Sewers of Rio de Janeiro and their Influence upon the Public Health," and "Popular Counsels on Matters of Hygiene."

Dangers to Health: A Pictorial Gnide to Domestic Sanitary Defects. By T. Pridgin Teale, M. A., Surgeon to the General Infirmary at Leeds. Fourth edition. New York: D. Appleton & Co. Pp. 163. Price, $3.

A most vivid presentation of the ills which follow in the track of the botching plumber and drain-builder is this by Dr. Teale. Convinced that pictures are more effective than words, the author depicts in seventy plates various faults of sewerage, most of them actual cases, and accompanies each with a few paragraphs of explanation or history. The course of sewer-gas is indicated by blue arrows, and the flow, the leakage, and infiltration of sewage are also represented in blue. Among the faults described are untrapped waste and overflow pipes passing directly into a soil-pipe, traps emptied by evaporation or by the flow of water past their outlets, drain-pipes of poor quality or badly joined, and drains running uphill. A particularly striking group of pictures, entitled "How People drink Sewage," shows the danger to be expected from drains passing near or over wells. Among the interesting histories is the following: "Enteric (typhoid) fever broke out in a gentleman's house, from which it spread into the village. On examination I found that the water-closet was in the center of the house, and that the soil-pipe discharged into a common stone drain running under a tiled entrance-hall. This drain was almost without fall, so much so that it had become blocked, and the sewage had found its way under the flooring of the passage and rooms. It goes to a man's heart to take up a tiled hall in order to inspect a drain. *Moral*—the drain ought never to have been placed under the hall." Some twenty additional defects are noted without plates, and methods for detecting the escape of sewer-gas are given. The book contains also some hints on ventilating houses and carriages.

History and Uses of Limestones and Marbles. By S. M. Burnham. Boston: S. E. Cassino & Co. Pp. 392, with Forty-eight Chromo-lithographs.

The modest aim of the author of this book has been, in the absence of any work exclusively devoted to limestones and marbles known to him, to present the facts and speculations of original writers "so selected and arranged as to illustrate the value of limestones in some departments of geology, but more especially their use in the mechanic and fine arts, and their history in civilization." These stones are so abundant and so diversified, their uses are so multifarious, and they play so important a part in every field, that there is certainly room and use for a book of this kind. Mr. Burnham does not claim that he has entirely filled the vacant place. That would be more than it were possible for one compiler to do at a first effort. But he has made a creditable attempt, and has produced a book embodying a large amount of authentic information concerning limestones in all parts of the globe, and their uses in all periods of history. The first chapters are devoted to a scientific consideration of limestones, describing the different classes, the fossils so abundant in them, and of which many of them are so largely composed, and the general divisions of geological time. The more particular account of the several classes of limestones and marbles follows, beginning with those of the United States, which are grouped by "regions"—Atlantic, Mississippi, and the Rocky Mountains and Pacific coast. Other limestones are classified and described as those of British America, the West India Islands, Mexico, and South America. European stones are similarly described, by countries, as well as those of Asia, Australia, and Africa. The description of the Grecian marbles is accompanied with a few remarks on their application in Greek art; and in the later chapters are given accounts of the "Antique Marbles," "Antique Alabasters, Serpentines, Basalts, Granites, and Porphyries," "Antique Stones and Works of Art in Modern Rome," and "Antique Stones used to decorate Roman Churches." The appendix gives tabular views of the "Age and Locality of the Principal Limestones," "French Marbles," and

"Marbles of Great Britain and Ireland, Germany, etc." The chromo-lithographs give clear and brilliant representations of the color and grain of some of the finer European, African, antique, and American stones.

Muster altitalienischer Leinenstickerei (Patterns of Old Italian Linen-Embroidery). Collected by Frieda Lipperheide. First Part. Pp. 32, with 30 Plates. Second Part. Pp. 36, with 30 Plates. Berlin: Franz Lipperheide. Price, six marks each part.

The custom of embroidering articles of household linen with designs in colored silk or wool went nearly out of vogue in the last century, but still survives in parts of Italy, and traces of it may be found elsewhere. An attempt is now made to revive it and commend it. The publication in the Berlin "Modenwelt," and afterward in books, of a collection of patterns of old German embroideries revealed a richness in beautiful specimens of art of this kind that the world was not aware it possessed. The publisher might have supplemented his collection with another, as large, of additional patterns, in the same style, but he has preferred to vary it by presenting a second one in a distinct style, the old Italian. In the German embroideries, the figure is brought out in stitch-work, while the ground is left in plain linen. In the older Italian work the opposite motive generally prevails, and it is the figure that is left plain, and is embroidered around; yet there are variations, and both styles may sometimes be found in the same piece. The Italian patterns are gracefully drawn, evenly parceled off, and always conventionalized and wholly ornamental. Some of them may be ultimately of Grecian origin, but they all come to the collectors from Italy. They seem to have enjoyed an extensive diffusion, for works in Italian stitch may be found among nearly all nationalities; and we are given in these volumes, besides the Italian and Grecian designs proper, Moroccan, Persian, and Spanish-Moorish groups, all congenial in motive, but having each traits and beauties peculiar to themselves. The designs reproduced by Frau Lipperheide are taken from authenticated specimens of from the sixteenth to the eighteenth centuries, or from Italian pattern-books of the sixteenth century. The letterpress preceding the plates furnishes full, clearly illustrated instructions for executing the work in the various stitches.

THE BERLIN REPORT.

The Question of a Division of the Philosophical Faculty. Inaugural Address on assuming the Rectorship of the University of Berlin. Delivered in the Aula of the University, on October 15, 1880, by Dr. August Wilhelm Hofmann, Professor of Chemistry. Second edition, with an Appendix containing Two Opinions on the Admission to the University of Graduates of Realschulen, presented to his Excellency the Royal Minister of Public Instruction, by the Philosophical Faculty of the Royal Frederick William University, in the Years 1869 and 1880. Boston: Ginn, Heath & Co. 1883. Pp. 77.

This is the somewhat formidable title under which the celebrated "Berlin Report" on classical and scientific education appears in English. The first part of it, embracing thirty-five pages, consists of the elaborate inaugural address of Dr. Hofmann, delivered October 15, 1880, devoted to a general discussion of the policy of dividing the Philosophical Faculty of the German universities so as to create a new faculty of the natural sciences. Dr. Hofmann opposes this on various grounds, and then passes to the question as to the admission for graduates of the real schools to the university, which he resists, and which is also a part of the general question of the unity of the Philosophical Faculty. Following the address is the opinion of the Philosophical Faculty of the Berlin University, given in 1869, against the proposed admission of the real-school graduates, and then comes the adverse report of the same faculty, made in 1880, after the real-school students had been admitted. The remainder of the appendix consists of notes and extracts from various authorities confirmatory of the views taken in the reports. The pamphlet contains a preface by John Williams White, of Harvard College, giving various interesting explanations. As the subject is one of considerable prominence just now, the appearance of this document in an English form will be helpful in the discussion, and will be welcomed by many readers.

Bulletin of the United States Fish Commission. Vol. I, for 1881, pp. 466; Vol. II, for 1882, pp. 467. Washington: Government Printing-Office.

The "Bulletin" is now published by the authority of an act of Congress, in two forms, a part of the edition being distributed signature by signature as the matter is collected and put in type, while the other part is bound up at the end of the year in an annual volume. Two classes of readers are thus accommodated—those who wish to get the matter as fast as it appears, as news, and those who prefer to have it in permanent form, in bound volumes. The two volumes now before us, being the first published under the new system, contain numerous articles on a variety of subjects relating to the description, propagation, catching, habits, and care of fish, the value of which is both scientific and practical; of American and of foreign origin; and original, relating to the home observations of the agents or direct correspondents of the commission, or selected from an extensive range of living ichthyological literature, and the reports of other countries. We regret the absence of an adequate classified index to the volumes. A copious general alphabetical index is given, and an index by authors, and they should not be dispensed with; but, in a work marked by the fullness of matter that characterizes these volumes, another index seems to be needed, giving the titles of articles.

Animal Life: Being the Natural History of Animals. By E. Perceval Wright, M. D. London, Paris, and New York: Cassel, Petter, Galpin & Co. Pp. 618. $2.50.

The author of this attractive work is Professor of Botany in the University of Dublin. He has prepared his book especially in view of "that class of readers who, while they take an intelligent interest in the study of natural history, have but little taste for the technical details which would naturally form the bulk of a scientific manual on the subject. With this view, nearly two thirds of the contents have been devoted to the mammals and birds. Nevertheless, the other classes have not been neglected, but a fair degree of consideration is given to the reptiles, fishes, insects, mollusks, and the lower divisions of the animal kingdom. The book has grown to its present form out of the series of lectures on zoölogy which Dr. Wright delivered several years ago to the natural history classes of his university, and the matter of it, enriched with copious citations from travelers distinguished for their researches in natural history, has been systematized and reduced to its present comprehensive and connected form, under advantages which only long-maturing thought can confer, and which a book prepared to meet a present demand can not so well enjoy. The systematic method is faithfully followed, and the animals are described by classes, orders, families, and the other related groups, in regular order, with the scientific distinctions carefully noted, so that a clear view is given of all that comes within the scope of the work. The adaptation of the style to the mind not familiar with technical language, the beauty of the broad pages with their clean paper, sharp type, and the profusion of appropriate and excellently executed illustrations, make the work eminently pleasant and suitable to the family and to general readers, and one which should attract all the young, who have any taste in that direction, to the study of natural history.

Mineral Resources of the United States. By Albert Williams, Jr. Washington: Government Printing-Office. Pp. 813.

This volume represents one of the divisions of the United States Geological Survey under the direction of the Hon. J. W. Powell. It is intended to furnish an account of every mineral, whether a metallic ore, a useful salt, a building material, or a fertilizer, that is economically mined in the United States, with notes of the localities where they are found, and estimates of the production and trade value of the stuff.

Ueber das galvanische Verhalten der Amalgame des Zinkes und des Cadmiums (On the Galvanic Behavior of the Amalgams of Zinc and of Cadmium). By William L. Robb, A. B. Berlin: Gustav Schade. Pp. 30.

This is the inaugural dissertation by the author, an American student, on receiving at the University of Berlin, in August last, the degree of Doctor of Philosophy.

THE PHYSICIAN'S VISITING LIST FOR 1884. Philadelphia: P. Blakiston & Co. Price, $1.

THIS, as the title implies, is a sort of annual hand-book or note-book for doctors, which now reappears in the thirty-third year of its publication. It is in a compact and convenient form, and is arranged for twenty-five patients weekly. Its dose-table has been revised to accord with the late changes in the Pharmacopœia, and has a list appended with suggestions for their exhibition. There are several other tables for ready reference, and aids for calculation, and the leaves for addresses, memoranda, etc., are arranged upon a plan at once simple and comprehensive. There are more advertisements included than it seems necessary for a physician to carry round in his pocket.

THE HANDY BOOK OF OBJECT-LESSONS. From a Teacher's Note-Book. By J. WALKER. Philadelphia: J. B. Lippincott & Co. Pp. 129. $1.25.

THIS work is intended as an aid to teachers, in furnishing them with material for their lessons, and suggestions as to the way it may be used. The matter is ruled into two columns—one, headed "Matter," containing the information to be imparted, while the other, headed "Method," is intended, not to be dogmatically adhered to, but to furnish what may serve as specimens of the various expedients to which teachers may resort. Two series of lessons are furnished. In the first series are given lessons on the animal, vegetable, and mineral kingdoms, and, in the second series, lessons on physiology, physical geography, and manufactures; besides which, each series contains a department of "Miscellaneous" lessons.

KING'S HAND-BOOK OF BOSTON. Cambridge, Mass.: Moses King. Pp. 360. $1.

THIS work is designed to describe every noteworthy feature and institution of Boston. The subjects are systematically arranged, beginning with a sketch of the history of the city, after which are described the "Arteries," the "Arms" (railroads, steamers, etc.), the "Hotels and Restaurants," the "Public Buildings," and so on, through the list. The matter is periodically revised, so as to bring the successive editions of the book up to the time of their issue. The whole furnishes a comprehensive and useful account of a very interesting city, presented in the best typographical style, with illustrations worthy of their subject.

PUBLICATIONS RECEIVED.

Johns Hopkins University. Studies from the Biological Laboratory. Professors H. Newell Martin and W. K. Brooks, editors. Vol. II, No. 3. Baltimore: N. Murray. Pp. 96.

The Geology and Topography of Iowa in a Sanitary Point of View. By P. J. Farnsworth, M.D. Pp. 12. Typhoid Fever of America: Its Nature, Causes, and Prevention. By R. J. Farquharson, M.D. Pp. 12. Hospitals for Contagious Diseases, and their Proper Location. By R. J. Farquharson, M.D. Pp. 12. Ventilation. By Justin M. Hull, M.D. Pp. 48. All published at Des Moines, Iowa, by the Iowa State Board of Health.

The Oyster Epicure. New York: White, Stokes & Allen. Pp. 61. 30 cents.

English as She is Spoke. "Her Seconds Part." New York: G. P. Putnam's Sons. Pp. 56. 20 cents.

The Antipyretic Treatment of Typhoid Fever. By G. C. Smythe, M.D., Indianapolis, Ind. Pp. 24.

Annual Report of the Kansas City Public Schools, 1882–'83. Kansas City, Mo.: Ramsey, Millett & Hudson. Pp. 157.

The Despotism of Words in Relation to Science. By Orpheus Everts, M.D., College Hill, Ohio. Pp. 8.

An Examination of Some Controverted Points on the Physiology of the Voice. By T. Wesley Mills, London. Pp. 28.

Description of a Revolving Astigmatic Disk. By Charles A. Oliver, M.D., Philadelphia. Pp. 7.

Ocean Grove Camp-Meeting Association. Fourteenth Annual Report. Ocean Grove, N. J. Pp. 76.

Experimental and Inductive Chemistry. Prospectus and Proof-sheets. By Charles R. Dreyer, Fort Wayne, Ind. Pp. 32.

Chicago Astronomical Society and Dearborn Observatory Reports, 1883. Chicago: Knight & Leonard. Pp. 15.

University of Georgia, Medical College, Closing Exercises. Pp. 4.

The Treatment of Wounds, as based on Evolutionary Laws. By C. Pitfield Mitchel. New York: J. H. Vail & Co. Pp. 29. 50 cents.

"Scandinavia: A Monthly Journal," 29 N. Clark Street, Chicago. Pp. 24. 20 cents; $3 a year.

Diccionario Tecnológico: Inglés-Español y Español-Inglés. (Technological Dictionary: English-Spanish and Spanish-English.) By Néstor Ponce de Leon. In Twelve Parts. New York: N. Ponce de Leon. Pp. 48 each part. 50 cents each.

Historical Essay on the Art of Bookbinding. By H. P. DuBois. New York: Bradstreet Press. Pp. 42.

The Evolutionary Significance of Human Character. By Professor E. D. Cope. Pp. 12.

State Asylum for Insane Criminals. Twenty-third Annual Report. Auburn, N. Y.: W. J. Moses. Pp. 40.

Calendar of American History, 1884. By Delia W. Lyman. New York: G. P. Putnam's Sons. 365 Leaflets and Index. $1.

Directory to the Charitable and Beneficent Societies and Institutions of the City of New York. New York: G. P. Putnam's Sons. Pp. 169.

Felicitas. A Romance. By Felix Dahn. New York: William S. Gottsberger. Pp. 208.

Explosive Materials. By M. P. E. Bertholet. New York: D. Van Nostrand. Pp. 180. 50 cents.

Wonders of Plant-Life under the Microscope. By Sophie Bledsoe Herrick. New York: G. P. Putnam's Sons. Pp. 248. $1.50.

A Hand-Book of Hygiene and Sanitary Science. By George Wilson. Philadelphia: P. Blakiston, Son & Co. Pp. 510. $2.75.

Manual of Chemistry, Physical and Inorganic. By Henry Watts, F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 595. $2.25.

The Organs of Speech. By G. H. von Meyer. New York: D. Appleton & Co. Pp. 349.

Queen Victoria. Her Girlhood and Womanhood. By Grace Greenwood. New York: John R. Anderson & Henry S. Allen. Pp. 401.

The Human Body. By H. Newell Martin, D. Sc. New York: Henry Holt & Co. Pp. 355. $1.50.

Text-Book of Popular Astronomy. By William G. Peck, Ph. B. New York: A. S. Barnes & Co. Pp. 330.

Zoölogy. By A. S. Packard, Jr. New York: Henry Holt & Co. Pp. 334. $1.40.

Destructive Influence of the Tariff. By J. Schoenhof. New York: G. P. Putnam's Sons. Pp. 112.

World-Life, or Comparative Geology. By Alexander Winchell, LL. D. Chicago: S. C. Griggs & Co. Pp. 642. $2.50.

Dangers to Health. A Pictorial Guide to Domestic Sanitary Defects. By T. Pridgin Teale. New York: D. Appleton & Co. Pp. 172.

History of the Literature of the Scandinavian North. By Frederik Winkel Horn, Ph. D. Chicago: S. C. Griggs & Co. Pp. 507. $3.50.

The Natural Genesis. By Gerald Massey. New York: Scribner & Welford. 2 vols. Pp. 552, 535.

Report of the Commissioner of Fish and Fisheries, 1880. Washington: Government Printing-Office. Pp. 1060, with Plates.

A Practical Treatise on Materia Medica and Therapeutics. By Roberts Bartholow. New York: D. Appleton & Co. Pp. 738.

Report of the Commissioner of Education, 1881. Pp. 840.

Cruise of the Revenue Steamer Corwin in Alaska and the Northwest Arctic Ocean in 1881. Notes and Memoranda. Washington: Government Printing-Office. Pp. 120, with Plates.

POPULAR MISCELLANY.

Origin of the Eastern End of Lake Erie.—Mr. Julius Pohlman, starting with the hypothesis that the beds of the Great Lakes were excavated by water in pre-glacial times, has sought for the river which washed out the eastern end of Lake Erie. The discovery of the many large pre-glacial rivers, in Pennsylvania and Ohio, running into the lake-basin, explains well enough how the erosion in general has taken place. "But the most easterly of these ancient water-courses yet discovered, the Alleghany, which ran northerly past Dunkirk, does not account for the forty miles of lake-valley between that place and Buffalo, and another pre-glacial river emptying into the lake-basin near Buffalo was necessary to complete the river system which occupied and excavated the valley of Lake Erie." The maps of the lake survey show that there are no indications of rocks on the shore of the lake between the southern limit of the city of Buffalo and the Horseshoe Reef of the Niagara River, and that the land is low and level for some distance back. The northern and eastern parts of the city and the bed of Buffalo Creek are underlain by a reef of corniferous limestone, which gradually ascends toward the north. Testings that have been made during the course of excavations for canals, of the depth of this rockless land, show that no rock can be found at a less depth than eighty feet below the surface. This probable fact points to the bed, and indicates the depth of the ancient river which we are seeking for. That river could not go north or east, on account of the outcropping corniferous limestone, but "it must have taken a westerly course through the soft shales of the Devonian epoch; and if we trace an imaginary line along the deepest portion of the eastern end of the lake from this ancient valley, in a direction a little southerly of west, we can connect our pre-glacial river with the ancient outlet of the river system of the Erie Valley opposite Dunkirk, and have a fair explanation of the origin of the eastern end of Lake Erie."

The New Standards of Time.—On the 7th of October a number of the railroads of the New England States, and on the 18th of November nearly all the important railroads of the Atlantic slope and the Mississippi Valley, adopted a new system of time-standards for the movement of their trains. The object of the change was to secure a more simple and harmonious way of calculating the time at the different stations on East and West lines. Under the time-system previously prevailing, the managers of each railroad endeavored to conform to the local time of the most important stations on its line. The result of this method of accommodation was that seventy-five different standards of time, varying apparently at hap-hazard from each other, were used in operating the railroads of the United States; and it was only with extreme difficulty that the traveler between the East and the West could keep an account of the hour. The new system which has been adopted contemplates the establishment, for the whole United States, of four principal meridians, distant from each other exactly one hour of solar time, to the nearest one of which the local time of every point in the country shall be referred. These meridians are selected so as to bear an exact relation, in even hours, with the meridian of Greenwich, whence most of the world computes its longitude. "Eastern time," to which the hour from Maine to Florida and in the region of the lower lakes is adjusted, conforms to the time of the seventy-fifth meridian, which is five hours slower than Greenwich time. Its region begins at 67½° longitude, or as near there as is convenient, and ends at or about 82½°. West of this is the region of Central time, which is governed by the time at the ninetieth meridian, and extends to longitude 97½°, including the Mississippi and Missouri Valleys, the upper lakes and Texas. The next division will conform to the one hundred and fifth meridian, and will include the Rocky Mountain region; and the next, for the Pacific coast, to the one hundred and twentieth meridian. To the east of the "Eastern time" region of the United States the maritime British provinces are expected to set their clocks by the time of the sixtieth meridian, one hour ahead of any part of the United States. As the clocks in the United States have for many years been practically regulated by the railroads, it will probably not be long before the whole country, and every interest in it, will be computing its hours so as to conform with the new standards. The movement of which this is the first and a very important practical step was begun in 1875 by the American Metrological Society, and is designed to embrace the whole world. It has been approved, in principle at least, by numerous learned societies and international associations. The complete scheme involves the division of the whole earth into time-sections of 15° of longitude, or one hour each, with standards of time determined at every fifteenth meridian; the establishment of a point where for the purposes of the monthly calendar the day shall end and the next day begin, at the one hundred and eightieth meridian from Greenwich; and a numbering, for scientific purposes at least, of the hours of the day from one to twenty-four without interruption.

Greek in the Colleges.—The "Boston Globe" says that "the Phi Beta Kappa address of Charles Francis Adams, Jr., is bearing fruit sooner and more plentifully than even he could have expected. The meeting of college presidents from nearly all the New England colleges, held in Boston the other evening for the purpose of discussing the question, indicated a very general agreement with the less sweeping of his propositions. A number of the gentlemen were ready to make a beginning of reform. Mr. Adams touched a fuse that was all ready to go off." This presents the case about as it is. The colleges were all represented at the meeting by the modern-language men, who naturally argued the claims of their department with earnestness. President Porter, of Yale, was absent, but President Robinson, of Brown, who was present, believes in the ancient languages for a foundation; and Presidents Bartlett, of Dartmouth, Carter, of Williams, and probably Seelye, of Amherst, are rather conservative in this matter. President Eliot, of Harvard, on the other hand, means to give an A. M. ultimately without regard to Greek. He hopes neither to require it in college nor in preparation, but to make modern languages an equivalent. Yale, too, proposes to require either French or German for examination, and will probably lessen its requirements of the ancient languages in order to make the preliminary work no more severe than now. The fact is, that Mr. Adams drew the attention of the country to a subject which had been receiving much consideration in the colleges, and his address will do much to hasten action in regard to the study of the ancient languages. President Eliot plans a revolution in this matter, while the other colleges will all give more attention to modern languages. At Williams, President Carter means in time to make German a required study running through sophomore year, leaving it optional the rest of the course.—*Springfield Republican.*

The March of Fever and Ague.—Dr. G. H. Wilson, of Meriden, Connecticut, reviewing the history of epidemic intermittent fever in Connecticut and other parts of New England, traces in it the evidence of a regular progress in a particular direction, and by successive advances from year to year. The advance appears to be "independent of any known or recognized influence, whether atmospheric, telluric, magnetic, or climatic, and through the most diverse conditions of surface, soil, humidity, and temperature, general and local." The direction of the movement appears to be toward the northeast; and in its invasion of Connecticut "the ague crossed, diagonally but decidedly, every one of our main rivers. Starting on the coast, west of the Housatonic, it crossed its valley the next year, but did not ascend it more than about fifteen miles in as many years. It next crossed the Naugatuck, within five miles of its mouth. The Quinepiac it first reached and crossed in South Meriden, sixteen miles from East Haven; the Connecticut at Middletown, twenty-five miles from the Sound; and the tributaries of the Thames in Coventry, forty miles from the sea." In Rhode Island, also, it entered at Westerly and passed through the State to the northeast, leaving the southeast and northwest parts unaffected. The northeast course was pursued during fifteen years, or till 1875, when the malarial influence had reached Windsor, on the Connecticut. After that time, the radiation, or lateral spread of the disease, became more decided, and it finally covered every town in the State, passing the line of Massachusetts at Agawam in 1878. In the next four years it had attacked all the towns in Western Massachusetts, and a few scattered over the eastern part of that State, and had invaded Vermont and New Hampshire, as well as Rhode Island. "It is not too much to suppose that it came over from Long Island and New Jersey, and possibly farther south, as well as from the same region over Westchester County; that its front extends from the Hudson on the west to Buzzard's Bay on the east; that it has moved a hundred miles north and east, and still reaches out its favors to those belated north-men and down-Easters who have hitherto mocked us."

Hygiene in Schools.—An article on this subject in "The Sanitary Record," by John W. Tripe, M. D., contains the following: "Children are now taught, in public, elementary, and other schools, a number of facts concerning the rivers, mountains, coasts, etc., of foreign countries, and many other things which do not immediately concern them, while the merest outlines of the relations existing between the blood and the various organs of the body, and of the changes occurring therein, rarely form any part of their education. It is not necessary to tell children about the size of the liver, the average weight and muscular power of the heart, the diameter and length of the great vessels of the body, the structure of the eye, or any other similar facts; but surely it would be better for children, at any rate in the advanced classes, to be taught as to the action of fermented liquors on the system, and on the organs by which they are excreted from the body, the injuriousness of excesses in eating and drinking, and such like facts, than commit to memory a mass of information which they forget almost as soon as learned. They would also be the better for being instructed in the relations that exist between health and the social habits and customs of those among whom they will pass their lives. They might also be told the reasons why high-heeled boots, constricted waists, unwashed skins, accumulations of refuse, and many other things, are injurious to health as well as opposed to comfort."

How Buzzards find their Prey.—On the debated question as to the particular sense by which turkey-vultures are directed to their prey from great distances, Mr. Samuel N. Rhoads brings strong evidence in the "American Naturalist" in favor of the sense of smell. In digging some sweet-potatoes, he partly uncovered a spot where a horse and cow had been buried some years before. In a few hours afterward the spot became the center over which buzzards hovered by scores, during the whole of the following day, and less numerously for several days afterward. It was a strangely interesting spectacle, he says, "to behold them swoop within a few feet of the horse-hades, and rise again with slow, reluctant flaps, indicative of disappointment, then return to deliberately 'beat' and 'quarter' the ground aërially speaking, with all the tact and persevering sagacity of their canine compeers." Gosse relates an instance that occurred in Jamaica, where vultures circled around a house in which some meat had been allowed to spoil, though they could detect nothing by sight. The smelling power which enables them thus to detect their prey must be very delicate; for Mr. Rhoads could not detect any taint in the atmosphere while he was working over the burial-place. Doubtless the birds also use their eyes, but these instances prove that the olfactory sense alone is sufficient to guide them.

Pond-Mud as a Diarrhœa-Breeder.—A fact is related in the report of the State Board of Health of Connecticut that illustrates the effect upon health of exposing the bottom of a pond. A small village in the town of Union was situated close upon the borders of a pond that was drawn down entirely during the summer and fall, for several years in succession, in order to get the water from another pond lying above it and communicating with it. When the pond was first drawn down, while the decaying materials at its bottom, which probably extended over twenty or thirty acres at least, were drying, offensive odors were complained of, and it was stated that they caused nausea and vomiting; and diarrhœal and dysenteric troubles were stated to be unusually frequent. But no cases of malaria were reported as having originated in any part of the town. Several large ponds between Palmer, Massachusetts, and Union, have been completely drawn down and had their beds exposed, without any cases of malaria being known to have originated in the region.

Pigs as Wine-Bibbers.—Mr. W. Mattieu Williams says that he once witnessed a display of drunkenness among three hundred pigs, which had been given a barrel of spoiled elderberry-wine all at once with their swill. "Their behavior was intensely human, exhibiting all the usual manifestations of jolly good-fellowship, including that advanced stage where a group were rolling over each other and grunting affectionately in tones that were distinctly expressive of swearing good-fellowship all around. Their reeling and staggering, and the expression of their features, all indicated that alcohol had the same effect on pigs as on men; that under its influence both stood precisely on the same zoölogical level." He quotes also MM. Dujardin-Beaumetz and Audigé's account to the French Academy of Sciences of their experiments during three years on the effects of alcoholic diet on pigs. "Eighteen of these animals were treated sumptuously, according to old-fashioned notions of hospitality, by mixing various alcohols with their food, in proportions about corresponding to a modest half-pint of wine at dinner. The alcohols that we drink in wine, malt-liquors, whisky, hollands, brandy, etc., invariably produced sleep, prostration, and general lassitude, while absinthe (included as another variety of alcohol) produced an excitation resembling epilepsy. Some of the animals died from the effects of alcoholic poison. The survivors were killed, and subjected to *post-mortem* examination. All were found to be injured, but the mischief was greatest when crude spirit was used, less when it was carefully redistilled and purified.

Food-Fishes of Lake Erie.—In a paper read before the Buffalo Naturalists' Field Club it is stated that Lake Erie and the Niagara River furnish thirty-seven marketable varieties of fish. But their numbers are becoming rapidly reduced in those waters, owing in great measure to so many fish being taken when they are full of roe. Some fish spawn late in the fall; the eastern salmon, salmon-trout, whitefish, brook-trout, and lake-herring, belong to this class, but the majority spawn in April, May, or early June. Black bass choose a place for their spawn-beds where the water is shallow and the bottom is a sandy gravel. They leave their winter quarters in deep water a month or six weeks previous to spawning. The eggs hatch in from one to two weeks, according to the temperature. Bass are very prolific, yielding fully one fourth their weight of spawn. The bass and the muskallonge (*Esox nobilior*) are the recognized game-fish of the lakes. Whitefish do not take the bait readily, but are caught in gill-nets, and can be taken in great numbers just at the time they are ready to spawn. They average three and a half pounds in weight, though some are taken weighing ten to eighteen pounds. Sturgeon average fifty pounds, but occasionally one is caught that weighs a hundred pounds or over. Fish differ greatly in rapidity of growth. Some grow in one, two, or three years to a definite size, and then growth seems to be arrested. Such fish are short-lived. Other kinds, which slowly and steadily increase in size, attain a great age. Pike have been known to be over a hundred years old. There is some confusion as to the names pike and pickerel. In England, where there is but one species of *Esox*, a young pike is called a pickerel. The pike of our Great Lakes is the true pike (*E. lucius*). The pickerel (*E. reticulatus*) is more common in small lakes and ponds. An easy way to distinguish them is to look at the gill-covers. If they are entirely covered with scales, it is a pickerel; but, if the lower half of the opercula is bare of scales, it is a pike.

Karen Funeral-Weddings.—Among the Shan Karens of Farther India, funerals are made the occasions of grand wedding festivals, in which all the marriageable young men and women of the village are prvileged to participate. As it is not always convenient to hold these interesting ceremonies at the exact time when a villager may die, it is customary to deposit the corpse of the deceased in some temporary resting-place, or to burn it and preserve the ashes till the times and the marriage-market are more favorable to giving it obsequies worthy of its former estate. Consequently, six months, or a year, or more, may frequently pass before the memory of the dead Karen receives the honor which is its due. When a good time for weddings comes, the remains are taken from their temporary resting-place and set upon a platform or mat which has been prepared for them, and the eligible bachelors and marriageable young women of the neighborhood having been invited to come and compete in a marrying-match, arrange themselves, dressed in their gayest, in two choirs on opposite sides of them. The "funeral service" is then begun with a chorus of the men celebrating the beauties of the Karen maidens in general. The girls respond in their drawling falsetto, "calmly accepting the eulogy of their graces." These overtures are usually set pieces, handed down from antiquity, or taken and translated from some popular Burmese play. Next, the bachelors, each in his turn, beginning usually, for the sake of peace, with the most muscular one, "deliver themselves of love-stricken solos," directed by name to the several damsels whom they have chosen; if one of them is rejected, he waits till his turn comes again, and addresses, if he sees fit, some other girl. The girls receive the proposals in perfect self-possession, and respond to them in phrases like those with which they have been addressed, the models of which have come down from the old times. All the praise the maiden has received, she appropriates as only her just due, and continuing, she declares that it is a shameful thing not to be married, but that it is worse to be divorced afterward, "to be like a dress that has been washed," but that she will do what she is bid. If the girl rejects the address, she may do so in a tone indicating that she does not consider she has been praised enough, or with some such indirect phrase as "Come to me when the full moon appears on the first day of the month; come dressed in clothes that have never been stitched. Dress and come before you wake. Eat your rice before it is cooked, and come before daylight." Rejections, however, seldom occur, except when some young man makes a mistake and applies to a girl who is known to be reserving herself for another. The "funeral service" goes on in this way till it is plain that no more alliances can be made, when it is closed, all the crockery that belonged to the deceased is broken, and the body is permanently buried. The matches thus made are binding, and no other way of making them is in favor; and, if any preliminary private courting takes place, it is subsidiary to the funereal occasion.

Steel-Iron.—Professor M. Keil has produced a composite material of iron and steel in which the valuable qualities of the two substances are combined, and the combination is made available for a variety of uses. The principle of his process is exemplified in a cast-iron mold divided centrally by a thin sheet of iron, on one side of which sheet fluid iron is poured, and on the other side fluid steel. The dividing plate should be thick enough to prevent the glowing masses on either side from burning through it, and yet so thin that those masses and it shall become thoroughly welded together. The combination has been produced in five shapes: steel by the side of iron; steel between two layers of iron; iron between two layers of steel; a core of steel with the surrounding shell of iron; and a core of iron with the surrounding shell of steel. This steel-iron may be used for a great variety of purposes in which the hard qualities of steel, enabling it to resist wear and tear, or adapting it to cutting purposes, need to be backed by a tougher material competent to resist strains and great vibration.

Hedgehogs and their History.—Professor Grant Allen, writing in an English paper of the structure and habits of the hedgehog, observes that the curious spines the animal wears on his back are a feature very apt to recur among animals of different classes the world over, which are much exposed to carnivorous enemies. The porcupine, a rodent in no way related to the hedgehog, and the Australian echidna, allied to the ornithorhynchus, have precisely similar spines. "The fact is, almost all surviving members of very low and early groups are extremely likely to have such peculiar spiny or armor-plated bodies, because only those which happened to be so protected have managed to escape the persistent attention of a million generations of vermin-eating carnivores. Hence they are apt to be either prickly, as in these instances, or else protected by a regular covering of bone-like hardness, as in the armadillo, the poyou, the pangolin, and the scaly ant-eaters. The spines of the hedgehog are in reality very hard, bristly hairs, specially developed for purposes of defense. Of course, however, he did not get these most effective *chevaux-de-frise* all at a single blow. They are the result of slow and constant modification in a long line of ancestors, and not a few intermediate forms are still in existence to show us, either directly or by analogy, the fashion in which the defensive prickles were originally evolved. The bulau, of Sumatra, has a few stout bristly hairs scattered among the fur of its back, and gives the first indication of a tendency toward the production of spines. It can not, however, roll itself up into a ball, like the hedgehog. The tanrec, of Madagascar, is covered with a mixture of hairs, bristles, and true spines; while another animal of the same island still more closely approaches the hedgehog in the greater spininess of its body and in the possession of the power of rolling itself up. "Finally, we get in Europe and Asia several kinds of genuine, fully developed hedgehogs, of which our own English specimen here in the ditch is a typical example. It is not often that all the intermediate stages between two distinct animal types have been so well preserved for us by nature as in this interesting instance."

Science in Brazil.—M. de Quatrefages recently improved the occasion of presenting to the French Academy of Sciences a number of documents from the Brazilian museum at Rio Janeiro, to speak in praise of the scientific progress that has been made in that country under the wise encouragement of the Emperor Dom Pedro II. The government, societies, municipalities, and a host of individuals, are rivaling one another in their zeal for the multiplication of educational establishments and for endowing them as richly as possible. Nearly one sixth of the revenue of the country is applied to purposes of public instruction. The first four volumes of the archives of the National Museum are marked by many valuable essays, among which were spoken of, as particularly deserving attention, the studies of Dr. Pizzarro on a curious batrachian, and of M. Frédérick Muller on insects; of M. Lacerda on the poison of different snakes and of a toad; the anthropological labors of MM. Lacerta and Peixoto on the tribe of the Botocudos, and on some skulls found in ancient funeral urns; and a memoir by M. Ladislau Netto regarding American origins and migrations. The last study is based upon the strange custom, which is observed in a large number of tribes from the extreme northwestern part of the continent to Brazil, of boring the lower lip and hanging from it ornaments of different forms and natures. A paper also appears in this volume by M. Fireira Penna on the *ceramios* of Para, low tumuli, which are wholly composed of urns or other vessels of terra-cotta, laid together and arranged in beds. The recent Brazilian Anthropological Exhibition, which was very successful, is to be followed by another, in which it is hoped the whole American Continent will be represented.

Magnetism of a Great City.—Mr. Richard Jeffries, in his essays on "Nature near London," remarks upon the way in which the magnetism of London is a force in its remotest suburbs, and the influence of the mighty city is felt in its most rural environments. "In the shadiest lane," he says, "in the still pine-woods, on the hills of purple heath, after brief contemplation there arose a restlessness, a feeling that it was essential to be moving. In no grassy mead was there a nook where I could stretch myself in slumberous ease and watch the swallows ever wheeling, wheeling in the sky. The something wanting in the fields was the absolute quiet, peace, and rest which dwell in the meadows, and under the trees, and on the hill-tops in the country." The inevitable end of every foot-path round about London is London; the proximity of the immense city induces a mental, a nerve restlessness; and, as you sit and dream, you can not dream for long, for something plucks at the mind with constant reminder "that the inland hills, and meads, and valleys, are like Sindbad's ocean, but that London is like the magnetic mountain which draws all ships to it."

Bacteria and Cholera.—Dr. Koch, of the German Cholera Commission, has made a report of the commission's examinations of cholera cases in Egypt. The disease was on the decline when the commission began its work, and this may partly account for the unsatisfactory character of the results. Twelve unquestionable cholera patients were examined, and autopsies were held on the bodies of ten persons who had died of cholera. No micro-organisms were found in the blood of the patients, and but few in the matters vomited up, but a considerable number were found in the dejections. In the autopsies, no infectious organic matter, except a few probably accidental bacteria in the lungs, was noticed in the lungs, the spleen, the kidneys, or the liver. A well-determined species of bacteria was, however, found in the walls of the intestines, and in some cases had penetrated to the tubular glands of the mucous coat, and provoked an irritation there, and had even reached the deeper layers of the mucous coat, and sometimes the muscular coat. It seemed evident that they had a connection with cholera, but whether as cause or merely as an accompaniment or result was still uncertain. To test this question, inoculations were made upon mice and monkeys, and a few dogs and chickens, and the bacterial poison was administered to some of the animals, but without effect in producing symptoms of cholera; although in a few of the cases septic affections followed. The results actually obtained, however, seem to Dr. Koch to afford a good reason why the experiments should be continued.

Superstitions about Infants.—Dr. H. Ploss remarks, in his book (in German) on "The Child in the Customs and Usages of Peoples," that the birth of a child impresses its relatives with the feeling that they are brought into the immediate presence of one of the mysterious powers of Nature, whose kindness in conferring the gift is acknowledged, and whose favor is invoked with observances in which feasts and offerings nearly always have a place; and the ceremonies observed on such occasions, and the toys that are given the child, have frequently an ingenious, sometimes an educational significance. The natural process of birth is brought, in the imagination of the people, into relation with hidden or supernatural causes: by many tribes it is supposed to be superintended by particular divinities; and the dangers and diseases to which the child is subject are ascribed to similar mysterious agencies. The accidents of pregnancy, the cries and calls, the influence of the evil-eye, the substitution of a changeling for the child, the ill-omened significance attached to certain acts, form a stock of superstitions deeply impressed in the popular imagination. From the search for supernatural means of driving away the evil spirits supposed to be working harm to the child have arisen very curious and wide-spread doctrines which are of great value in the history of customs. The little being who has come into the world is not always believed to be pure, and to have a clear right to existence. Many peoples regard it as "unclean" and not to be touched for a certain time. Others require it to be expressly recognized by the father; and some give the parents a right to expose or kill it immediately. Among most people it is considered essential to perform some kind of ceremony for formally adopting the child into the family and society. Such ceremonies are generally dietetic, or relate to washing and bathing, anointing the skin, giving the first food, circumcision, putting on clothing, or cutting the hair, and are observed as important mysteries favorable to bodily endurance and mental vigor. Here we approach the transition from the instinctive hygiene of popular customs to religious ceremonies. Survivals of the notions here pointed to are traced by Herr Ploss among popular customs that have not yet died out in the more retired districts of Europe.

Use of Salt.—Among other follies of the day, some indiscreet persons are objecting to the use of salt, and propose to do without it. Nothing could be more absurd. Common salt is the most widely-distributed substance in the body; it exists in every fluid and in every solid; and not only is it everywhere present, but in almost every part it constitutes the largest portion of the ash when any tissue is burned. In particular, it is a constant constituent of the blood, and it maintains in it a proportion that is almost wholly independent of the quantity that is consumed with the food. The blood will take up so much and no more, however much we may take with our food; and, on the other hand, if none be given, the blood parts with its natural quantity slowly and unwillingly. Under ordinary circumstances, a healthy man loses daily about twelve grains by one channel or the other, and, if he is to maintain his health, that quantity must be introduced. Common salt is of immense importance in the processes ministering to the nutrition of the body, for not only is it the chief salt in the gastric juice, and essential for the formation of bile, and may hence be reasonably regarded as of high value in digestion, but it is an important agent in promoting the processes of diffusion, and therefore of absorption. Direct experiment has shown that it promotes the decomposition of albumen in the body, acting, probably, by increasing the activity of the transmission of fluids from cell to cell. Nothing can demonstrate its value better than the fact that, if albumen without salt is introduced into the intestine of an animal, no portion of it is absorbed, while it all quickly disappears if salt be added. If any further evidence were required, it would be found in the powerful instinct which impels animals to obtain salt. Buffaloes will travel for miles to reach a "salt-lick"; and the value of salt in improving the nutrition and the aspect of horses aud cattle is well known to every farmer. The popular notion that the use of salt prevents the development of worms in the intestine has a foundation in fact, for salt is fatal to the small thread-worms, and prevents their reproduction by improving the general tone and the character of the secretions of the alimentary canal. The conclusion, therefore, is obvious that salt, being wholesome, and indeed necessary, should be taken in moderate quantities, and that abstention from it is likely to be injurious.—*Lancet.*

Intelligence of a Turret-Spider.—The nest of the *Tarentula arenicola*, or American turret-spider, is a vertical tube, extending twelve or more inches into the ground, and projecting half an inch to an inch above the surface. The projecting portion, or turret, is in the form of a pentagon, more or less regular, and is built up of bits of grass and straw, small twigs, etc., cemented with mud, like a miniature old-fashioned chimney. The upper part of the tube has a thin lining of web-silk. A nest was exhibited by Vice-President H. C. McCook, D. D., at a meeting of the Academy of Natural Sciences, of Philadelphia, which, during its journey from Vineland, New Jersey, where it was found, had been plugged at top and bottom with cotton. Upon the arrival of the nest in Philadelphia, the plug guarding the entrance had been removed, but the other had been forgotten. The spider, which still inhabited the tube, immediately began removing the cotton from the lower end, and cast some of it out. But guided, apparently by its sense of touch, to the knowledge that the soft fibers would be an excellent material with which to line its tube, it speedily put in a cotton padding for about four inches downward from the opening. Dr. McCook pointed out the very manifest inference that the spider must, for the first time, have come in contact with such a material as cotton, and had immediately utilized its new experience by adding the soft fiber to the ordinary silken lining.

NOTES.

The Franklin Institute will open an International Exhibition of Electricity and Electrical Appliances in Philadelphia, on the 2d day of September next. By a special act of Congress, all articles "imported solely for exhibition" on this occasion will be admitted free of duty; but, if they are sold or withdrawn for consumption, the regular duties must be paid upon them.

Victor-Alexandre Puiseux, a French astronomer, died in September last. He was the author of numerous memoirs on astronomical subjects to the Academy of Sciences, and had been occupied very industriously with calculations based upon the transits of Venus of 1874 and 1882.

Dr. J. B. Sutton, of Middlesex Hospital, in a communication to the "Lancet," disproves the current opinion that monkeys die chiefly from tubercle. Having been permitted to attend the *post-mortem* examinations of animals dying in the Zoölogical Gardens, Regent's Park, he personally inspected the remains of ninety-three monkeys. Of this number, three were found to have died of tubercle, twenty-two of bronchitis, three of lobar pneumonia, seven of lobular pneumonia, one of septic pneumonia, twenty-three of other diseases, including three of scrofula and four of typhoid fever, while in thirty-four cases no lesion was met with sufficient to explain the deaths of the creatures.

Dr. Conrad Bursian, a distinguished German philologist, died on the 21st of September, having just a few days before finished his great work on the "History of Philology." He had been a professor successively in the Universities of Leipsic, Tübingen, Zurich, and Munich, and was a member of several learned societies.

M. Chevreul, the "dean" of the French Academy of Sciences, reached his ninety-eighth year on the last day of August, and was still physically vigorous and fresh of heart. The President of the Academy, in taking notice of the fact, remarked: "M. Chevreul has belonged to the Academy which he has so much honored by his labors for fifty-seven years; and he would, in fact, have counted it sixty-seven years, if by an extremely rare sentiment of generosity he had not allowed himself to be passed over in 1816, to give place to a chemist (M. Proust) whom he called his master."

Statisticians have pronounced the United States to be not only potentially but actually richer than the United Kingdom. Counting the houses, furniture, manufactures, railways, shipping, bullion, lands, cattle, crops, investments, and roads, it is estimated that there is a grand total in the United States of $49,770,000,000. Great Britain is credited with something less than $40,000,000,000, or nearly $10,000,000,000 less than the United States. The wealth per inhabitant in Great Britain is estimated at $1,160, and in the United States at $995. With regard to the remuneration of labor, assuming the produce of labor to be 100, in Great Britain 56 parts go to the laborer, 21 to capital, and 23 to government. In France 41 parts go to labor, 36 to capital, and 23 to government. In the United States 72 parts go to labor, 23 to capital, and five to government.—*London Times.*

M. Joseph-Antoine-Ferdinand Plateau, an eminent physicist and emeritus professor at the University of Ghent, died September 15th, in his eighty-second year.

M. A. Milne-Edwards reports that he met with great success near Teneriffe on his deep-sea expedition in the steamer Talisman. The dredging apparatus is strong enough to bring up rocks weighing a hundred kilogrammes from the depth of a thousand metres. The collections promise to be immense, greater than it will be possible to bring home. Among the species gathered are crustaceans of forms resembling those of the Antilles, curious fishes with luminous organs, crinoids, asterias, strange holuthurians, numerous sponges, and mollusks, exhibiting a novel mingling of African with Mediterranean and Polar forms. On the Island of Branco, which had never been scientifically visited before, the expedition found large lizards, such as are not known to occur anywhere else, and which appear to have a good living of herbaceous food, although the island is nearly destitute of vegetation.

Dr. J. Lawrence Smith, of Louisville, Kentucky, died on the 12th of October last, in the sixty-fifth year of his age. He had distinguished himself by many valuable chemical researches and publications respecting them, particularly by his investigations into the composition and nature of meteoric stones. A portrait and sketch of Dr. Smith were given in "The Popular Science Monthly" for December, 1874.

Mr. Morgan J. Roberts tells in "Nature" of a collie-dog owned by him which was accustomed to go with him fishing, and took great interest in the business. She learned that there existed a close connection between the bobbing and final disappearance of the float and the pulling up of a fish, and would become very much excited whenever she saw the float in agitation. On one occasion when her master was away from the rods, observing a float disappearing, she uttered one or two sharp yelps, and, her master failing to come, herself seized the rod, and, "backing" with it, attempted to pull the line from the water. The hook held "a goodly eel."

Professor Oswald Heer, the distinguished Swiss paleontologist and botanist, died at Lausanne, September 27th. He was director of the Botanical Garden at Zurich, and editor of the Swiss "Journal of Agriculture and Horticulture"; and was the author of the "Urwelt der Schweitz" ("Primitive World of Switzerland"), which has been translated into many foreign languages; of a work on Swiss *Coleoptera;* and, in connection with Hegetschweiler, of the "Flora of Switzerland."

Millemaine is the name of a new cereal which has been introduced into South Carolina, from Colombia, South America. It is allied to sorghum and Guinea corn, and has the merit of an almost unlimited capacity to endure drought. Cakes made from the meal have been described as better than corn-cakes, and the grain has been pronounced by the chemist of the Savannah Guano Company superior in food qualities to wheat.

M. Alfred Niaudet, who died in October last, is pronounced by "La Nature" to have been the person who, more than any other one, contributed to the development in France of the industries dependent on electricity. He did valuable service to the country in his special line during the Franco-Prussian War, and, besides numerous papers on dynamo-electric machines, telephony, and telegraphy, was the author of two works that are authorities on electric piles and dynamo-electric motors.

The death is reported of M. F. S. Cloëz, an industrious French chemist, who assisted M. Chevreul some thirty-six years ago, and was afterward Professor of Physics in the School of the Fine Arts. He was author of several memoirs of considerable value.

According to Dr. Sach, of Buenos Ayres, there is no danger of an exhaustion of the quinine-supply. The experimental plantations in Java and the Island of Réunion have been very successful; and, besides these nurseries, the trees have been cultivated in Bolivia by the million for ten years. At three places in the last-named country, taken as they come, the number of trees growing is given, severally, at 70,000, 200,000, and 3,500,000.

Dr. Charles William Siemens, the distinguished engineer and electrician, died in London, November 20th, of rupture of the heart. He was born in Lenthe, Hanover, in 1823, and has given the world the regenerative gas-furnace, with an improved process for making steel; has been greatly instrumental in the extension of telegraphic cables, and has produced a series of valuable improvements in the saving and utilization of heat and in applications of electricity.

M. Jules Carret has found, by comparing the statistics of conscripts furnished from a certain region of France during ten years of the first empire with those for 1872-'79, that in every commune an increase is apparent in the average height of the inhabitants. If this is established, the fact will tend to contradict Broca's view that stature is almost wholly a matter of ethnic heredity, and to show that improvement in the conditions of life has something to do with it.

With the death of M. Louis Breguet, which took place suddenly on the 27th of October, is "effaced for the moment," says M. Blanchard, President of the French Academy of Sciences, "a name celebrated in the mechanic arts from the eighteenth century." He was the grandson and business successor of Abraham Breguet, who founded the watch-making house of that name in 1780, and was the father of the late Antoine Breguet, of the "Revue Scientifique." He was himself distinguished for services in the applications of electricity and in the advancement of telegraphy, and was a member of several learned societies. He was sixty-nine years old.

A way has been found for utilizing the bodies of animals that have died of anthrax. They are treated with sulphuric acid, and then converted into superphosphates. The germs are destroyed during the process.

Dr. John L. Le Conte, one of the most eminent American entomologists, died at his home in Philadelphia, November 15th. He presided at the Hartford meeting of the American Association in 1874. A portrait and sketch of him were given in "The Popular Science Monthly" for September, 1874.

CHARLES WILLIAM SIEMENS.

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THE NEW TORYISM.

By HERBERT SPENCER.

MOST of those who now pass as Liberals, are Tories of a new type. This is a paradox which I propose to justify. That I may justify it, I must first point out what the two political parties originally were; and I must then ask the reader to bear with me while I remind him of facts he is familiar with, that I may impress on him the intrinsic natures of Toryism and Liberalism properly so called.

Dating back to an earlier period than their names, these two political parties at first stood respectively for two opposed types of social organization, broadly distinguishable as the militant and the industrial—types which are characterized, the one by the *régime* status, almost universal in ancient days, and the other characterized by the *régime* of contract, which has become general in modern days, chiefly among the Western nations, and especially among ourselves and the Americans. If, instead of using the word "co-operation" in a limited sense, we use it in its widest sense, as describing the combined activities of citizens under whatever system of regulation, then these two are definable as the system of compulsory co-operation and the system of voluntary co-operation. The typical structure of the one we see in an army formed of conscripts, in which the units in their several grades have to fulfill commands under pain of death, and receive food and clothing and pay arbitrarily apportioned; while the typical structure of the other we see in a body of producers or distributors, who severally agree to specified salaries and wages in return for specified services, and may at will, after due notice, leave the organization if they do not like it.

During social evolution in England, the distinction between these two fundamentally-opposed forms of co-operation made its appearance gradually; but long before the names Tory and Whig came into use, the parties were becoming traceable, and their connections with militancy and industrialism respectively were vaguely shown. The truth is familiar that here, as elsewhere, it was habitually by town-populations, formed of workers and traders accustomed to co-operate under contract, that resistances were made to that coercive rule which characterizes co-operation under status. While conversely, support of co-operation under status, arising from, and adjusted to, chronic warfare, came from rural districts, originally peopled by military chiefs and their dependents, which retained the primitive ideas and traditions. Moreover, this contrast in political leanings, shown before Whig and Tory principles became clearly distinguished, continued to be shown afterward. At the period of the Revolution, "while the villages and smaller towns were monopolized by Tories, the larger cities, the manufacturing districts, and the ports of commerce, formed the strongholds of the Whigs"; and that, spite of exceptions, the like general relation still exists, needs no proving.

Such were the natures of the two parties as indicated by their origins. Observe, now, how their natures were indicated by their early doctrines and deeds. Whiggism began with resistance to Charles II and his cabal, in their efforts to re-establish unchecked monarchical power. The Whigs "regarded the monarchy as a civil institution, established by the nation for the benefit of all its members"; while with the Tories "the monarch was the delegate of Heaven." And these doctrines involved the beliefs, the one that subjection of citizen to ruler was conditional, and the other that it was unconditional. Describing Whig and Tory as conceived at the end of the seventeenth century, some fifty years before he wrote his "Dissertation on Parties," Bolingbroke says:

> The power and majesty of the people, an original contract, the authority and independency of Parliaments, liberty, resistance, exclusion, abdication, deposition; these were ideas associated, at that time, to the idea of a Whig, and supposed by every Whig to be incommunicable, and inconsistent with the idea of a Tory.
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> Divine, hereditary, indefeasible right, lineal succession, passive-obedience, prerogative, non-resistance, slavery, nay, and sometimes popery too, were associated in many minds to the idea of a Tory, and deemed incommunicable and inconsistent, in the same manner, with the idea of a Whig ("Dissertation on Parties," p. 5).

And if we compare these descriptions, we see that in the one party there was a desire to resist and decrease the coercive power of the ruler over the subject, and in the other party to maintain or increase his coercive power. This distinction in their aims—a distinction which transcends in meaning and importance all other political distinctions—was displayed in their early doings. Whig principles were exemplified in the Habeas Corpus Act, and in the measure by which judges were made independent of the Crown ; in defeat of the Non-Resisting Test Bill, which proposed for legislators and officials a compulsory oath, that they would in no case resist the king by arms ; and later, they were exemplified in the Bill of Rights, framed to secure subjects against monarchical aggressions. These acts had the same intrinsic nature. The principle of compulsory co-operation throughout social life was weakened by them, and the principle of voluntary co-operation strengthened. That at a subsequent period the policy of the party had the same general tendency is well shown by a remark of Mr. Green concerning the period of Whig power after the death of Anne :

> Before the fifty years of their rule had passed, Englishmen had forgotten that it was possible to persecute for differences of religion, or to put down the liberty of the press, or to tamper with the administration of justice, or to rule without a Parliament (Green, 705).

And now, passing over the war-period which closed the last century and began this, during which the extension of individual freedom previously gained was lost, and the retrograde movement toward the social type proper to militancy was shown by all kinds of coercive measures, from those which took by force the persons and property of citizens for war purposes to those which suppressed public meetings and sought to gag the press, let us recall the general characters of those changes effected by Whigs, or Liberals, after the re-establishment of peace permitted revival of the industrialism *régime*, and return to its appropriate type of structure. Under growing Whig influence there came repeal of the laws which forbade combination among artisans as well as of those which interfered with their freedom of traveling. There was the measure by which, under Whig pressure, Dissenters were allowed to believe as they pleased without suffering certain civil penalties ; and there was the Whig measure, carried by Tories from compulsion, which enabled Catholics to profess their religion without losing part of their civil freedom. The area of liberty was extended by acts which forbade the buying of negroes and the holding them in bondage. The political serfdom of the unrepresented was narrowed in area, both by the Reform Bill and the Municipal Reform Bill ; so that, both generally and locally, the many were less under the coercion of a few. Later came diminution and removal of restraints on the buying of foreign commodities and the employment of foreign vessels ; and later still the removal of those burdens on the press, which were originally imposed to hinder the diffusion of opinion. And of all these changes it is unquestionable that, whether made or not by Liberals themselves, they were made in conformity with the principles professed and urged by Liberals.

But why do I enumerate facts so well known to all ? Simply because, as intimated at the outset, it seems needful to remind everybody what Liberalism was in the past, that they may perceive its unlikeness to the so-called Liberalism of the present. It would be inexcusable to name these various measures for the purpose of pointing out the character common to them, were it not that in our day men have forgotten their common character. They do not remember that in one or other way all these truly Liberal changes diminished compulsory co-operation throughout social life and increased voluntary co-operation. They have forgotten that, in one direction or other, they diminished the range of governmental authority, and increased the area within which each citizen may act unchecked. They have lost sight of the truth that in past times Liberalism habitually stood for individual freedom *versus* state coercion.

And now comes the inquiry, How is it that Liberals have lost sight of this? How is it that Liberalism, getting more and more into power, has grown more and more coercive in its legislation? How is it that, either directly through its own majorities or indirectly through aid given in such cases to the majorities of its opponents, Liberalism has, to an increasing extent, adopted the policy of dictating the actions of citizens, and, by consequence, diminishing the range throughout which their actions remain free? How are we to explain this spreading confusion of thought which has led it, in pursuit of what appears to be public good, to invert the method by which in earlier days it achieved public good?

Unaccountable as at first sight this unconscious change of policy seems, we shall find that it has arisen quite naturally. Given the unanalytical thought ordinarily brought to bear on political matters, and under existing conditions, nothing else was to be expected. To make this clear, some parenthetic explanations are needful.

From the lowest to the highest creatures, intelligence progresses by acts of discriminations; and it continues so to progress among men, from the most ignorant to the most cultured. To class rightly—to put in the same group things which are of essentially the same natures, and in other groups things of natures essentially different—is the fundamental condition to right guidance of actions. Beginning with rudimentary vision, which gives warning that some large opaque body is passing near (just as closed eyes turned to the window, perceiving the shade caused by a hand put before them, tell us of something moving in front), the advance is to developed vision, which, by exactly-appreciated combinations of forms, colors, and motions, identifies objects at great distances as prey or enemies of this or that kind, and so makes possible adjustments of conduct for securing food or evading death. That progressing perception of differences and consequent greater correctness of classing constitutes under one of its chief aspects the development of mind, is equally seen when we pass from the relatively simple physical vision to the relatively complex intellectual vision—

the vision through the agency of which things previously grouped by certain external resemblances or by certain extrinsic circumstances come to be more truly grouped in conformity with their intrinsic structures or natures. Undeveloped intellectual vision is just as indiscriminating and erroneous in its classings as undeveloped physical vision. Instance the early arrangement of plants under the heads trees, shrubs, and herbs: size, the most conspicuous trait, being the ground of distinction, and the assemblages formed being such as united many plants extremely unlike in their natures, and separated others that are near akin. Or still better, take the popular classification which puts together under the same general name fish and shell-fish, and under the sub-name, shell-fish, puts together crustaceans and mollusks; nay, which goes further, and regards as fish the cetacean mammals. Partly because of the likeness in their modes of life as inhabiting the water, and partly because of some general resemblance in their tastes, creatures that are in their essential natures far more widely separated than a fish is from a bird, are grouped under the same class and under the same sub-class.

Now, the general truth thus exemplified holds throughout those higher ranges of intellectual vision concerned with things not presentable to the senses, and, among others, such things as political institutions and political measures. For among these, too, we shall find that the results of inadequate intellectual faculty, or inadequate culture of it, or both, are erroneous classings and consequent erroneous conclusions. Indeed, the liability to error is here much greater, since the things with which the intellect is concerned do not admit of examination in the same easy way. You can not touch or see a political institution: it can be known only by an effort of constructive imagination. Neither can you apprehend by physical perception a political measure: this still more requires a process of mental representation by which its elements are put together in thought, and the essential nature of the combination conceived. Here, therefore, still more than in the cases above named, defective intellectual vision is shown in grouping by external characters or extrinsic circumstances. How institutions are wrongly classed from this cause, we see in the common notion that the Roman Republic was a popular form of government. Look into the early ideas of the French revolutionists who aimed at an ideal state of freedom, and you find that the institutions and doings of the Romans were their models; and even now an historian might be named who instances the corruptions of the Roman Republic as showing us what popular government leads to. Yet the resemblance between the institutions of the Romans and free institutions properly so called was less than that between a shark and a porpoise—a resemblance of general external form accompanying widely different internal structures. For the Roman Government was that of a small oligarchy within a larger oligarchy, the members of each being unchecked autocrats. A society in which the only men who had political power, and were in a qualified sense free, were so many petty despots, holding not only slaves and dependents but even children in the same absolute bondage as they held their cattle, is, in its intrinsic nature, more nearly allied to an ordinary despotism than it is to a society of citizens politically equal.

Passing now to our special question, we may understand the kind of confusion in which Liberalism has lost itself, and the origin of those mistaken classings of political measures which have misled it—classings, as we shall see, by conspicuous external traits instead of by internal natures. For what, in the popular apprehension and in the apprehension of those who effected them, were the changes made by Liberals in the past? They were abolitions of grievances suffered by the people, or by portions of them: this was the common trait of them which most impressed itself on men's minds. They were mitigations of evils which had directly or indirectly been felt by large classes of citizens, as causes of misery or as hindrances to happiness. And since in the minds of most a rectified evil is equivalent to an achieved good, these measures came to be thought of as so many positive benefits; and the welfare of the many came to be conceived alike by Liberal statesmen and Liberal voters as the aim of Liberalism. Hence the confusion. The gaining of a popular good being the external conspicuous trait common to Liberal measures in earlier days (then in each case gained by a relaxation of restraints), it has happened that popular good has come to be sought by Liberals, not as an end to be indirectly gained by such relaxations, but as the end to be directly gained. And, seeking to gain it directly, they have used methods intrinsically opposed to those originally used.

And now, having seen how this reversal of policy has arisen (or partial reversal, I should say, for the recent Burials Act, and the efforts to remove all remaining religious inequalities, show continuance of the original policy in certain directions), let us proceed to contemplate the extent to which it has been carried during recent times, and the still greater extent to which the future will see it carried if current ideas and feelings continue to predominate.

Before proceeding, it may be well to say that no reflections are intended on the motives which have prompted one after another of these various restraints and dictations. These motives were doubtless in nearly all cases good. It must be admitted that the restrictions, placed by an act of 1870 on the employment of women and children in Turkey-red dye-works, were, in intention, no less philanthropic than those of Edward VI, which prescribed the minimum time for which a journeyman should be retained. Without question, the Seed Supply (Ireland) Act of 1880, which empowered guardians to buy seed for poor tenants, and then to see it properly planted, was moved by a desire for public welfare no less great than that which in 1533 prescribed the number of sheep a tenant might keep, or that of 1597, which commanded that decayed houses of husbandry should be rebuilt. Nobody will dispute that the various measures of late years taken for restricting the sale of intoxicating liquors, have been taken as much with a view tó public morals as were the measures taken of old for checking the evils of luxury, as, for instance, in the fourteenth century, when diet as well as dress was restricted. Every one must see that the edicts issued by Henry VIII, to prevent the lower classes from playing dice, cards, bowls, etc., were not more prompted by desire for popular welfare than were the acts passed of late to check gambling.

Further, it is no part of my present purpose to question the wisdom of these modern interferences, which Conservatives and Liberals vie with one another in multiplying, any more than the wisdom of those ancient ones which they in many cases resemble. We will not here consider whether the plans of late adopted for preserving the lives of sailors are or are not more judicious than that sweeping Scotch measure which, in the middle of the fifteenth century, prohibited vessels from sailing during the winter. For the present, it shall remain an open question whether there is a better warrant for giving the police powers to search certain provision-dealers' premises for unfit food than there was for the law of Edward III, under which innkeepers at seaports were sworn to search their guests to prevent the exportation of money or plate. We will assume that there is no less wisdom in that clause of the Canal-boat Act, which forbids an owner to gratuitously board the children of the boatmen, than there was in the Spitalfields Acts, which up to 1824, for the benefit of the aritsans, forbade the manufacturers to fix their factories more than ten miles from the Royal Exchange.

We exclude, then, these questions of philanthropic motive and wise judgment, taking both of them for granted, and have here to concern ourselves solely with the compulsory nature of the measures which, for good or evil, as the case may be, have been put in force during periods of Liberal ascendency.

To bring the illustrations within compass, let us commence with 1860, under the second administration of Lord Palmerston. In that year, the restrictions of the Factory Act were extended to bleaching and dyeing works; authority was given to provide analysts to be paid out of local rates; there was an act providing for inspection of gas-works, as well as for fixing quality and limits of price; there was the act which, in addition to further mine-inspection, made it penal to employ boys under twelve unable to read and write; and there were further provisions for cheap locomotion on railways. In 1861 occurred an extension of the compulsory provisions of the Factory Act to lace-works; power was given to poor-law guardians, etc., to enforce vaccination; local boards were authorized to make improvements in private property, and charge to the owner; and certain locally-formed bodies had given them power of taxing the locality for rural drainage and irrigation works, and for supplying water to cattle. In 1862 an act was passed for restricting the employment of women and children in open-air bleaching, and an act for making illegal a coal-mine with a single shaft, or with shafts separated by less than a specified space. In 1863 came the extension of compulsory vaccination to Scotland, and also to Ireland; there came the empowering of certain boards to take from rate-payers money to employ and pay those out of work; there came the empowering of town authorities to take possession of neglected ornamental spaces, and rate the inhabitants for their support; and there came the Bakehouses Regulation Act, which, besides specifying minimum age of employés occupied between certain hours, prescribed periodical lime-washing, three coats of paint when painted, and washing with hot water and soap at least once in six months. Of compulsory legislation dating from 1864, may be named an extension of the Factory Act to various additional trades, including regulations for cleansing and ventilation, and specifying of certain employés in match-works that they might not take meals on the premises except in the wood-cutting places. Also there were passed the Chimney-Sweepers Act, the act for further regulating public-house closing, the act for compulsory testing of cables and anchors, and the Contagious Diseases Act, which last gave the police, in specified places, powers which, in respect of certain classes of women, abolished sundry of those safeguards to individual freedom established in past times. The year 1865 witnessed further provision for the reception and temporary relief of wanderers at the cost of rate-payers; and another public-house closing act containing sixty-four amendments. Then, under the ministry of Lord John Russell, in 1866, have to be named an act to regulate cattle-sheds, etc., in Scotland, giving local authorities power to inspect sanitary condition, and fix number of cattle; an act forcing hop-growers to label their bags with the year and place of growth, and the true weight, and giving police power of inspection; an act to facilitate the building of lodging-houses in Ireland, and providing for regulation of the inmates; a Public Health Act, under which there is registration of lodging-houses and limitation of occupants, with inspection and directions for lime-washing, etc.; and a Public Libraries Act, giving local powers by which a majority can tax a minority for their books.

Passing now to the legislation under the first ministry of Mr. Gladstone, we have, in 1870, the establishment of state-telegraphy, with the accompanying interdict on telegraphing by any other agency; we have inspection, not only of endowed schools but of registered private schools, and dismissal, without appeal, of teachers and officials not approved; we have a law authorizing the Board of Public Works to give compensation for landlord's improvements; we have the act which enables the Education Department to provide school-boards, purchase sites for schools, provide free schools supported by local rates, and enabling school-boards to pay a child's fees, to compel parents to send their children, etc., etc.; we have a further Factories and Workshops Act, making, among other restrictions, some on the employment of women and children in fruit-preserving and fish-curing works. In 1871 we meet with an amended Merchant Shipping Act, directing officers of the Board of Trade to record the draught of sea-going vessels leaving port; there is another Factory and Workshops Act, making further restrictions; there is a Peddlers' Act, inflicting penalties for hawking without a certificate, and limiting the police-district within which the certificate holds, as well as giving the police power to search peddlers' packs; and there are further measures for enforcing vaccination. The year 1872 had, among other acts, one which makes it illegal to take for hire more than one child to nurse, unless in a house registered by authorities, who prescribe the number of infants to be received; it had a Licensing Act, interdicting sale of spirits to those under sixteen; and it had another Merchant Shipping Act, establishing an annual survey of passenger-vessels, as well as an interdict against pilots who are not licensed. Then, in 1875, was passed the Agricultural Children's Act, which made it illegal for a farmer to employ a child who has no certificate of elementary education; and there was passed a Merchant Shipping Act, requiring, on each vessel, a scale showing draught, requiring examination of officers, and prescribing the number of boats and life-preservers. Turn now to Liberal law-making under the present ministry. We have, in 1880, a law which forbids conditional advance-notes in payment of sailors' wages; and also a law which dictates certain arrangements for the safe carriage of grain-cargoes. In 1881 comes legislation to prevent trawling over clam-beds and bait-beds, and an interdict making it impossible to buy a glass of beer on Sunday in Wales. In 1882 corn-factors were required, under a penalty of twenty pounds, to furnish for publication a weekly return of their transactions; municipal bodies were enabled to levy rates for electric lighting; further exactions from rate-payers were authorized for facilitating more accessible baths and wash-houses; and local authorities were empowered to make by-laws for securing the decent lodging of persons engaged in hop-picking, or picking fruit and vegetables. Then, finally, of such legislation during the last session may be named the Cheap Trains Act, which, partly by taxing the nation to the extent of £400,000 a year (in the shape of relinquished passenger duty), and partly at the cost of railway-proprietors, still further cheapens traveling for workmen: the Board of Trade, through the Railway Commissioners, being empowered to insure sufficiently good and frequent accommodation. Again, there is the act which, under penalty of ten pounds for disobedience, forbids the payment of wages to workmen at or within public-houses; there is another Factory and Workshops Act, commanding inspection of white-lead works and bake-houses, regulating times of employment in both, and prescribing in detail some constructions for the last, which are to be kept in a condition satisfactory to the inspectors.

But we are far from forming an adequate conception if we look only at the compulsory legislation which has actually been established of late years. We must look also at that which is advocated, and which threatens to be far more sweeping in range and stringent in character. We have lately had a cabinet minister, one of the most advanced Liberals, so called, who pooh-poohs the plans of the late Government for improving industrial dwellings as so much "tinkering"; and contends for effectual coercion to be exercised over owners of small houses, over land-owners, and over rate-payers. Here is another cabinet minister who, addressing his constituents, speaks slightingly of the doings of philanthropic societies and religious bodies to help the poor, and (apparently ignoring the Poor Law) says that "the whole of the people of this country ought to look upon this work as being their own work"; that is to say, some wholesale government measure is called for. Here, again, is a radical member of Parliament, who leads a large and powerful body, aiming, with annually-increasing promise of success, to enforce sobriety by giving to local majorities power to prevent freedom of exchange in respect of certain commodities. There is a rising demand, too, that education shall be made gratis for all: the payment of school-fees is beginning to be denounced as a wrong—the state must take the whole burden. Moreover, it is proposed by many that the state, regarded as an undoubtedly competent judge of what constitutes good education for the poor, shall undertake also to prescribe good education for the middle classes—shall stamp the children of these, too, after a state pattern, concerning the goodness of which they have no more doubt than the Chinese had when they fixed theirs. Then there is the "endowment of research," of late energetically urged. Already the Government gives every year the sum of many thousand pounds for this purpose, to be distributed through the Royal Society; and, in the absence of those who have much interest in resisting, the pressure of the interested, backed by those they easily persuade, may by-and-by establish that paid "priesthood of science" long ago advocated by Sir David Brewster. Once more, plausible proposals are made that there should be organized a system of compulsory insurance, by which men during their early lives shall be forced to provide for the time when they will be incapacitated.

Nor does enumeration of these further measures of coercive rule, looming upon us near at hand or in the distance, complete the account. Nothing more than cursory allusion has yet been made to that accompanying compulsion which takes the form of increased taxation, general and local. Partly for defraying the costs of carrying out those ever-multiplying coercive measures, each of which requires an additional staff of officers, and partly to meet the outlay for new public institutions, such as board-schools, free libraries, public museums, baths and wash-houses, recreation-grounds, etc., local rates are year after year increased, as the general taxation is increased by grants to the departments of science and art, etc. Every one of these involves further coercion—restricts still more the free action of the citizen. For the implied address accompanying every additional exaction is: "Hitherto you have been free to spend this portion of your earnings in any way which pleased you; hereafter you shall not so spend it, but we will spend it for the general benefit." Thus, either directly or indirectly, and in most cases both at once, the citizen is, at each further stage in the growth of this compulsory legislation, deprived in one or other way of some liberty which he previously had.

Such, then, are the doings of the party which claims the name of Liberal, and which calls itself Liberal as being the advocate of extended freedom.

I doubt not that many a so-called Liberal will have read the preceding section with impatience, wanting, as he does, to point out an immense oversight which he thinks destroys the validity of the argument. "You forget," he wishes to say, "the fundamental difference between the power which, in the past, established those restraints that Liberalism abolished, and the power which, in the present, establishes the restraints you call anti-Liberal. You forget that the one was an irresponsible power, while the other is a responsible power. You forget that, if by the recent legislation of Liberals people are variously regulated, the body which regulates them is of their own creating, and has their warrant for its acts."

My answer is, that I have not forgotten this difference, but am prepared to contend that the difference is in large measure irrelevant to the issue.

In the first place, the real issue is whether the lives of citizens are more interfered with than they were; not the nature of the agency which interferes with them. Take a simpler case. A member of a trades-union has joined others in establishing an organization of a purely representative character. By it he is compelled to turn out if a majority so decide; he is forbidden to accept work save under the conditions they dictate; he is prevented from profiting by his superior ability or energy to the extent he might do were it not for their interdict. And he can not disobey without abandoning those pecuniary benefits of the organization for which he has subscribed, and bringing on himself the persecution, and perhaps violence, of his fellows. Is he any the less coerced because the body coercing him is one which he had an equal voice with the rest in forming?

In the second place, if it be objected that the analogy is faulty, since the governing body of a nation, to which, as protector of the national life and interests, all must submit under penalty of social disorganization, has a far higher authority over citizens than the government of any private organization can have over its members; then the reply is that, granting the difference, the answer made continues valid. If men use their liberty in such a way as to surrender their liberty, are they thereafter any the less slaves? If people by a *plébiscite* elect a man despot over them, do they remain free because the despotism was of their own making? Are the coercive edicts issued by him to be regarded as legitimate because they are the ultimate outcome of their own votes? As well might it be argued that the savage who breaks a spear in another's presence that he may so become bondsman to him, still retains his liberty because he freely chose his master.

Finally, if any—not without marks of irritation, as I can imagine—protest against this reasoning, and say that there is no true parallelism between the relation of people to government where an irresponsible single ruler has been permanently elected, and the relation where a responsible representative body is maintained, and from time to time re-elected, then there comes the ultimate reply—an altogether heterodox reply—by which most will be greatly astonished. This reply is, that these multitudinous restraining acts are not defensible on the ground that they proceed from a popularly chosen body; for that the authority of a popularly chosen body is no more to be regarded as an unlimited authority than the authority of a monarch; and that as true Liberalism in the past disputed the assumption of a monarch's unlimited authority, so true Liberalism in the present will dispute the assumption of unlimited parliamentary authority. Of this, however, more anon. Here I merely indicate it as an ultimate answer.

Meanwhile it suffices to point out that until recently, just as of old, true Liberalism was shown by its acts to be moving toward the theory of a limited parliamentary authority. All these abolitions of the restraints over religious beliefs and observances, over exchange and transit, over trade combinations and the traveling of artisans, over the publication of opinions, theological or political, etc., etc., were tacit recognitions of the propriety for limitation. In the same way that the final abandonment of sumptuary laws, of laws forbidding this or that kind of amusement, of laws dictating modes of farming, and many others of like meddling nature, which took place in early days, was an implied admission that the state ought not to interfere in such matters; so were those removals of hindrances to individual activities of one or other kind, which the Liberalism of the last generation effected, practical confessions that in these directions, too, the sphere of governmental action should be narrowed. And this recognition of the propriety of narrowing governmental action was a preparation for narrowing it in theory. One of the most familiar political truths is that, in the course of social evolution, usage precedes law, and that, when usage has become well established, it becomes law by receiving authoritative recognition and defined form. Manifestly, then, Liberalism in the past, by its practice of limitation, was preparing the way for the principle of limitation.

But, returning from these more general considerations to the special question, I emphasize the reply that the liberty which a citizen enjoys is to be measured, not by the nature of the governmental machinery he lives under, whether representative or other, but by the number and degree of the restraints it imposes on him ; and that, whether this machinery is or is not one which he has shared in making, its actions are not of the kind proper to Liberalism if they increase such restraints beyond those which are needful for preventing him from directly or indirectly aggressing on his fellows—needful, that is, for maintaining the liberties of his fellows against his invasions of them ; restraints which are, therefore, to be distinguished as negatively coercive, not positively coercive.

I doubt not, however, that the Liberal, and still more the subspecies Radical, who more than any other in these latter days seems under the impression that so long as he has a good end in view he is warranted in exercising over men all the coercion he is able, will continue to protest. Knowing that his aim is popular benefit of some kind, to be achieved in some way, and believing that the Tory is, contrariwise, prompted by class-interest and the desire to maintain class-power, he will regard it as palpably absurd to group him as one of the same genus—will scorn, as mere chop-logic, the reasoning used to prove this.

Perhaps an analogy will help him to see its validity. If, away in the far East, where personal government is the only form of government known, he heard from the inhabitants the account of a struggle by which they had deposed a cruel and vicious despot, and put in his place one whose acts proved his desire for their welfare—if, after listening to their self-gratulations, he told them that they had not essentially changed the nature of their government, he would greatly astonish them ; and probably he would have difficulty in making them understand that the substitution of a benevolent despot for a malevolent despot still left the government a despotism. Similarly with Toryism as rightly conceived. Standing as it does for coercion by the state *versus* the freedom of the individual, Toryism remains Toryism, whether it extends this coercion for selfish or unselfish reasons. As certainly as the despot remains a despot, whether his motives are good or bad, so certainly does the Tory remain a Tory, whether he has egoistic or altruistic motives for using state-power to restrict individual liberty, beyond the degree required for maintaining the liberties of other individuals. The altruistic Tory as well as the egoistic Tory belongs to the genus Tory, though he forms a new species of the genus. And both stand in distinct contrast with the Liberal as defined in the days when Liberals were rightly so called, and when the definition was, "one who advocates greater freedom from restraint, especially in political institutions."

Thus, then, is justified the paradox I set out with. As we have seen, Toryism and Liberalism originally emerged, the one from militancy, and the other from industrialism. The one stood for the *régime* of status, and the other for the *régime* of contract—the one for that system of compulsory co-operation which accompanies the legal inequality of classes, and the other for that voluntary co-operation which accompanies their legal equality; and beyond all question the early acts of the two parties were respectively for the maintenance of agencies which effect this compulsory co-operation, and for the diminution of them. Manifestly the implication is that, in so far as it has been extending the system of compulsion, what is now called Liberalism is a new form of Toryism.

How truly this is so, we shall see still more clearly on looking at the facts the other side upward, which we will presently do.

COLLEGE ATHLETICS.

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I.—ADVANTAGES.

VERY few persons will dissent from the proposition that students should exercise their bodies. If called upon to state the amount and kind of exercise needed, most people would be at a loss to prescribe these particulars, and would content themselves with the usual generalities about its being essential to health; that it should be so regulated as to be recreative, but not so excessive as to be exhausting. There are numbers of intelligent men who, even assenting to these generalities, never wake to the real truth of them till a violated law of nature inflicts its penalty in their own ill health. However, we must assume that we shall have the assent of sensible people if we start with two principles: first, that young men who study need exercise; and, second, that exercise, to be beneficial, should be regular and systematic. If we can show that college athletics supply this need to quite a large body of students, and supply it regularly and systematically, we may secure a patient consideration of their good effects long enough to add a discussion of their accompanying evils. In this discussion we hope to prove that the evils have been exaggerated; that they are not so great as would be the evils of a college-life without a system of athletics; and, lastly, that such evils as do inhere in the present system are capable of remedy.

In order to give foundation and strength to our belief in the benefits of physical exercise, let us consider what it does, and how really necessary it is. Though we admit the truth of all the wise sayings with regard to a "sane mind in a sound body," we are yet too apt to regard the sound body as a mere accident of inheritance or environment. So we read the proposition as an hypothetical one, viz., "If the body is sound, the mind will be sane." Few but physicians read it as indicating a connection between body and mind, by means of which we can make, or help to make, a good healthy brain by making a good sound body. In the fact that the brain always seems to direct the body, we are prone to forget that the body carries the brain and feeds it with its own life. If the body has good blood, the brain will have good blood also. If the body does not furnish good material, the brain will do, according to its capacity, poor work, or will not work at all. That many men of weak bodies have done good brain-work in their day is true, but many such men have been hindered from doing better work by physical weakness. Moreover, can any man say that the work done would not have been greater or better if the men doing it had had better bodies? After the body has attained maturity, most men recognize the connection and sympathy between mind and body. During the time of growth, however, this interdependence is often taken into small account.

There are two kinds of brain-work—one which we may very properly call body brain-work, and the other mind brain-work.* Most people, including a great many educators of youth, consider mind brain-work to be the only kind of brain-work. But body brain-work is quite as essential to the healthy existence of the brain, and really comes first in the order of brain-growth. The child, too young to know anything except its bodily wants, and conscious of them only when the denial of them causes pain, develops brain every time it makes a will-directed effort to grasp the thing it wants. The movement of its hand is as necessary to the development of its brain as the guidance and government of the brain are to the growth of the hand. What is true of the hand is true of the other bodily organs whose motion is under the control of the will. They and the brain are developed by reciprocal action. Interfere with this body brain-work in childhood, or at any period of growth, either by repressing it or by diverting from it too much vital energy to mind brain-work, such as is involved in the acquisition of knowledge, and you not only stunt the body, but also enfeeble the brain, by depriving both of their proper growth. The worst feature of such interference, at such a time, is that the evil then done can not be remedied, and the power lost to body and brain can never be regained.

Care to guard against this interference is all the more necessary in cases in which the brain is large or sensitive. Now, will any man say

* Dr. Clarke, "Building of a Brain."

that at the time of life when young men come to our American colleges, when, in fact, all their bodily organs are approaching maturity, this body brain-work ought to cease, or can, without danger, be neglected? Is it not most essential that at this very period the reciprocal action between body and brain should be steadily maintained, in order that both should be able to endure the strain put upon them by the various stimulants of thought and feeling to be found in college-life? The great pressure brought to bear upon them is toward conscious cerebration. Acquisitions of knowledge, scholarships, the ambitious desires of parents, and prizes, all incite them to neglect body brain-work, under the mistaken impression that time given to that is time lost to the other. Many a fine scholar has left college with great honors, to experience in his subsequent career the serious results of the mistake made in college, and has discovered, often too late, that a vigorous body to carry his brain is more essential to success in life than a well-trained brain full of knowledge but lacking a strong body from which to draw its nourishment and strength.

Again, exercise, to be beneficial, should be regular and systematic. To be most beneficial it should be in the open air. The oxygenation of the blood is not the least important effect of exercise. In consequence of the reciprocal action of mind and body, to be as beneficial as possible it should be accompanied by mental occupation. The mind should be interested in the exercise while the body is engaged. How shall all these requisites of the best kind of exercise be secured? First, a regularly set *time* for exercise; next, a fixed *amount* of time devoted to it; then a *place* where the lungs should breathe fresh air; and, lastly, a *kind* of exercise which should engage the mind as well as the body. By the present system of college athletics these requisites are met, if not perfectly, at least as well as it is possible for them to be met. If the millennium had come, and all men, and especially young men, would do right, without any compulsion, and simply because it is the only thing to do, we might come to a settlement of these important particulars of exercise for our students. The regularity of the exercise, and the amount of time devoted to it, could easily be arranged. There could be no question as to the expediency of taking it in the open air. But how secure the co-operation of the mind? How make bodily exercise interesting, so that a man will desire to take it and will take it with gladness, not making a burden of it, and not considering it as a duty merely? That is the real problem to solve, when we set ourselves to the task of prescribing the right kind of exercise. Very few can be induced to exercise from a sense of duty. The majority go without it till they suffer illness from the want of it, and then prefer a doctor's remedies to Nature's. Here athletics accomplish the greatest good. They do furnish a mental stimulus. They set up an object to be striven for, and an ideal of strength or skill. The object is honor—honor of no great worth, perhaps, but still honor to the student-mind. In boating, the object is a victory over a crew of a rival class or a rival college. In lacrosse, base-ball, and foot-ball, besides working for the ultimate object of the championship, the mind of the player has continual occupation in the game itself. To secure a victory in any of these sports, good brains in the players contribute quite as much as good muscles. In fact, it is the skilled muscles rightly directed by good brains which win, and not the players most skilled in the use of their muscles. Mind as well as body has to be considered by the successful captains in the selection of their men. Then there are minor considerations which keep students in steady training, and help to induce more men to work than finally appear in the great contests, such, for instance, as the ambition to secure an office or position in one of the university organizations, and thus an honorable standing as a college man. These various considerations not only accompany the men into the field or at the oar, but also, when they are prevented from taking out-door practice, send them into the gymnasium to prepare for the later work.

The following brief account of the exercise taken by the students is offered in order to insure a better understanding of the system of college athletics:

Almost as soon as the college opens in the fall, the various class nines begin their games for the college championship. At the same time the class crews, the foot-ball and lacrosse teams put their men into training. This means regular exercise in the open air from four to six weeks for about one hundred and forty men. Quite as many more are benefited, some by actual participation in the games, in order to furnish opponents to the teams in practice, and others by training for the Athletic Association contests. After the class base-ball championship is decided, and the Athletic Association meetings have terminated, fewer men exercise. The interest of the college then centers in the Foot-ball Elevens, one selected from the whole university, and the other from the freshman classes of the academic and scientific departments. To give these teams practice, all the college is urged to go to the field and play against them; and though, of course, the invitation is not accepted as extensively as it is given, yet it does induce quite a large number of men to exercise. But this is not the only good effect of the existence of these teams. Catching the enthusiasm of the sport, often the men of different dormitories and of different eating-clubs send out teams for matches. The foot-ball season terminates at the thanksgiving recess. The two or three weeks intervening between this recess and the winter examinations see very little exercise taken by the students, except by the few who regularly use the gymnasium. Immediately on the opening of the winter term activity in athletics manifests itself again. The captain of the University Crew, the captain of the University Base-ball Nine, the captains of the different class crews, and the captain of the Freshman Base-ball Nine, call for men who wish to try for positions on these organizations. The candidates are put into regular training in the gymnasium, while the season prevents exercise out-of-doors. Nearly a hundred men come forward, who are actually in training for at least one hour a day. They are required to live rightly in all respects. Each man is bound to avoid excesses of all kinds. The force of a public opinion created by the sight of these men attending to their physical development, and living according to laws and rules, acts upon the college world to encourage regularity of life and obedience to authority. It is a moral power in the community. As soon as the season permits, the men are sent out-of-doors. The crews take their seats in the boats. The nines take their positions in the field. The spring regatta terminates the practice of the class crews, but, as that event occurs about three weeks before the June examinations, and five weeks before the close of the college year, it does not leave the young men a long time without exercise. The University, Consolidated, and Freshman Nines, the Lacrosse Team, and the University Crew (with sometimes a second eight), continue their practice much longer, some of them stopping work only after the close of the college year.

Now, it may be said that the writer has only shown that regular exercise has been secured during a few weeks of the first term to one hundred and forty men at the most, and during the whole winter term to one hundred men ; and in the spring and summer to one hundred men part of the term, and to half that number during the whole of the term. Granted. But there are other organizations which induce men to exercise. The Athletic Association has already been mentioned. This gives three exhibitions ; one during the winter or early spring in the gymnasium, and two in the open air, one in the summer and one in the fall. The Dunham Rowing Club has a membership of forty-four men. Then there are canoe clubs, tennis clubs, and gun clubs. It would be putting the estimate too low to say that at least half of the undergraduate members of the academic and scientific departments get quite a regular amount of systematic out-door exercise from, or in consequence of, the present system of college athletics. This activity, too, has been mainly the outgrowth of the attention given to boating and to base-ball. They had the first regular organizations, and the others have taken pattern from them. It is no argument against the system that all the members of the university do not take advantage of it. The need of exercise is met, and opportunities for regular and systematic exercise are given, with inducements to take it, which do act upon at least half of the membership of the two departments most in need of it. The system might do more good if time were set apart by the various Faculties for the purpose of encouraging exercise, but in considering the system it must be borne in mind that it has grown up in a continual struggle for existence ; and, until within a few years, without either help from graduates or favor from the college authorities. But, in view of the good already done by it as a voluntary system proceeding from the students themselves, no candid man can maintain that it should be put aside without a fair consideration of its merits. In addition to those already mentioned, we claim for it the following advantages:

1. The college is sending out a better breed of men. College athletics send their healthy influence into the schools, and in them consequently increased attention is given to physical development. Thus the material coming from the schools is improved. In college this material is better preserved and better developed under the present system of athletics. More well-trained minds in more forceful bodies are graduated from college than in former years. What President Eliot says on this subject is as applicable to Yale as to Harvard: "It is agreed on all hands that the increased attention given to physical exercise and athletic sports within the past twenty-five years has been, on the whole, of great advantage to the university; that the average physique of the mass of students has been sensibly improved, the discipline of the college been made easier and more effective, the work of many zealous students been done with greater safety, and the ideal student been transformed from a stooping, weak, and sickly youth, into one well-formed, robust, and healthy."

2. The system of college athletics gives opportunity for the development of certain qualities of mind and character not all provided for in the college curriculum, but qualities nevertheless quite as essential to true success in life as ripe scholarship or literary culture. Courage, resolution, and perseverance are required in all the men who excel in athletic sports. The faculty for organization, executive power, the qualities which enable men to control and lead other men, and again those other qualities by which men yield faithful obedience to recognized authority, are all called into action in every boat-race, in every ball contest, and through all the preliminary training. In athletics the college world is a little republic of young men with authority for government delegated to presidents, captains, and commodores, and loyally supported by the resources and bodies of the governed. Is the system not worth something as a means of preparation for the responsibilities of life in the larger republic outside the campus?

3. The system is conducive to the good order of the college. It conduces to good order in furnishing occupation for the physically active. There are men in every class who seem to require some outlet for their superabundant animal life. Before the day of athletics, such men supplied the class bullies in fights between town and gown, and were busy at night in gate-stealing and in other pranks now gone out of fashion. A number of them were dissipated men, and had to diversify the monotony of their class-room life by a spree and a row. Many such men, under the present system, find occupation for all this activity in regular training. A man who goes into training can not go on sprees,

and must economize and systematize his time in order to both study and train. Having steadied their nerves by hard work of the muscles, many such men settle down to study and often make fair scholars. Any instructor who has kept track of the ways of college during the past fifteen years can not fail to be struck by the decreasing number of the really great disorders, by the mildness of those which remain, and by the increasing regard on the part of the students for college authority, college property, and for the rights of fellow-students.

The system is conducive to the good order of the college, because it furnishes a healthy, interesting topic of conversation out of study-hours. Dr. McCosh has been reported to be alarmed by the very absorbing nature of this topic of conversation. The reporter makes him say, "When one walks across the campus, the conversation he overhears bears no relation to the science and knowledge which we come here to pursue, but it is this game and that game, this record and that record." Does the gentleman suppose that, if there were no athletics, members of the college who meet one another on the campus would fall into conversation on the absorbing questions of science and knowledge? The college world is like the world in general, in that its inhabitants, when off duty, find their recreation in talking of other subjects than those of regular business. The campus is the place where the students discuss other themes than those of the class-room, for the reason that they come together on the campus for diversion. They rightly regard the study and the lecture-room as the places in which the themes of knowledge and science are properly considered. It is not to be expected, neither would it be wise nor desirable, that young men should spend all their time in thinking and talking of their studies. Since they must have something else for their leisure hours, it is well for them to have some such healthy topics of conversation as the athletic sports furnish. They naturally seek some excitement with which to vary the monotony of recitations and lectures. Their manly contests supply this want, and prevent many a man from looking to dissipation and disorder as reliefs from the daily drudgery of the study and the class-room.

Again, the system conduces to good order in its effects upon class-feeling. It acts upon this class-feeling in two ways: first, in the contests between class organizations furnishing a safety-valve for it; and, second, in the university organizations tending to moderate it. The *esprit de corps* of a class is not bad in itself. It often furnishes a motive to combined action which can be made powerful for good. In the contests between the class organizations, and in all the athletic exhibitions of the college, there are legitimate opportunities for the free play and development of this feeling. But it is possible for it to become excessive, so that a class, as a body, may have a dangerous feeling of actual enmity to another class. It is this excessive class-feeling which is the active power in the disorders between classes. It is at this point that the influence of the university organizations acts as a check. Since these organizations are composed of men of all classes, it is impossible for all college to be enthusiastic for its crew, team, or nine, without a common sympathy binding all the classes together. Moreover, it is observable that the time of the year when the athletic contests are not absorbing the attention of the college is the very time when the disorders between classes and the persecutions of freshmen are most prevalent. Besides, the captains of the university organizations command their men to keep out of disorders, because they know that they might lose their services if these men came under the discipline of the college authorities. The writer has seen the captain of the University Foot-ball Eleven personally restraining his men from participation in a "rush." Formerly it was the strong men who incited and took the chief part in disorders. Now all their interests and all their efforts are against them.

4. The system furnishes to instructors an opportunity of meeting their pupils as men interested in a common good, without the chilling reserve of the recitation-room. It does not require a great effort to be a spectator of their contests. An interest in the contestants is a very natural result of witnessing their struggles. The college officer who gives a little of his time even to the boys' play soon finds his sympathies widen, and, by learning from actual observation how young men feel and think, becomes able to deal more wisely with those under his charge, from a fuller knowledge of them.

5. The power of the athletic contests to awaken enthusiasm ought not to be held of small account. The tendency of academic life is toward dry intellectualism. However desirable such a tendency may be for those who are training to be investigators, there can be no question that it is lamentable for a young man to begin life without enthusiasm. It is not too much to say that in many a student, while passing from freshman to the end of senior year, this spirit would die for lack of culture were it not for athletics. There is training for it in every contest witnessed. These contests affect graduates as well as undergraduates, and go far toward accounting for the warm interest which the alumni of all of the larger colleges feel in their Alma Mater.

6. The system of athletics, by its intercollegiate contests, brings the students into a wider world. They are no longer "home-keeping youths," "with homely wits." They measure themselves by other standards than those they find in the limits of their own campus.

In the next paper the writer proposes to discuss the accompanying evils of the present system of college athletics, and to present some statistics bearing upon the general subject.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

NERVOUS MALADIES.

HYGIENIC pathology, or the plan of curing the disorders of the human organism by the aid of the remedial agencies of Nature, is founded on the fact that disease is not only a wholly abnormal condition, but that, within the years allotted to the individuals of our species, there is a strong healthward tendency in the constitution of the human system, which tendency does not fail to assert itself as soon as the predisposing cause of the disorder has been removed. In the treatment of consumption and scrofula, the principles of this theory have been generally recognized; but I believe that their application to the nervous diseases (*asthenia*, neurosis, chlorosis, hysteria, nervous debility) is destined to effect a still greater reform in the present system of therapeutics.

The study of biology is largely a study of hereditary influences. In the form and structure, in all the peculiar life-habits of each organic being, we can trace the outcome of ancestral transmissions, and, as a general rule, the persistence of such peculiarities corresponds to the length of time during which the influence of their causes was impressed upon the character of the species. The period of artificial civilization, even if considered as coeval with the era of recorded history, is but a moment compared with the ages during which man-like creatures, the ancestors of our domestic animals and the prototypes of our cultivated plants, existed in the warmer zones of our planet. After six thousand years of cultivation on parched hill-sides, the vine is still by preference a tree-shade plant. After many thousand generations of cats have been fed and petted in daytime and neglected after dark, puss is still a night-prowler. Barn-yard fowl have still a predilection for thorny jungles, and in the plains of Russia the descendants of the mountain-goat climb wood-piles and cottage-roofs. In the constitution of all organic beings there is a tendency to revert to the original life-habits of the species. Biologists have long recognized the significance of that law, but its hygienic importance has hardly begun to be understood. For it implies not less than this: *That the vital functions of every living being are performed more easily and more vigorously under the conditions to which the constitution of its organism was originally adapted.* A swamp-boa may subsist for years in a dry board cage; eagles have been chained to a post for a quarter of a century, and lost the gloss of their feathers, their vigor, their courage, though not their lives. No drugs would cure the ailments of such captives; but restore them to their native haunts, and see how fast they will regain their native vigor! Their infirmities could not have been traced to any single cause, but were due to the combined influence of numerous unnatural conditions.

A similar combination of abnormal circumstances causes thousands of the perplexing complaints known as *nervous diseases*—nervous debility, languor, want of vital vigor. The introduction of narcotic drinks is no sufficient explanation for the present increase of such disorders. Prince Pückler-Muskau describes an iron-fisted Arab chieftain of Southern Tunis who, in his eightieth year, could manipulate a bow that would have nonplused the champions of our archery clubs, who undertook an expedition that kept him in the saddle for three days and two nights, and who could abstain from food for the same length of time, but always traveled with a skinful of moist coffee-paste, which he sucked and chewed like tobacco. West China mountaineers, able to contest the prize of any weight-lifting match or wrestling-bout, and of otherwise most abstemious habits, can not subsist without a daily dose of the national beverage. No sensible person would maintain that such people owe their vigor to their narcotic tipples; no pathologist would deny that it deprives them of part of their strength, but that its use alone could cause the premature decrepitude of millions of Indo-Germanic invalids would be an equally untenable assertion. It is merely an additional factor in the multitude of unnatural habits that make up the misery of our modern modes of life.

That our primogenitors passed their days among trees is one of the few points on which Moses and Darwin agree; whether four handers or frugivorous two-handers, they certainly were forest-creatures, and breathed an air saturated with elements of which the atmosphere of our tenement barracks is more devoid than the briny breeze of the ocean. Our lungs suffer for it; but not our lungs alone. Besides being the best pulmonary pabulum, oxygen is a nerve-tonic; a forester, a hunter, a Swiss shepherd-boy, in a state of tubercular consumption, would be less exceptional phenomena than in a state of nervous fretfulness. A constitutional kind of good-humor sweetens the hardships of the overtaxed peasantry of Southern Europe, as its absence certainly aggravates the misery of our factory-slaves. And it would be a mistake to suppose that only summer air can exercise this nerve-soothing influence. Let a chlorotic girl take a sleigh-ride on a cold, clear winter day, or through a snow-storm; let her skate; give her a chance to get an hour's out-door exercise even on drizzly or frosty days. The north wind may white-freeze her ear-tips, but it will restore the color of her cheeks, it will restore her appetite, her energy, and her buoyant spirits. Those whom necessity compels to limit their out-door rambles to the half-mile between home and shop, should let the night make up for the shortcomings of the day, and sleep—in dry weather, at least—in the draught of a wide-open window. Only a first experiment of that sort will necessitate the addition of a night-cap to one's bedclothing; and even nervous ladies will resist the temptation to cover up their faces, if they find how soon the wonted morning languor gives way to the influence of Nature's restorative. Those who dislike to risk the discomfort of initiation before ascertaining the value of the remedy can make another test-experiment: After a summer excursion, when fatigue and early rising enable anybody to sleep soundly in an open tent, the first few nights after returning home will be a favorable time for defying the night-air superstition and sleeping, perhaps with slight qualms of the old prejudice, but without the least bodily discomfort, on a balcony or in an open hall, with open windows on all sides. After a week, transfer the couch to the old air-tight bedroom, and note the result: All the next forenoon a queer feeling of discomfort, as after a prolonged exposure to the fumes of a smoky kitchen, will illustrate the difference between natural and unnatural modes of life. To persons who have thus emancipated themselves from the delusions of the night-air dread, the atmosphere of a close bedroom is oppressive enough to spoil the night's rest and bring on a relapse of many of the distressing concomitants of nervous insomnia. A slight elevation of the window-sash will remedy the evil, and we might expatiate upon the correlation between the nerve-centers and the respiratory apparatus of the human body, but the plain ultimate reason is that the organism has been restored to an essential element of its original existence.

Jacob Engel has a story of a splenetic student who composed his own funeral dirge, with a lugubrious list of the sorrows from which he anticipated demise would liberate his soul. On discovering the lyric, his father ordered him to excavate a gravel-bank for a family vault, as none of his relatives could be expected to survive his untimely fate. The prescription proved a success, and a few weeks later Heraclitus Junior was caught writing sonnets to the hired girl. Want of exercise is, indeed, a most fruitful cause of nervous maladies. Our Darwinian relatives, creatures so similar to us in the structure of every muscle, every joint and sinew of their bodies, are the most restless habitants of the woods. "It makes one dizzy to watch the evolutions of the long-armed gibbons," Victor Jacquemont writes from the Nerbudda; "the first one I saw made me think that he was suffering from an acute attack of St. Vitus's fits, but I have found out that it is a chronic disease. They keep moving while the sun is in sight." Savages alternate their wigwam holiday with periods of prodigious exertion, and an occasional mountain tour would atone for a good many days of city life, but hardly for weeks of sedentary occupation. Without at least one hour per day of active out-door exercise, no native strength of constitution can resist the morbific influences of stagnant humors. Of the immortal soul's dependence upon the conditions of the body there are few stranger illustrations than the psychic influence of narcotic drugs. A mere indigestion can temporarily metamorphose the character of the patient, and all manner of symptoms ascribed to "heart-disease," aneurism, intestinal parasites, spinal or cerebral affections, are often simply due to depraved humors and their reaction on the nervous system. By increasing the action of the circulatory system, physical exercise promotes the elimination of such humors, with their whole train of morbid consequences—chlorosis, tantrums, troubled dreams, and the nervous affections proper; restlessness and want of vital energy. What amounts of "tonic" nostrums—keeping their promise of restoring the vigor of the system by producing a *fever-energy*—would be thrown in the gutter, if the patient could be persuaded to try the receipt of Jacob Engel! "When I reflect on the immunity of hard-working people from the effects of wrong and over feeding," says Dr. Boerhaave, "I can not help thinking that most of our fashionable diseases might be cured *mechanically instead of chemically*, by climbing a bitterwood-tree, or chopping it down, if you like, rather than swallowing a decoction of its disgusting leaves." For male patients, gardening, in all its branches, is about as fashionable as the said diseases, and no liberal man would shrink from the expense of a board fence, if it would induce his drug-poisoned wife to try her hand at turf-spading, or, as a last resort, at hoeing, or even a bit of wheelbarrow-work. Lawn-tennis will not answer the occasion. There is no need of going to extremes and exhausting the little remaining strength of the patient, but without a certain amount of *fatigue* the specific fails to operate, and experience will show that labor with a practical purpose—gardening, boat-rowing, or amateur carpentering—enables people to beguile themselves into a far greater amount of hard work than the drill-master of a gymnasium could get them to undergo. Besides the potential energy that turns hardships into play-work, athletes have the further advantage of a greater disease-resisting capacity. Their constitution does not yield to every trifling accident; their nerves can stand the wear and tear of ordinary excitements; a little change in the weather does not disturb their sleep; they can digest more than other people. Any kind of exercise that tends to strengthen—not a special set of muscles, but the muscular system in general—has a proportionate influence on the general vigor of the nervous organism, and thereby on its pathological power of resistance.

For nervous children my first prescription would be—the open woods and a merry playmate; for the chlorotic affections of their elder comrades—some diverting, but withal fatiguing, form of manual labor. In the minds of too many parents there is a vague notion that rough work brutalizes the character. The truth is, that it regulates its defects: it calms the temper, it affords an outlet to things that would otherwise vent themselves in fretfulness and ugly passions. Most school-teachers know that city children are more fidgety, more irritable and mischievous than their village comrades; and the most placid females of the genus *homo* are found among the well-fed but hard-working housewives of German Pennsylvania.

That hard work in the factory does not lead to the same result is due to the contrast between fresh and foul air; but also to the difference between sunshine and artificial twilight. Light is a chief source of vital energy, and every deduction from the proper share of that natural stimulus of the organic process is sure to tell upon the well-being of every living organism. See the difference between the vegetation of the south side and the north side of the same mountain-range, the gradations in the stunted appearance of hot-house plants, house-plants, and cellar-plants, the achromatism and strange deformities of animals inhabiting the waters of underground rivers. The direct rays of the sun seem to exercise many of the effects which the manufacturers of "electric brushes" ascribe to the use of their contrivances. In ancient Rome special sun-bathing houses were used as a specific for a form of asthenia, which was then more frequent than premature debility—the infirmity of extreme old age. In winter-time white-haired invalids, stripped to the waist, basked for hours under the glass-roof of a *solarium* which excluded the chill winds, but admitted the light from all sides, and the same remedy would prove even more effective in the treatment of chlorosis—properly a twilight-disease, and due to the same causes that rob a cellar-plant of its color and vigor. A board fence may fail to remove the fear of peeping Toms, but on sequestered mountain-meadows, warmed by a July sun, or better yet on the beach of a lonely sea-shore, the patient may while away an hour in the costume of the Nereids; or, after the manner of the sensible Brazilians, children may at safe hours be permitted to turn a leafy garden into paradise. Persons of highly limited means can utilize the elevation of their garrets, and use a half-screened window-corner as a *solarium*, for hours together. The expectation of disastrous consequences will be as surely disappointed as the dread of the night air. "Colds" are not taken in that way. The hairy coat which may, or may not, have covered the bodies of our prehistoric forefathers, did not interfere with the beneficial action of the solar rays, and it is not the least among the disadvantages of our artificial modes of life, that this benefit is now limited to one tenth, or, in the case of a muffled-up lady of fashion, to one per cent, of the cutaneous surface.

The diet should be sparing, but not to the degree of being astringent, for chronic constipation and nervousness are almost invariable concomitants. There are many appetizing vegetable articles of diet of which a liberal quantum can be eaten without exceeding the needs of the organism; but here, more than elsewhere, it is of paramount importance to remember the chief rule of the peptic catechism: not to eat till we have leisure to digest. Vertigo, myopsis (visions of floating specks clouding the eye-sight), palpitation of the heart, and the indescribable irritations and discomforts of the sufferers from nervous disorders, can frequently be traced to the influence of after-dinner work — work, perhaps, requiring severe mental application, though the brain aches for rest—while about a million of American school-teachers and counting-house drudges still aggravate their misery by the use of tonic bitters in the United States, and of ginger-drops and *chilé colorado* in South America. Narcotic drinks are an equally fruitful source of nervous affections, and *tea,* the chief culprit, is too often mistaken for a liberator. A cup of "good, strong tea" relieves a nervous headache in exactly the same manner that medicated whiskey relieves the distress of a torpid liver, and the fact that the abnormal excitement is regularly followed by a depressing reaction would not undeceive the victim of the stimulant-delusion, if the repetition of the stimulation-process were not sure to impair the efficacy of the tonic, unless the dose is steadily increased. Only after that increase has in vain been carried to an alarming extent, the patient is apt to look for a less delusive remedy. And yet the sudden discontinuance of a long-wonted tonic will at first aggravate the distress to a degree that would overtax the endurance of most persons, and the trials of the transition period should therefore be mitigated by the influence of some healthy stimulus—the diversion of a journey, or of an exciting and very pleasant occupation. Indigestible made dishes should also be carefully avoided, and the gratitude of suffering thousands—both nurses and patients—awaits the philanthropist who shall give us a treatise on the art of preparing an appetizing dinner without the use of the frying-pan. Nervous people are extremely fastidious, especially in the choice of their solid food, and doubly so after the interdict of their favorite liquids, yet a single plateful of fried and spiced viands may bring on a relapse of the unhappiest symptoms, with the attendant mental affections of the poor followers of Epicurus who "would be perfect gentlemen if it were not for their tantrums." Spleen is a disorder of the nerves, rather than of the brain, and a large complexus of nerve-organs is situated in the close proximity of the stomach. The eel-stews of Mohammed II kept the whole empire in a state of nervous excitement, and one of the meat-pies which King Philip failed to digest caused the revolt of the Netherlands. If hired girls had a vote in the matter, ladies of a certain temper would be restricted to a diet of attractive vegetables.

Everything that tends to exhaust the vital resources of the body disposes it to nervous disorders. *Sexual excesses,* therefore, contribute a large share to the debilitating influences of civilized life. Hysterical affections may sometimes result from the unsatisfied cravings of the sexual passion, but chiefly because the suppression of that instinct often leads to its perversion. There is such a thing as mental incontinence; the writings of hysterical nuns, for instance, abound with erotic effusions. And, while spinsters and widows are often strong-minded to an unsexing degree, the most pitifully nervous women are found among the wives of the wretches who consider a marriage-contract a license for illimited venery. For girls of a chlorotic disposition, a prurient literature does what sewer-gas would do for a consumptive—though idleness will find other means to supply the want of dime-novels. In such cases, *out-door work* is worth all the medicines of the drug-market.

A quiet country home is the best refuge from the sufferings of that dreary form of nervous disorders that result from the reaction of deep mental wounds—disappointed hope, reverses of fortune, or the loss of a favorite child. Seasons make no difference; the very hardships of rustic life often act as a balm in such afflictions. After the death of his only son, Goethe sought solace among the pines of the Thuringian forest, like Shenstone in his Ainsford solitude, and Petrarch in his hermitage of Vaucluse. "A sick man," says old Burton, "sits upon a green bank, and, when the dog-star parcheth the plains and dries up the rivers, he lies in a shady bower, *fronde sub arborea ferventia temperat astra*, and feeds his eyes with a variety of objects, herbs, trees, to comfort his misery—or takes a boat on a pleasant evening, and rows upon the waters, which Plutarch so much applauds, Ælian admires, upon the river Pineus—in those Thessalian fields, beset with green bays, where birds so sweetly sing that passengers, enchanted, as it were, with their heavenly music, *omnium laborum et curarum obliviscantur*, forget forthwith all labors, care, and grief." Especially if the passenger can be persuaded to row his own boat, and to dismiss the delusion that the night-mists of his Pineus have to be counteracted with a bottle of alcoholic bitters.

In the homes of the poor, nervous afflictions are sometimes the result of *insufficient sleep*. After a sleepless night, the attempt to engage in labor of an exacting kind will lead to a fever of fidgets and nervous twitchings, and the same consequences may result from the habit of rising every morning before Nature admits that the gain of the night has quite equalized the expenses of the foregoing day. But it is a true saying that we are not nourished by what we eat, but by what we digest, and that an indigestible meal is as bad as a fast-day. Nervous people should remember that unquiet sleep is not much better than sleeplessness, and that the blessing of a good night's rest can be enjoyed only in a well-ventilated bedroom. With the largest possible supply of fresh air by day and by night, with sunshine, out-door exercise, and healthy food, the most obstinate nervous disorders can be gradually overcome; the impediments yield, till the river of life flows with an unobstructed current: the body has been restored to the conditions of existence for which its organism was originally adapted.

DANGEROUS KEROSENE AND THE METHODS FOR ITS DETECTION.

BY DR. JOHN T. STODDARD,
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KEROSENE, in virtue of its cheapness and the brilliant light it gives, has found its way into almost every house. And yet frequent and often horrible accidents prove that much of the oil now sold is of a most dangerous character. It is the recognized duty of the State to render the sale of such oil impossible by proper inspection. Almost daily reports of loss of property and life, as the result of the use of unsafe kerosene, show, however, that this official control fails to effect its object. This may be due, in a measure, to the undoubted negligence of cities and towns to appoint competent inspectors—if, indeed, any appointment is made—or to the carelessness of the inspectors ; but of greater importance even than this are the low standards adopted, and the unreliability of the tests which are used to determine the character of the oil.

It is the object of this paper to consider the conditions of safety in an oil used for illuminating and heating purposes, and to give a brief sketch of the principal methods which have been proposed for determining this important point.

Petroleum, from which kerosene is prepared, is, as is generally known, a mixture of a large number of intimately related compounds of widely differing volatility. Some are gaseous, and escape in this form as the petroleum issues from the ground, while others form the solid paraffine. The middle portions of the crude oil are separated from the more and less volatile compounds by distillation, and after a further process of purification go into the market as kerosene. The entire removal of the lighter and more volatile portions, which are known as naphtha and benzine, is of the utmost importance, for it is in their presence that the danger lies. Alone, they are easily ignited, and alone or mixed even in small proportion with kerosene, they readily emit vapors which are inflammable and which with air form an explosive mixture.

An oil is safe only when it will not yield these dangerous vapors at any temperature which it is liable to assume. This temperature depends obviously (1) upon that of the place where the oil is kept or used, and (2) upon the influence of the heat of the burning wick in warming the oil in the reservoir of the lamp. As the result of carefully conducted experiments with lamps of different patterns, it has been found* that the maximum increase of temperature of the oil

* "Zeitschrift für anal. Chem.," xxi, 332.

in a burning lamp is some 16° Fahr. (9° C.). Before the lamp is lighted the oil in it will in most cases have the temperature of the air about it. Our rooms in summer often have a temperature of 90° Fahr., and reach 100° Fahr. in a few exceptional days, while in winter the oil assumes even a higher temperature than this when the lamp is placed—as it often is—near a stove or an open fire.

Hence, it is plain that the lowest temperature at which an oil may evolve inflammable vapors and be considered safe must be put at 116° Fahr., or better still at 120° Fahr.

What, now, are the means for determining the temperature at which these vapors appear, and thus for deciding upon the safety or danger of an oil? It seems at first thought a simple and certain matter. Put a little oil in a cup and suspend a thermometer in it; warm it slowly, and, as the temperature rises from degree to degree, pass a lighted match just above its surface. Presently the match will cause a tiny explosion. This indicates that the dangerous vapors are appearing, and the thermometer now gives the so-called *flashing-point* of this oil. Go on heating and testing as before, and at last the oil will take fire and continue burning by itself. The mercury is now at the *burning-point*. But repeat the experiment with fresh samples of the same oil, and you will find that a trifling variation in the conditions will alter the flashing-point to a wonderful extent. The quantity of oil used for the test, the rate of heating, and the range of temperature through which the oil is heated, the distance above the surface at which the match passes—each and all have a marked influence on the determination.

The *burning-point*—or *fire-test*, as it is often misleadingly called—is of little value; for not only does it always lie above the flashing-point—which is the real danger-point—but it bears no simple relation to the latter, so that its determination gives really no clew to the temperature at which the oil becomes unsafe.

The unreliability of this simple method of testing and the importance of the problem have called forth numerous suggestions for improvement. Within the last fifteen years no fewer than twenty-five different instruments have been proposed, presenting as many more or less widely modified forms of the simple cup-tester indicated above. The most essential variations are (1) in the size and form of the oil-holder or cup, which in some apparatus is open, in others partly or wholly closed; (2) in the dimensions of the water-bath—which is invariably employed in all as the best means for communicating a slow and uniform increase of temperature to the oil; (3) in the means used for igniting the vapor—a burning match, waxed thread, small gas-jet, electric spark, or little oil-lamp standing on the cover of the oil-cup being the chief devices for this purpose.

But, notwithstanding all the ingenuity displayed, and the elaborate and costly apparatus to which it has in some instances given birth, we find Engler and Haass,* at the close of a careful investigation into the reliability of petroleum-testers, in which all the more promising methods were laboriously examined and compared, laying down these general principles, which are to be observed in the construction and use of this class of testers :

1. The quantity of oil must be the same in all experiments.—In the Saybolt tester, for instance, which was adopted in 1879 by the New York Produce Exchange (chiefly, however, for the purpose of determining the burning-point), variations of one millimetre, or about one twenty-fifth of an inch, in the height of the oil, cause differences of some degrees in the flashing-point.

2. The oil must be heated slowly and uniformly.

3. The temperature of the oil at the beginning of the test must be at least 18° Fahr. (10° C.) below its flashing-point (which is approximately determined by a preliminary test). Hence, a low-grade oil, which flashes not far from the air temperature, must be cooled down before an accurate determination can be made.

4. The size and intensity of the flame or spark used to produce the flash must remain unchanged in all tests. Increase in size or intensity lowers the flashing-point.

5. The distance of the flash-flame or spark from the surface of the oil must be the same in all tests. The flashing-point is lowered by decreasing this distance. Care must be taken that this distance is not so small that a local evolution of vapor from the surface occurs.

6. The time during which the flame or spark acts must be reduced to a minimum, increase in the time causing a sensible lowering of the flashing-point.

7. On account of the practical purpose for which the tests are made, the conditions under which the vapor is formed in the tester should correspond as closely as possible to those which determine its formation and explosion in lamps, etc.

Comment upon methods which depend for trustworthy results upon such a formidable array of conditions is hardly necessary ; the best apparatus must be electrical and costly, and even then unreliable except in the hands of an expert. We are not surprised to find Mr. A. H. Elliott, in his report of a similar investigation ordered by the New York State Board of Health, giving as his general conclusion : "Of all the apparatus examined, not one can be called perfectly satisfactory. . . . Of the electric testers it may be stated, that any advantage obtained from the use of electricity is more than overcome by the trouble necessary to maintain the galvanic battery and induction-coil." But, even if the performance of some of these instruments is such as to yield concordant results, when all the precautions are carefully heeded, these results can have only a *relative* significance, and agreement of different testers can only be secured by

* "Zeitschrift für anal. Chem.," xx, 1.

selecting one with its manipulation as an arbitrary standard, and adopting conditions in the others which shall give corresponding results. Nor can it be affirmed that all the conditions under which explosions in lamps are liable to occur are provided for in any single instrument

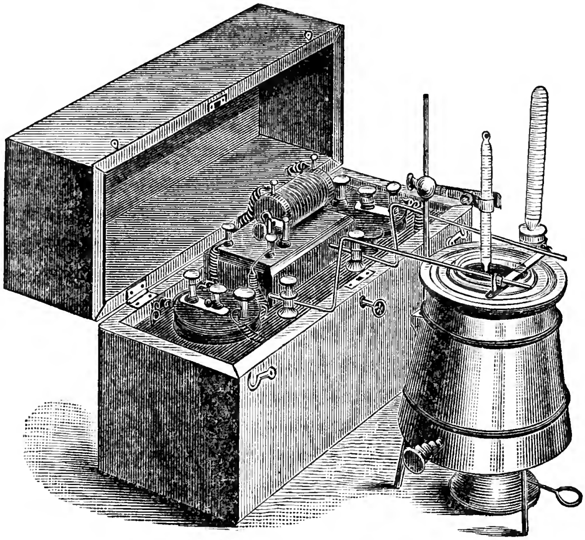


FIG. 1.—THE SAYBOLT TESTER.

of this class. The oil-reservoirs of our lamps differ much in size and shape, and hence have different capacities. Moreover, the quantity of oil, its surface, and the amount of air in the reservoir with which the vapor mingles, are constantly changing while the lamp is in use and the danger greatest. Again, it is not alone in quietly burning lamps that accidents occur. Probably half are due to upsetting or breaking, and the oil, which would have been safe otherwise, gives rise to explosion or flames under these more dangerous circumstances.

If it is important to test the oil, it certainly is wise to employ, if possible, a test which shall indicate the lowest temperature at which, under *any conditions*, inflammable vapors can be evolved, and not to trust to a method which merely proves an oil safe under certain arbitrary conditions.

Besides these instruments which aim at a direct determination of the temperature at which an oil becomes dangerous, others have been proposed in which the character of the oil is tested in an indirect manner, by finding the elastic force or tension of its vapor at a given temperature. The tension is measured by the height of the column of water which it sustains. By comparing the tension which any oil gives in this apparatus with that of some kerosene which has been selected as a standard, the quality of the former is ascertained—a higher tension indicating a more dangerous oil. It is plain that the reliability of this method depends upon the assumption that a definite relation exists between vapor-tension and flashing-point in all kerosenes. It has, however, been shown in the most conclusive manner, that this is not the case.* Four different oils, which all had a flashing-point of 28·5° to 29·5° C., as determined by one of the most trustworthy of the testers before described, were found to give, at 28° C., vapor-tensions of 75, 104, 118, and 168 millimetres (of water); and, at 40° C., tensions of 126, 149, 165, and 201 millimetres. Further, seven different kerosenes gave, when tested by the two methods, the following results:

OIL.	1.	2.	3.	4.	5.	6.	7.
Flashing-point....	25° C.	26° C.	26° C.	28° C.	30° C.	44° C.	48° C.
Tension at 35° C..	95mm.	160mm.	201mm.	73mm.	45mm.	13mm.	5mm.

It thus appears that the results obtained by the measurement of the vapor-tension are quite worthless as indications of the dangerous character of kerosene, and the method must be regarded as far less reliable than even the imperfect ways of testing which have been already discussed.

The uncertainties of the foregoing methods are entirely avoided by a *distillation test*, which also enables one to decide the quality of the oil as an illuminating material, and thus gives the fullest information in regard to its nature.† The oil is separated by the distillation into three fractions: a light oil distilling below 150° C.; illuminating oil coming over between 150° and 270° C.; and a heavy oil which boils above 270° C. The first fractional distillate represents the dangerous constituents, and should not exceed, according to Bielstein, five per cent of the whole. The heavy oil affects the freedom with which the kerosene burns in a lamp, and, in American kerosene, should not form more than fifteen per cent of the oil. The operation must be conducted with care, in a flask provided with a dephlegmator, and the fractions, as well as the original sample, must be weighed. These circumstances are likely to prevent the general adoption of a method which is otherwise so simple and satisfactory, and kerosene will probably be tested in the future, as now, by the determination of its flashing-point.

In 1879 Victor Meyer ‡ suggested a principle by which the minimum, or, as he called it, "true or absolute" flashing-point, could be determined. It is to *saturate air with oil-vapor* at the test-temperature. His method is simply this: A glass cylinder of about 200 c. c. capacity is partly filled with oil, stoppered with a cork through which a ther-

* Engler and Haass, *loc. cit.* † "Zeitschrift für anal. Chem.," xxii, 313.
‡ Wagner's "Jahresbericht," 1879, 1175.

mometer passes, and heated by plunging into warm water; when the temperature is reached at which the test is to be made, the cylinder is briskly shaken, the stopper removed, and a small flame introduced. Flashing-points obtained by this plan are considerably lower than those given by the methods which have been discussed, and are found, moreover, to be largely independent of the conditions so essential to success in the latter.

Haass * has described an elaborate and clever apparatus based on the same principle, and differing essentially from Meyer's only in the substitution of an electric spark, at a fixed distance from the surface of the oil, for the flame which the latter employed. In both of these methods the flashing-point depends upon the time allowed between the shaking and testing, Haass recommending an interval of one minute after the bubbles have disappeared from the surface of the oil, in order to permit the suspended oil-particles to settle. The shaking, which must be repeated from degree to degree, is a troublesome feature of these methods, and, though Meyer's apparatus is certainly simple and inexpensive enough, that of Haass is difficult of construction, electrical, and costly. The general principle of these methods is, however, without question the correct one for obtaining a minimum (and approximately "absolute") flashing-point, and it is to L. Liebermann † that we owe the suggestion of an ingenious and successful plan for

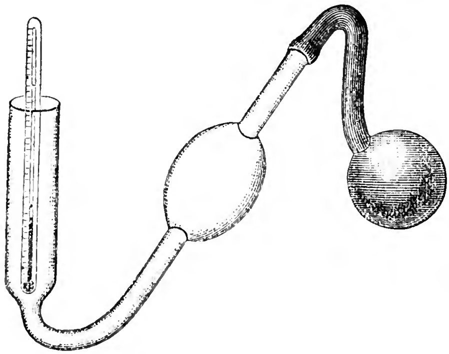


FIG. 2.—LIEBERMANN'S TESTER.

avoiding the difficulties mentioned above. In Liebermann's method the saturation of air with vapor is accomplished by forcing an air-current through the oil as it is warmed from degree to degree; and the test made by bringing a small flame to the mouth of the oil-holder at the same instant.

It has, however, been shown that the intermittent current of air which is recommended gives somewhat irregular results, and that more concordant flashing-points are obtained by letting a continuous current

* "Chem. Industrie," 1880, 123, and "Zeitschrift für anal. Chem.," xx, 29.

† "Zeitschrift für anal. Chem.," xxi, 321.

run through the oil for at least one minute before the flash occurs. It may perhaps seem, at first thought, that a continuous current of air would dilute the vapor to such an extent that the flashing-point must be materially raised, and that this effect must be more marked as the velocity of the current is increased. This is, however, not the case. On the contrary, while a *slow*, continuous current raises the flashing-point appreciably, a sufficiently *rapid* one gives nearly the same results as the intermittent method ; nor does any further increase in the velocity alter the flashing-point to a sensible extent. It has indeed been found that a large dilution of kerosene-vapor with air is necessary to furnish the conditions for the most violent explosion ; and these conditions are also those for the readiest flash by this method of testing. The most explosive mixture, according to Chandler, is formed by nine parts of air to one of vapor. The passage of a large quantity of air through the oil tends, of course, to make the flashing-point higher, by carrying away with it the more volatile portions which determine the flash, and this effect is greater when the quantity of oil is small and the air-current long continued. It is, consequently, necessary in the employment of this method to know the minimum quantity of oil and the maximum duration of air-current which will permit concordant results. These limits have been ascertained in a recent investigation,* the results or which are given a little further on.

A tester of still simpler construction than that of Liebermann has also been proposed.† It consists, as shown in the cut, of a glass cylinder, closed at one end by a cork, through which a small bent tube, *d*, *c*, *b*, passes. Just within the cork the end of this tube contracts to a small orifice. The other end of the tube connects with a small bellows, or other source of slightly compressed air, the flow of which can be regulated by the pinch-cock *e*.

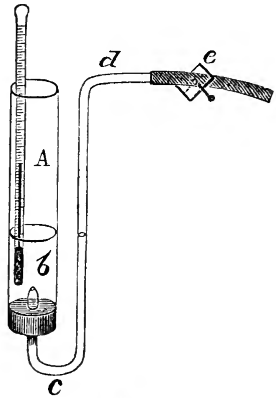


FIG. 3.

Experiments made with cylinders of different dimensions have shown that the best results are obtained when the diameter is between 2·5 and 4 c. m. The length (if only great enough to allow at least the minimum quantity of oil to be used) makes no difference. Cylinders of the same diameter but of different lengths, when filled with oil to within the same distance from the top, all give the same flashing-point. Change in length in such cases is simply equivalent to change in the quantity of oil employed in the test, and it has been proved that the quantity of oil does not affect the determination when it is above a certain minimum.

* "American Chemical Journal," vi, No 1.

† Ibid , iv, No. 4, 285, and "Ber. d. Deutschen chem. Gesell.," xv, 2555.

The distance of the oil, or rather of the foam into which the surface is broken by the air-current, from the top of the cylinder, however, makes a considerable difference in the results—the flashing-point falling as this distance is decreased, until at about 5 to 6 c. m. it reaches a minimum.

These considerations lead to the following statements and directions for the use of this method :

1. The oil-cylinder should have a diameter of 2·5 to 4 c. m. It may be of any convenient length, provided it holds, when filled, for the test not less than 50 c. c. of oil. With a diameter of 2·5 c. m., the length should be at least 16 c. m. ; with a diameter of 3 c. m., the least length should be 13 c. m. A good tester may be made from the chimney of a student-lamp, by cutting off the lower part, a little above the contraction. (Glass is easily cut by filing a deep notch at one point, and letting a little gas-flame play slowly back and forth across it in the line of the proposed section, until a crack springs quite through the glass ; this crack can then be led in any desired direction by keeping the little flame just ahead of it on the glass.) The whole chimney may also serve as an oil-cylinder by corking the large end. The irregularity of shape at the bottom does not affect the results ; but the length makes it rather inconvenient by requiring a correspondingly deep water-bath.

2. The cylinder is filled with oil to a point such that, when the air-current is running, the top of the foam is 4 or 6 c. m. below the mouth.

3. The oil is heated by means of a water-bath, into which the cylinder is plunged to the level of the oil. The temperature of the oil should not rise faster than two degrees a minute.

4. Air is forced through the oil with such velocity that about (and not less than) 1 c. m. foam is maintained on the surface, and a flash-jet brought to the mouth of the cylinder every half degree, or oftener in the vicinity of the flashing-point. The approach of the flashing-point is announced by the appearance of a faint blue halo of burning vapor around the flash-jet ; this finally detaches itself and runs down to the surface of the oil, and the reading of the thermometer at this instant gives a trial flashing-point, which may be a little too high if the air-current has been running too long, or not long enough.

The test is now repeated with a fresh sample of the oil, and the air-current started in full strength not less than one nor more than three or four minutes before the flash occurs. It is a good plan, however, to let a very slow current of air bubble through the oil from the time that the tester is put in the water-bath, so as to secure regularity in the heating of the oil.

A very good flash-jet is a little gas-flame from the tip of a blowpipe, or glass tube drawn out to a point.

The advantages of this method are :

1. Simplicity of apparatus. It can be made in a few moments by any one who can bend a glass tube.

2. Simplicity of manipulation. A manufacturer, asked to try it, obtained concordant and accurate results at the first trial.

3. Trustworthiness of the results, which are independent of arbitrary conditions, and have a significance wholly wanting in methods based upon other principles. The flashing-point determined is the *lowest*.

The lowest flashing-point for illuminating oils in New York is fixed by law at 100° Fahr., and this is as determined by a modification of the Wisconsin tester, an instrument which demands all the precautions so emphatically given by Engler and Haass. In Massachusetts, method and flashing-point are apparently both left to the wisdom and discretion of the inspector.

And yet we have seen that 116° Fahr. is the very lowest flashing-point consistent with safety, and this should mean the *minimum* flashing-point determined by some fully reliable method. We must not be misled in this matter by the statement that our best kerosenes are "150° or 160° test" oils; for this has reference, not to the flashing-point, but to the fire-test, or burning-point, which, as has already been shown, gives little indication of the character of an oil. The best oils sold *flash* at about 109° Fahr., while the cheaper grades have much lower flashing-points—at least as low as 85° Fahr.

We need not be surprised, then, at the numerous accidents; they will not diminish until a much more efficient and intelligent system of inspection is enforced than now. We are far too much inclined to take our risk, even in the midst of constant warnings; we leave our kerosene to the ignorant and careless handling of our servants; we buy, perhaps, a cheaper grade from motives of economy, only to find that the oil in which we thoughtlessly trusted has occasioned loss of property, horrible suffering, or even death.

As long as unsafe kerosene is offered for sale, we may be sure purchasers will be found. The only safe way is to banish the dangerous stuff from the market.

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

IV.—RIGHT AND WRONG.

In its scientific aspect, then, as indicated by processes of evolution, conduct is good in proportion as it tends to increase the quantity and the fullness of life, bad in proportion as it exerts a contrary influence. Conduct may tend to increase life in its fullness directly or indirectly, proximately or remotely; and again conduct may in one aspect increase, while in another aspect it may diminish, the fullness and quantity of life: but our definition of good and bad conduct is not affected by such considerations. Just as a knife may be a good knife for cutting bread, and a bad knife for cutting wood, just as a business transaction may be good in relation to some immediate purpose, yet bad when remoter effects are considered, so can we truly apply to conduct the terms *good* and *bad* in reference to one set of considerations, even though we may have to invert the terms when conduct is considered in reference to another set of considerations. But always, in its scientific aspect, conduct is to be regarded as good where it increases life or the fullness of life, and bad where it tends the contrary way.

When we separate conduct ethically indifferent from conduct in its strict ethical aspect, it is convenient to substitute for the words *good* and *bad* the words *right* and *wrong*. But the change is slighter than at first sight it appears. Indeed, the more carefully the question of rightness or wrongness—the question of *duty*—is considered, the more thoroughly does the kind of conduct judged to be morally indifferent merge into that which we regard as praiseworthy or censurable.

Taking first those parts of conduct which relate directly to the quantity or to the fullness of individual life, we find that while the terms good and bad are freely applied to them, and even the terms right and wrong, they are, for the most part, regarded as morally indifferent. When we say you *ought* to do this or to refrain from that, the idea of duty is often not really present, so long as the act in question relates to a man's own life or its fullness. Even when we use words of praise or censure in relation to such acts, they do not imply that a moral obligation has been discharged or neglected. The reason doubtless is that, as a rule, men need little encouragement to look after those parts of their conduct which affect themselves and their own interests. For it may be observed that where it is likely there may be want of due care or wisdom in such matters, there we find distinct exceptions to the general rule just indicated. So far as quantity and fullness of life are concerned, the man who crosses a crowded thoroughfare carelessly, he who neglects his business, and he who wears insufficient or unsuitable clothes in cold and wet weather, act with as little propriety in their adjustments as is shown by the man who steadily drinks intoxicating liquors. But while none preach such duties as caution in street-crossing, prudence and energy in business, and care about clothing, at least as duties morally obligatory, quite a number of persons preach against steady and heavy drinking as against a moral offense. The Bible, indeed, does not, though it has many a word of advice against wine-bibbing; yet even in the Bible we find evidence of the early existence of total abstainers, and it is altogether unlikely that those ancient Blue-Ribbonists omitted to recognize sinfulness in all who did not share their views and follow their practices. Here we find evidence of the law of moral philosophy that a system of ethics, with recognition of moral rightness and wrongness, only begins to be formed where the best conduct (so far as fullness of life is concerned) runs the chance, for whatever reason, of being neglected, and inferior conduct followed. In this case, the best conduct is apt to be neglected because the increased fullness of life to which it conduces is more remote than the temporary increase of life fullness to which inferior conduct tends.

Yet, speaking generally, it may be said that, as Mr. Herbert Spencer puts it: "The ethical judgments we pass on self-regarding acts are ordinarily little emphasized; partly because the promptings of the self-regarding desires, generally strong enough, do not need moral enforcement, and partly because the promptings of the other self-regarding desires, less strong, and often overridden, do need moral enforcement."

When we turn to the life-regarding actions of the second class, those which relate to the rearing of offspring, we no longer find the words good and bad, right and wrong, used with doubtful meaning. Here the question of duty is clearly recognized. The conduct of parents, who, by neglecting to provide for their children's wants in infancy, diminish their chances of full and active life, or of life itself, is called bad and wrong not solely or chiefly because it is not favorable to the increase of life, but as open to moral censure. In like manner, men blame as really wrong, not merely unwise or ill-adjusted, such conduct as tends to make the physical and mental training of children imperfect or inadequate.

Still clearer, however, is the use of the words right and wrong as applied to conduct by which men influence in various ways the lives of their fellows. Here the adjustments suitable for increasing the fullness of individual life, or for fostering the lives of offspring (alike in quantity and fullness), are often inconsistent with the corresponding adjustments of others. The development by evolution of conduct tending to the advancement of individual lives or lives of offspring would of itself tend constantly to acts inconsistent with the well-being or even with the existence of others, were it not for the development (also brought about, as we have seen, by processes of evolution) of conduct tending to the increase of the quantity and fullness of life in the community. But there arises a constant conflict between tendencies to opposite lines of conduct. It is so essential for the welfare of the community that tendencies to advance the life interests of self and children should be in due subordination (which is not the same thing, be it noticed, as complete subordination) to tendencies leading to the furtherance of the fullness of life in others, that rules of conduct toward others than self or children have to be emphatic and peremptory in tone. Hence it is, as Mr. Spencer justly remarks, that the words good and bad have come to be specially associated with acts which (respectively) *further* the complete living of others and acts which *obstruct* their complete living.

We approach now the heart of the matter. We have seen how conduct has been evolved in the various races of living creatures, from the lowest to man the highest. We have learned how closely related are men's ideas of good and bad to that which is the chief end of all conduct—the preservation and extension of life. And we have found that while the conception of rightness and wrongness is not very marked in relation to conduct affecting self-life, it becomes clear and obvious in relation to conduct affecting the life of offspring, and attains its greatest definiteness and as it were emphasis in its application to conduct affecting the lives of others. Where the rules determining right and wrong in regard to the life of self, of offspring, and of others, come into conflict, as they must until social relations become perfect, the right in regard to self mostly gives way to right in regard to offspring, and both usually give way to right in regard to the rest of humankind. But in Mr. Spencer's words (I quote them with emphasis, because he has been so preposterously and indeed wickedly charged with teaching a very different doctrine) "the conduct called good rises to the conduct conceived as best, when it fulfills all three classes of ends at the same time."

But now the vital question of all comes before us.

We conceive as good or bad such conduct as conduces or the reverse to life and the fullness of life, in self and others. But is conduct of the one kind really good or conduct of the other kind really bad? Though good or bad with reference to that particular end, and though held to be right or wrong because that end is actually in view among men, may not conduct be differently judged when the nature of that end is considered? In other words, the question comes before us, Is life worth living? We need not take either the optimist view, according to which life is very good, or the pessimist view, according to which it is very bad. But each one of us from his experience as regards his own life, and from his observation (often most misleading, however) on the lives of others, may be led to hold that on the whole life is good, or that on the whole it is bad. Of course, in the very theory of the evolution of conduct, or rather in the series of observed facts demonstrating the evolution of conduct, we see that life and the fullness of life are fought for throughout nature as if they were good. In the highest race the love of life in self, which assumes that the life of others also is good, has attained its highest expression. "Everything that a man has he will give for his life," is a rule established rather than shaken by exceptions and the attention directed to such exceptions. Yet the mere fact that life is fought for by all, and that the struggle for life has been so potent a factor in the development of life, does not in itself prove life to be an actual good. Death comes not alone. To creatures full of life death comes in company with pain and suffering. It may be these which move all living creatures to struggle for life, and not mere fear of death.

Now, to the question, Is life worth living? it would be impossible to give an answer that would suit all. Probably there have not been two human beings since the world was made who, could they express their precise opinion on this point, would give precisely the same answer. Many whose whole lives have been full of sorrow and trouble, who have had occasion many times to say that man was born to sorrow, would yet, even taking survey of their own sad lives, say—life is sweet. That many whose own lives have been bitter enough, think yet that life is sweet, is shown by this, that among them have been found those who have done most to foster the lives of others. But many of them would say that life is sweet, speaking even from their own experience of life. And on the other hand many who are held by those around them to have had little sorrow, who from childhood to old age have scarce ever known pain or suffering, who have had more than their fill of the pleasures of life, and have escaped the usual share of life's afflictions, would speak of life as dull and dreary if not bitter. It has been indeed from such men that the doubting cry has come, Is life worth living? Men of more varied experience would give other answers to that vain question. All answers, indeed, must be as idle as the question itself. Yet most men would give the answer which says most for the pleasantness of life—that, as a whole, life is neither bitter nor sweet, neither sharp nor cloying, but that it "has all the charm in bitter-sweetness found."

We are not concerned, however, to inquire what is the true answer to the question, Is life worth living? Though it is clear that if life is not worth living the observed action of evolution has been unfortunate, and the resulting laws of conduct are a mistake, while the reverse must be held if on the whole life is well worth living, yet, so far as our subject of inquiry is concerned, it matters not which view we take. That which is common to both views is all we have to consider. The man who holds that life is worth living, so thinks because he believes that the pleasures of life on the whole outweigh its pains and sorrows. The man who holds that life is not worth living does so because he thinks that the pains and sorrows of life outweigh its pleasures. So much is true independently of all ideas as to what are the real pleasures or the real pains of life, or whether life here is most to be considered or chiefly a future life with pleasures or pains far greater in intensity and in duration than any known here.

Where or what the chief pleasures or pains of life may be, when or how long endured, in no sort affects the conclusion that life is to be considered worth living or the reverse according as happiness outvies misery or misery happiness, and that therefore the rightness or wrongness of conduct must be judged not by its direct action on life and the fullness of life but by its indirect influence in increasing or diminishing the totality of happiness. To quote again the words of the great teacher who is so often misquoted and so much misunderstood:

"There is no escape from the admission that in calling good the conduct which subserves life, and bad the conduct which hinders or destroys it, and in so implying that life is a blessing and not a curse, we are inevitably asserting that conduct is good or bad according as its *total** effects are pleasurable or painful."—*Knowledge.*

THE AURORA BOREALIS.

By M. ANTOINE DE SAPORTA.

HOW can we describe, how can an artist paint, the aurora borealis? We of temperate climates are not strangers to the phenomena; we know something of the arcs and radiating streaks of various-colored light which frequently adorn our northern skies; and we are occasionally permitted to witness exhibitions in which the whole heavens shine with their marvelous glow. Yet travelers from the far North say that we can have no conception of the wonderful splendor of the phenomena as witnessed within the Polar Circle, and that nothing but the actual sight can convey an adequate idea of it.

The aurora borealis was well known to the ancients. The Greeks, discovering graceful symbols in everything, thought it was the glory of the Olympian gods holding council in a sky illuminated for the occasion. The Romans, on the other hand, always looking for unlucky omens, were in dread of it. Pliny, following Aristotle and Seneca, speaks of celestial fires that tinged the sky with a blood-red, of beams of light, of openings yawning in the starry vault, of fantastic lights that changed night into day; and he took care not to omit the political events that accompanied such manifestations, without, however, affirming that the phenomena were the cause of the catastrophes that attended or followed them.

* I have ventured to emphasize this word (though the emphasis is not necessary for the ordinarily attentive), simply because so many have either actually misunderstood Mr. Spencer's saying here, or else have pretended to do so. The word emphasized makes the saying not only true, but (as it was intended to be) obviously true. Mr. Spencer is here purposely stating a truism, or what ought to be a truism. No matter what a man's doctrine in religious matters may be, no matter what his views as to a future state, the saying above quoted is absolutely true. It is true in small matters as well as in great. By overlooking the word "total," or by treating the saying as though for the word "total" the word "immediate" might honestly be substituted, the saying expresses what Carlyle contemptuously called pig-philosophy; but Spencer's actual saying is about as remote from pig-philosophy as any teaching well could be. It inculcates a philosophy more truly regardful of self than the sheerest egoism, more justly and beneficently regardful of others than the purest altruism.

At troubled seasons in antiquity and the middle ages, in times of war, famine, or epidemic, the only sentiment the aurora excited was that of fear, and the people thought they could see in the sky rivers of blood, armies clashing, and infantry and cavalry engaging in mysterious combats. Now, except among a few superstitious or uninformed persons, the phenomena are witnessed with simple curiosity by some, with indifference by others.

A thousand years after Gregory of Tours, who gave the meteor the name it now bears, Gassendi first examined it with a scientific eye, and definitively baptized it on the 12th of September, 1621. The terms "polar light" and "northern light," which have been proposed by various physicists, have never prevailed; the bishop and the philosopher have triumphed. From the beginning of the eighteenth century, observations became more numerous, and theories and scientific discussions began to appear. The subject even tempted the poets. To say nothing of the Abbé Delille, an Italian Jesuit, Father Noceti, sung the aurora in Latin verse. Frazier, in 1712, first witnessed a southern aurora.

It is affirmed that the aurora was not common in Scandinavia and Holland previous to about 1716, after which it began to appear more frequently. Whether this be so or not, the attention of several Swedish, Dutch, and French investigators was fixed upon it. Celsius, the designer of the centigrade thermometer, remarked the curious distractions to which compass-needles were occasionally subject, without visible cause; studying the perturbations more closely, he had no difficulty in assuring himself (1741) that they coincided with the appearance of the aurora borealis. Hjorter, another Swede, made the same observation at about the same time.

The question whether auroras are of cosmic origin, or whether they proceed from purely terrestrial influences, which still provokes discussion, has from the beginning divided the learned into two parties. Mairan maintained the extra-terrestrial character of the meteor, while the contrary opinion found a supporter in Musschenbroek, the inventor of the Leyden-jar.

Musschenbroek, still evidently under the influence of old middle-age prejudices, gave out the following hypothesis: Near both poles, and at a little distance beneath the surface of the globe, are immense reservoirs of phosphorescent matter. Whenever a fissure is formed reaching to them, the substances, readily volatile, escape and illuminate the atmosphere with their glow. The frequency of auroras in particular years was explained by supposing a subterranean cavern to have been opened. When the pocket was exhausted, the phenomenon would of course be at an end for some time. So, after the exhaustion of the provisions of phosphorescent stuff accumulated in a particular region, the meteors would necessarily cease to show themselves, not to appear again till after a long time, during which the matter would accumulate again. It was thought that years of dry weather were years of maxima of auroras, and it seemed natural to suppose that moisture would hinder exhalations. Extensive efforts were made, without success, by studying the properties of the recently discovered phosphorescent substances, to determine the nature of the stuff that thus shone in space. Previous to this, an explanation of the phenomenon had been suggested by supposing a fermentation of gross exhalations from the earth's surface which were driven toward the pole and there took fire.

Quite different from this was Mairan's theory ; and the reading of his book, "Traité physique et historique de l'aurore boréale" ("A Physical and Historical Treatise on the Aurora Borealis"), which appeared in 1733, is still indispensable, after a hundred and fifty years, to any person wishing to study the meteor to-day. Rejecting the ideas outlined above, and another curious hypothesis, that the rays of the sun were reflected from the polar ice, and sent back to the observer from the concave surface of the upper strata of the atmosphere, he had recourse to the zodiacal light which had been observed by Cassini some fifty years before. While some explained this phenomenon by supposing a ring of light concentric with the sun, and surrounding it without touching it, others, and Mairan among the number, considered it a prolongation of the solar atmosphere, accumulated chiefly in the plane of the ecliptic or of the solar equator, and extending beyond the orbit of Venus. Emanations from the sun, or rather the corona that surrounds it, according to Mairan, strike our atmosphere and illuminate our globe. Then, must we suppose that the zodiacal light shines of itself ? That is not necessary, says Mairan. A chemical combination, an essentially luminous precipitate, results from the mixture that takes place in the upper regions of the atmosphere.* This supposition is hazardous, and Mairan seems to be a little too fast. It is, however, indisputable that then, as now, auroras were more frequent in March and September, or the months when the zodiacal light is brightest. It is also worthy of remark that Angström, in 1867, and Respighi, in 1872, found in the spectrum of the zodiacal light a green ray identical with a line of the same color characteristic of the aurora borealis.

Mairan found a redoubtable antagonist in the celebrated mathematician Euler, who did not admit the hypothesis of an immense solar atmosphere, and believed only in the existence of a ring. He invented, in explanation of the meteor, a somewhat obscure theory, according to which the subtile and rarefied portions of the air were driven away from the surface of the globe, and the particles, having become lumi-

* Mairan observes that, the centrifugal force being less toward the poles than at the equator, the parts of the globe at the tropics will repel the foreign matter, and it will accumulate toward the high latitudes. Hence there will be few auroras except in the frigid and temperate zones; and this is the case.

nous (he does not say how), gave rise, at some distance from the earth, to the phenomena of the aurora.*

A large library would hardly be sufficient to hold all the memoirs and notices that have been published during the past sixty years on the subject of the aurora borealis, to say nothing of the numerous treatises on physics, meteorology, and astronomy which have devoted one or more chapters to it. Some authors have limited themselves to the simple description of what they have perceived, or to a mere exposition of their theories, while others have done more. Alexander von Humboldt has drawn in his "Cosmos" an excellent outline of the ideas which science entertained on the subject in his time; and the "Popular Astronomy" of Arago contains valuable details, well classified and arranged, on the same question.

About 1850, M. de La Rive, a Genevese physicist, endeavored to found a definite theory of the aurora borealis, and with this view artificially reproduced the phenomenon with considerable success. A prime point, which is still far removed from being fixed, is the approximate height of the meteor above the ground. Sometimes two observers, in the neighborhood of a thousand miles apart, will affirm that they have seen the same aurora at the same time and under the same aspect; at other times, the phenomenon is visible only within a radius of a few leagues. Mairan, basing his calculations on data that are not without value, concluded an elevation of two or three hundred leagues; Bravais proposed one hundred and fifty kilometres as a mean value. Other authors have supposed that the highest flashes soar to an elevation of eight hundred kilometres.

M. de La Rive has made a table of all former data, and represents that the auroræ boreales, very low in reality, hardly pass beyond the zone of clouds. They have been perceived (by Parry) projected on the flanks of mountains. Contradictions of this view are also not wanting. In support of his opinion that the meteor is low in height, M. de La Rive cites the well-established cases in which sounds have been heard during the manifestations. Sometimes a sulphurous odor has been perceived. The crackling occasioned sometimes by slow electric discharges and the odor of electrified oxygen or ozone are quite analogous. Explorers and aëronauts have pretended, according to M. de La Rive, to have gone through the aurora or through the mist that gives rise to it.

Arago had conceived the electric nature of the meteor, and assumed to predict its appearance by consulting the compass. Other facts, proving a connection between auroras and magnetic phenomena, are abundant. Jessan, in 1878, sailing on the Venus, relates that during a fine aurora all the compasses of the vessel were disordered, and they

* In this Euler made use of Newton's corpuscular theory of light, though he was an adversary of it.

went out of their way.* Under similar circumstances, Matteucci observed the iron of the Tuscan telegraphic apparatus to be so strongly magnetized that the entire service between Florence and Pisa was interrupted. In the United States, when the like conditions are prevailing, the telegraphers work their instruments without the batteries.

The beautiful arcs of light which are observed in the polar regions have their culminating point on the magnetic meridian, as the vertical plane defined by the points of a horizontal magnetic needle is called. Bravais thought these arcs, or the circles of which they form part, were concentric with the magnetic axis of the globe, or with the straight line uniting the two magnetic poles and passing through the center of the earth. The arcs, then, do not coincide with the geographical parallels, a fact which the earlier observers had already perceived. The magnetic pole is, moreover, not immovable, but its position may vary during a century several degrees in longitude or latitude.

The auroræ boreales certainly appear to be connected with a particular condition of the atmosphere, and M. de La Rive finds in this a confirmation of his theory. Nearly all the observers agree that *cirro-stratus* clouds accompany or precede the phenomena, and are frequently seen within the dark segment. Hardly less invariable is the simultaneous presence in the air of hosts of fine, transparent, microscopic needles of ice, that favor the formation of lunar halos before the aurora itself breaks out. The essential points of M. de La Rive's theory are that the earth is charged with negative fluid, and the same is the case with the strata of air very near the soil. The upper regions of the atmosphere are, on the other hand, positively electrified. This double fact, the result of certain experiments, is not denied by any one. The two electricities of opposite polarity, accumulated near the tropics in enormous masses, are combined at the poles, where the air, less moist, is a better conductor. The polar discharges produce incessant calls of fluid, if we may use such an expression, and currents of electricity are constantly departing from the equator toward the poles, one kind traveling through the rarefied gases of the upper strata, and the other kind through the ground. It is from the phenomenon of recomposition, favored by the presence of infinitesimal vesicles of air, of imperceptible snow-crystals, and of little icy needles, that proceeds the meteor of which we are trying to present the history.

M. de La Rive satisfied himself of the sufficiency of his theory by an experiment. Tubes were inserted opposite to each other into the sides of a glass bottle. The air within the bottle was exhausted by means of one of the tubes, while in the other one was fixed a rod of iron projecting on the outside, and having its other end prolonged to

* Nevertheless, if the observer is *within* the circle formed by the aurora, its action on the needle is almost nothing. This fact has been noticed more than once.

the middle of the bottle. The iron was covered with an insulating material, except at the end, and over that was a copper ring, connected with an electrical machine. The copper was then charged with positive electricity, and the iron, having been put in communication with the soil, was negatively electrified by induction. The two electricities combined in the rarefied atmosphere of the bottle, forming a luminous sheaf, like that of the lights in the Geissler tubes; but, when the iron was magnetized, a corona or concentric aureole, whence radiated brilliant jets, was formed around its free end. As a little reflection will show, the iron represented the earth and the terrestrial magnet; the copper, the upper strata of air; and the free end of the magnetized rod, the polar regions.

The fact mentioned by Mairan, that auroras are most frequently seen during the equinoctial months, March and September, is easily explained on M. de La Rive's theory. March corresponds with a period of increasing heat in the tropical part of the northern hemisphere, while September coincides with the time when fogs are condensed from vapors near the pole. In the one case, an excess of electricity is developed; in the other, a more ready combination of the two fluids. Perhaps the supposed eleven-years period, corresponding with the sun-spot period, may be explained in a similar way. There may also be secular variations in the prevalence of the phenomenon, but too little time has passed since careful observations have been made for their law to be as yet apprehended.

In the last months of 1878, M. Nordenskjöld, who was wintering in Berhing Strait, remarked on clear nights, when the moonlight was not too strong, the presence of a feebly luminous arc, with its crest toward the north-northeast. Regular in form and curvature, this arc rested on a segment of a circle which was itself limited by the horizon, and covered about 90°, or a quarter of the horizon. Its lower limit was quite clearly marked on the dark segment, probably by contrast, but its outer outline was less distinct, and it was hard to measure its thickness exactly; but that was estimated at about five degrees. The light of the arc was calm and uniform, without any appearance of rays, but dull enough, as we have said, and displayed nothing comparable to the draperies, the brilliant flashes, and the streaks of the Scandinavian auroras. M. Nordenskjöld observed it from day to day, taking notice of all the special features he could remark, and came to the following conclusions: Above the surface of the earth, at a distance of about four hundred kilometres, is situated a permanent, or nearly permanent, luminous corona, which encircles the entire globe without its direction coinciding with that of the parallels, for its center does not correspond with the north pole, but with the magnetic pole.

So our globe has, by this theory, a ring like Saturn's, but with some differences. The ring of the latter planet is around its equator.

Our ring, incomparably smaller, covers only a narrow zone of the polar regions, the center of which is at a considerable distance from the pole. The inhabitants of Saturn's equator—if there are any—look out upon a ribbon very wide in the vertical but very narrow in the horizontal direction. On the other hand, an observer in the high latitudes of Asia or America stands in the presence of a corona of little thickness, but relatively extensive; that is, the development of our ring is nearly parallel to the part of the terrestrial surface dominated by it, and which it would overshadow if it were opaque.

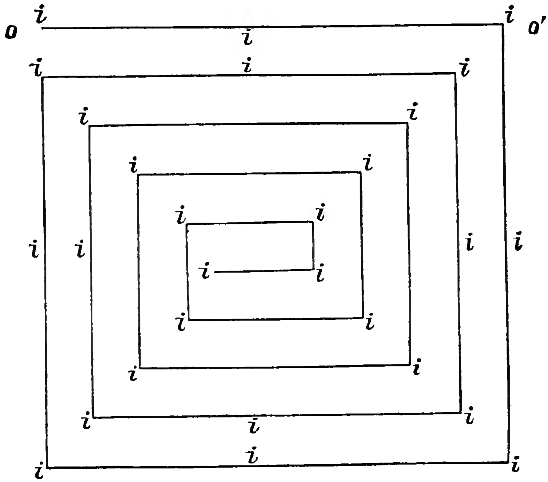
To this theory the objection may be offered, that no one before M. Nordenskjöld has remarked the meteor in question, while many should have done so if it is permanent. An observer standing near the auroral pole should perceive a luminous circle completely enveloping the horizon. M. Nordenskjöld replies to this by saying that the luminous arc is only a residuum of more brilliant and more complex phenomena; we can hardly hope to see it except in years when auroras are weak, or years of minima, of which the year 1878–'79 was one. Most commonly the accessory masks the principal, much in the same way that we can not see the foundations of a house while the building is standing. The light of the ring is so weak that not only the day and the twilight, but simple moonlight makes it invisible. If the sky is charged with frost, it will all disappear, and even the presence of too much vapor in the air extinguishes it. The observer must, then, be favored with dry and cold weather. If the temperature is above the freezing-point, it is useless to look for the corona. The coasts of Norway, moist with the breezes from the Gulf Stream, are badly situated to give views of it. Nearly all other regions where it could be perceived are dismal solitudes. In the second place, a spectator situated near the auroral poles would see nothing, for the horizon would hide the meteor from him in the same way that a Saturnian, who never left the high polar regions of his planet, would not be aware of the existence of his ring. Our observer, leaving the auroral pole, and going toward the magnetic south, would finally distinguish in that direction an arc gradually rising above the horizon. An entire circle of considerable width is dominated—that is the word—by the corona, which is then near the zenith; but, although the meteor may be nearer the ground at that point than anywhere else, it is not visible there, for it is too thin to be seen, looking at it vertically. Outside of this latter zone, another zone, concentric with it, enjoys the sight of the arc, now situated obliquely in the direction of the magnetic north. Further on, the arc, grazing the horizon, ceases to be visible; some time before reaching this point, in fact, it is hidden by the mists that gather in the horizon, as well as by the density of the atmosphere which the visual rays have to traverse. M. Nordenskjöld would not have been able to see it if it had been only half as luminous.

The meteor is relatively stationary, but is not rigorously motionless.

Besides the slow variations of its radius and its thickness, besides the oscillations which displace its center movements, the laws of which are worth studying, the luminous arc rises, falls, and fades away for intervals of some hours. Its light, generally uniform, is heightened by "knots of light" that play from one end to the other. Sometimes a second arc is formed parallel to the first; according to M. Nordenskjöld, this is nearly always concentric with the usual arc and situated in the same plane with it, but farther from the surface. Sometimes, also, the two arcs amalgamate, and a vertically flattened aurora results. Not rarely, supplementary arcs intervene, and frequently luminous rays play between the two arcs and into the undefined exterior space. If, now, we imagine the phenomena growing more complicated and becoming irregular, with the arcs rising above the horizon and the rays multiplying, shooting through the curves in such a way as to illuminate the vacant space, and extending themselves out toward the magnetic south in somewhat oblique directions, we have the common aurora borealis passably explained. Within the projection of the corona, toward the magnetic pole, is a zone where we may observe the auroras in a southerly direction, and, still nearer to that pole, the meteor only rarely illuminates the horizon. A few travelers, Dr. Hayes, for example, noticed this fact some time ago. The zone of no auroras embraces a circle having a radius of about eight degrees.

The labors of M. Lenström, in Lapland, are of particular interest, because they constitute a direct and definite proof of the electrical nature of the aurora borealis. They go further than those of M. de La Rive, for the Swedish observer, instead of operating in his laboratory, has succeeded in reproducing the meteor itself in the open air, and has compelled it to manifest itself, as Franklin forced the lightning to come down from the sky, so that he could examine it scientifically. We must not forget, furthermore, that it is a very meritorious thing to work in a cold of twenty degrees below zero, with a strong wind blowing and the frost all the time clogging the apparatus, having to be constantly on the watch, and enjoying no better shelter than a charcoal-burner's hut.

Not satisfied with provoking artificial auroras, the Finnish expedition, of which M. Lenström was a part, has collected a number of important data relative to the free manifestation of the phenomenon. The observations were made at Sodankylä (lat. 67° N., long. 27° E.), and Kultala (lat. 78° 30′ N., long. 27° E.), Lapland, in November and December, 1882. In the former place "the polar aurora appeared frequently of a very great intensity, but did not exhibit much variation. It generally began with a faint arc in the north, which shortly developed into an arc with rays and sometimes into draperies extending from the east to the west, most frequently a little toward the north. But little change of color took place; nearly always a pale-yellow tint, lightly washed with green, was shown. Although the meteor was not visible continuously, there was often observed in the spectroscope, and even quite high above the horizon, the characteristic band of the auroras without the eye perceiving any trace of their light. Since this fact was remarked even when there was no snow, it could not be attributed to reflected auroral flashes. Moreover, the observers not rarely saw during the nights a light yellowish, diffuse, and phosphorescent light that illuminated the horizon and paled the stars. The effect produced was compared to that of the moon half veiled by clouds. M. Lenström and his associates attempted, on the 8th of December, 1882, to measure the height of an auroral arc above the surface of the earth. They divided themselves into two groups, and took with a theodolite the angular distance from the crest of the arc to the horizon. The two stations were four and a half kilometres apart on the same magnetic meridian, and correspondence was had during the observations by a telegraphic wire previously arranged for the purpose. They endeavored to look in concert at the same point of the meteor, but, after reiterated essays, they recognized that any particular ray visible to one party could not be seen by the other. The results of the views were irreconcilable, for the angle obtained was greater for the southern post than for the northern one, although the latter post was, *a priori*, nearer to the meteor. M. Lenström concluded from this, as M. de La Rive had done, that every observer sees his own aurora the same as every one sees his own rainbow, and that the phenomenon is produced at the height of only a few thousand metres. He also calls attention to the results obtained in Greenland by the engineer Fritze, which lead, in certain cases at least, to numbers twenty times as small. During the Swedish Polar Expedition of 1868, faint flashes or phosphorescent lights were remarked around the summits of the mountains. This fact, with which M. Lenström did not become acquainted till 1871, related as it was to some of the descriptions given by other travelers, decided him to try to provoke or facilitate the appearance of the meteor by artificial means. The first attempts date from 1871, and, like those that followed them, were made in Lapland. The enterprise being successful from the first, the experiments were resumed during the Finnish Polar Expedition of 1882, and were renewed twice on two different peaks, called respectively Oratunturi and Pietarintunturi. Oratunturi, rising more than five hundred metres above the level of the sea, is situated in latitude 67° 21′, near the village of Sodankylä. Near the topmost height of the mountain was placed a long copper wire, so bent upon itself as to form a series of squares within squares, having a total surface of nine hundred square metres, supported by insulated posts. Tin points or nibs bristled out from this connecting net at distances of half a metre apart, and the whole was connected by an insulated wire running along on stakes with a galvanometer fixed in a cabin at the foot of the peak. The galvanometer was connected with the earth by the other extremity of its own circuit.* Nearly every night after the installation of the apparatus, a yellow-white light illuminated the points without anything like it appearing on the heights in the neighborhood, while the needle of the galvanometer by its motions betrayed the passage of an electric current. The light was analyzed in the spectroscope, and gave the greenish-yellow ray that characterizes the aurora borealis. The



intensity of the glow and the deviations of the needle, moreover, varied continually. In the mean time the hoar-frost which was deposited on the wires quickly destroyed the insulation, and rendered an experiment of any duration almost impossible. The numbness of the fingers of the operators, induced by the cold, added to the difficulties of the study.

The apparatus afterward set up on Pietarintunturi, in more than 78° of latitude, was disposed in an almost identical manner, except that the surface furnished with points was a half less; but, M. Lenström remarks, the proximity to the "maximum zone" of auroras compensated for this inferiority. On the 29th of December an "auroral ray" made its appearance above the net, which it dominated vertically from a height of one hundred and twenty metres.

The difficulties of the question of the exact origin and nature of the auroral phenomena have not been solved yet; but we have good reason to believe that a long approach has been made in the recent experiments toward a solution, and grounds to believe that science will soon remove them all; and we shall no longer be able to repeat what Haüy, less than a hundred years ago, said on the same subject, "It is not always what has been known longest that is best."—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

* Professor Lenström's apparatus is represented in the figure. The wire begins at *o*, and connection with the galvanometer is made from the inner end. The letter *i* indicates an insulator.

DEFENSES OF THE LESSER ANIMALS.

By Professor L. GLASER.

ALL organic beings are, in the course of their lives, subject to a series of dangers and destructive influences arising from the conditions of climate and temperature, and from the competition of their fellow-beings, the universality and power of which are well illustrated in Darwin's phrase, "the struggle for existence." Yet all creatures are adjusted with most wonderful art and adaptation to the conditions of their existence and the state of the world around them. Among these adaptations are the means given to the most helpless animal existences for securing themselves against the depredations of their enemies. It is proper to observe, in considering this subject, that the protection enjoyed by the lower animal organisms is not absolute and individual, but that it is generally effective principally for the preservation of the species against destruction. For where peculiar means of protection are given to one creature, corresponding means for overcoming it are often given to another, its enemy. To the protective sharp sight of the rodents and birds are opposed the equally sharp sight of the fox and the long range of vision of the hawk. It is only in averaging the mass of such animals that we find they are secured as a whole against danger, while numerous individuals are overtaken by their enemies.

Some of the higher animals illustrate the manner in which Nature contrives to furnish special measures of precaution for its little-gifted, unalert, unarmed, and helpless creatures. The absence of teeth in the edentates is offset by shields or scale-armor; helpless beetles are furnished with hard wing-cases; the pheasants, quails, and larks of the fields are hidden from the keen vision of birds of prey by their earthy color, birds of the river and sea-shore by their resemblance in color to the sand and shingle.

Protection is required by the lower animals chiefly against the weather and against parasites and other external enemies. Frequently the place of their abode is their only and ordinarily a sufficient protection, as is the case with earth-worms and burrowing larvæ, wood-worms and fruit-borers. But such animals appear to be afflicted with particular enemies peculiarly fitted to hunt them out in their otherwise secure fortresses—in the shape of moles, mole-crickets, long-nosed hedgehogs, shrew-mice, and swine, hook-billed lapwings, and sharp-tongued woodpeckers. Frequently, also, each animal is defended by some special relation peculiar to its species. Insects, which in their comparatively brief state of maturity are secured by their powers of flight, have to be guarded, in their three previous conditions of egg, larva, and pupa, against hosts of enemies to which they would otherwise be an easy prey and a palatable food. In the condition of the apparently lifeless and really helpless egg, they are covered by their obscurity and littleness, or by being deposited in holes and cracks, or covered with slime or hairy or silken veils and cocoons, under which they escape all but the sharpest search and rare accidents.

More curious are the many-sided and diversified means provided for the security of the young insect during the helpless larval condition. In this state, when it is destitute of eyes and wings, it is either furnished with hairy bristles or spiny envelopes, like those of numerous caterpillars, or with covers composed of fine chips, bud-scales, or other fragments, compactly woven together with a few threads of silk; or else it is screened from the sun and from parasites and birds by a plaster of mud. A group of insects, described sometimes as sack-weavers or sack-moths, make a kind of sack or pocket out of fragments of leaves and splinters, within which they perfect their growth. The case-moths make thick and close-fitting garments for their bodies, out of leaves loosely strung together, within which they hang, head downward, from the skeletons of the leaves they have attacked, undistinguishable to birds and parasites from a long bud-scale or from a dry splinter; and clothes-moths conceal themselves in similar cases made from the hair-dust or wool of the fabrics of which they have taken possession. Some beetles envelop themselves and go through their changes in balls of earth within which they inclose themselves. The larvæ of one group protect themselves by a kind of foam which they manufacture from the juice of the plants they suck. The woolly aphides are well cared for with the great tufts of wool with which they are provided, under the cover of which they suck the juices of plants and bring forth their multitudinous offspring, which given to the winds, the same hairy envelopes serve them as sails on which they are borne afar to new plantations. A species that feeds on the ash-tree takes possession of the galls that form upon it, and can not be removed without taking off the whole limb, for birds will not attack insects thus protected. These and other aphides, which are particularly injurious to fruit-trees, are so carefully protected against the ordinary attacks of external enemies that man is left to contend against them alone. The bark-lice or scale-insects are particularly difficult to reach, and seem to multiply in perfect security against all ordinary attacks.

A whole series of gall-insects provide security for their posterity by colonizing them in the swellings or knots that are produced on the trees wherever they sting the bark and lay their eggs. The larvæ, continuing to irritate the tissues of the tree, cause the knots to swell and grow correspondingly with their own growth, and thus find themselves in a well-fortified home exactly fitted to their wants. Within the galls, the naked, helpless worms are at once protected from exterior assaults of every kind and provided with an unfailing supply of food which they can reach without effort, so that their development goes on without obstruction of any kind. According to A. Schenck, the gall-nuts of the rose are adapted to the shelter and support of the larvæ of more than two hundred species of flies, and those of the oak are also the home of numerous varieties. Malpighi, who died near the end of the seventeenth century, remarked that there was no part of the plant on which galls did not arise. The roots, runners, stalks, leaf-stems, leaves, buds, flower-stems, flowers, and fruit, all are made to serve as the nest or place of transformation for the young of one or more species of insect ; but only the aphis lives upon them permanently.

Another very frequently observed means of securing young insect broods is by envelopes formed, sometimes with great apparent skill, by rollings or foldings of the leaf. Some weevils have the art of cutting out patterns of leaves, and, without wholly severing their attachment, rolling them up into a scroll, within which they deposit their eggs ; and they do the whole with such mathematical accuracy that their constructions have been made the subjects of formal monographs, like those of Drs. Heis and Debey on the funnel-rollers. Specimens of these scrolls are familiar enough, as they have been observed on the hazel, beech, hornbeam, alder, birch, aspen, and vine, where the operations of the insects are in some seasons attended with injury to the crop. The caterpillars of many butterflies and moths are also sheltered in the same manner ; while other caterpillars associate themselves together and spin webs for their nests, in the air between the leaves and twigs of trees. Nests of this kind are frequently found on fruit-trees and shrubbery, and afford a very good degree of protection to their inhabitants against late frosts, storms, birds, and parasites. The nest of the procession-spinner serves, curiously, only as a resting-place for the insect in the larval state, though it finally becomes the common home of the pupæ. The caterpillars, to satisfy their hunger, are accustomed to leave the nest in a kind of orderly procession, climbing up the stem of the tree to wander all over the crown of the foliage, and, after they have done their work, to return again in procession to their nest. They are avoided by man on account of the irritation produced by the sting of their hairs, and are for the same reason safe against all birds but the cuckoo. A carnivorous beetle, the *Calosoma sycophanta*, also despises their fortress and their weapons, and breaks voraciously into their communities, like a wolf into a sheep-fold. We must remember here, the consummate architectural skill with which honey-bees build up their combs of waxen cells closely joined one to another. Their whole manner of life and their professional division of labor, in which they remind us of civilized human life, provoke the query, Whence the mechanical and technical skill and the intelligence of these little creatures ?

A considerable number of our insects are burrowers, and during the period of their larval development excavate, under the epidermis of the leaves and other green parts of plants, passages, small at first, but which widen as the larvæ grow, feeding themselves from the parenchyma in which they work, and at the same time obtaining a defense against external injurious influences and disturbances. They usually leave their burrow, when about to assume the chrysalis state, by a little hole that may be found at the extreme end of the excavation, and either fall to the ground or make a cocoon, attached to some plant, in the air. Other burrowing larvæ bury themselves in the ground.

For the preservation of the chrysalis, Nature has provided many insect-larvæ with the faculty of spinning, and organs for the purpose. This function is so extraordinarily developed in the larvæ of the butterflies that a whole group of that order have been called "the spinners"; while many of these spinners—the silk-worms—have been made serviceable to human civilization. Before the spinning larva advances to its last change of skin, it selects a sheltered, dry spot—between leaves, on bark, in a hedge, in turf, or on a post—and then, drawing from the spinning-glands situated under its neck and between its head and fore-feet fine silken threads, it prepares an ample, firm, and intricate web of flock-silk for its envelope. Having completed its cocoon, it shakes off its old skin, and lays itself to sleep in this soft but solidly-made bed, while its pupa-skin hardens and it awaits the time for its next transformation; and only when disturbed from without does it show by some spasmodic motion of the posterior segment that it can still feel, and that its pupa-rest is not a death-sleep, but only a temporary repose. If the larva is provided with a hairy skin or bristles, they become interwoven with the cocoon, and a composite texture is formed, which man must be careful how he touches, or the bristles will sting his fingers and make them smart. Naked caterpillars, or larvæ, weave, like the real silk-worm, cocoons of pure silk, or, like the false-caterpillars, and the larvæ of wasps, ants, and bees, transparent, cylindric-oval envelopes of a consistency like that of parchment or waxed paper. The naked caterpillars of the Hermione moth make a kind of roof of pieces of bark over a hollow which they have excavated in the ground for their bed; and a hairy larva provides for itself in a similar manner. Many other larvæ go for the security of their pupæ into or upon the ground, where they prepare, from leaf-dust, moss, and grains of sand, a ball rough on the outside but smoothly finished within, or simply a hole in the ground, as an envelope.

Arrived at last at its perfect and free state, the insect is efficiently protected by that "mimicry" which has been much discussed by Wallace and other writers, or the likeness in color, and sometimes in other qualities, which it presents to objects that are associated with its most accustomed haunts. Some instances of this mimicry may be observed among higher animals, but it is most conspicuous and significant with insects. We need only refer to the appearance of different butterflies resting with their wings folded together on flowers, leaves, bark, old walls, dead wood, etc., and to the thousands of instances daily in which insects pass unobserved by being confounded in their general harmony with the objects that are nearest to them.

The shells which serve as houses to land-snails, and which the animals close in winter by their opercula, or doors, are known to all. Many snails are not provided with shells, and they secure themselves by creeping under dead leaves, stones, or pieces of wood, or into the sod and the ground.

If we regard the animals in the water we shall find that they are furnished with safeguards as well adapted to their wants as those of their fellows of the air. The larvæ hide, like those of the *Ephemeræ*, with their whole bodies in the ground, and thus escape destruction by the fish ; or they live, like the larvæ of the May-flies, in cases made of splinters of wood, pieces of rush, seeds, bits of shells, or hollow straws and stalks of weeds. Other larvæ conceal themselves in leaf-rollings on the surface of the water or beneath the floating leaves of water-plants The soft animals of the water find their protection in shells of limestone, either spirally coiled or double-valved and kept tightly closed by a strong muscle. Crustaceans are protected by the peculiar armor which gives the class its name, and which they change once a year for a suit of larger size ; some members of the family take possession of deserted shells, and concealing their hinder parts within them live thus, and carry their acquired houses about with them, as Diogenes did his tub. The coral-polyps of the ocean build from their secretions solid, branching masses of limestone, within which they conceal their jelly-like forms, furnishing another striking example of the care Nature takes for all its creatures. The boring-worms of the sea, the *Serpulæ*, and the borers of oyster and other shells, the *Sabellæ* and the *Terchellæ*, offer other examples of a similar kind. And the *Arenicolæ*, or sand-worms, like the earth-worms of the land, find their security simply by being under the cover of the sand as they crawl around for their food.—*Translated and abridged for the Popular Science Monthly from Die Natur.*

THE COMET OF 1812 AND 1883.

By Professor DANIEL KIRKWOOD.

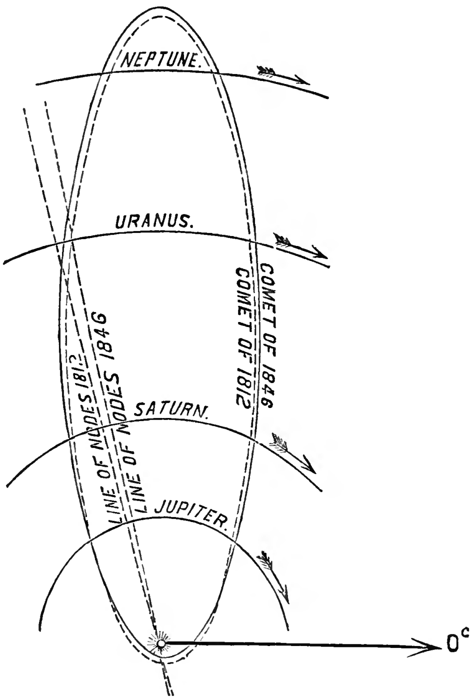
IN the quarter of a century included between August, 1802, and August, 1827, Jean Louis Pons discovered thirty comets—twice as many as all observers besides. Of this number are the celebrated comets of short period designated as Encke's, Biela's, and Winnecke's, as well as the comet of 1812, now visible on its first predicted return. It was originally detected on the 20th of July, and was the thirteenth discovered by Pons within ten years. Its appearance at first was that of an irregular nebula without tail or beard, and it was only visible through a telescope. By the 14th of September it was easily seen without optical aid; its tail was over two degrees in length, and the diameter of its nucleus was five or six seconds. It continued visible till October—a period of ten weeks—and was consequently well observed. Cooper's valuable work on "Cometic Orbits" contains eight sets of elements by different computers. Encke distinctly recognized the elliptic form of the orbit, and the elements which he assigned have been generally preferred. They are as follows:

Perihelion passage	1812, Sept., 15·3136, G. M. T.
Longitude of perihelion	92° 18′ 46″
Longitude of ascending node	253° 1′ 3″
Inclination	73° 57′ 3″
Perihelion distance	0·771
Eccentricity	0·9545
Period	70 68 years.
Motion	direct.

According to Encke, therefore, the next perihelion passage was to have been expected in June, 1883—about three months before the actual discovery of the comet by Mr. W. R. Brooks. A re-discussion of the observations of 1812 had, however, been recently completed by Dr. Schulhof and M. Bossert, whose calculations gave a probable period about seven months longer than that obtained by Encke. The true period is found to be very nearly a mean between these earlier and later estimates.

On its present return the comet was first glimpsed on the night of September 1st, by Mr. William R. Brooks, Director of Red House Observatory, Phelps, New York. He was, however, prevented by clouds from verifying his conjecture of the cometary character of the nebulous speck till the evening of the 3d. Its identity with the comet of 1812 was shown on the 18th of September, by the Rev. Mr. Searles, of New York, and independently on the day following by Professor Lewis Boss, of the Dudley Observatory. The latter designated January 25, 1884, as the date of perihelion passage. Astronomers of the twentieth century will probably witness its next apparition in the summer of 1955.

The comet of 1812 is one of a remarkable group whose periods range between sixty-eight and seventy-six years, all of their aphelia being some distance beyond the orbit of Neptune. It seems, however, to be specially related to the fourth comet of 1846. The latter was discovered by De Vico, at Rome, on February 20th, and independently, by Professor G. P. Bond, February 26th. It remained visible ten weeks, and its elements were calculated by Peirce, Hind, Van Diense, and others. The present writer has elsewhere* called attention to the close agreement of the elements of the comets of 1812 and 1846. These coincidences are seen at a glance in the following figure, where the dotted ellipse represents the orbit of the comet of 1812, and the continuous curve that of the fourth comet of 1846.



It seems difficult to regard this general similarity as accidental. A possible explanation may be found in the hypothesis of an ancient comet's separation into parts—a phenomenon known to have occurred in the case of Biela's comet. It has also been pointed out that the paths of both comets very nearly intersect the orbit of Venus; that of 1812 in true anomaly 341°, and that of 1846 in 347°.

On the hypothesis of a common origin it is obvious that these bodies must have entered the solar system at a remote epoch. It seems, therefore, quite remarkable that neither is known to have been observed before 1812. The period of De Vico's comet of 1846 is still too uncertain to be traced backward through former returns; but, with a mean period of the Pons-Brooks comet equal to the interval between the two observed apparitions, we find the dates of former perihelion passages to have been approximately as given below. The

* "Comets and Meteors," Chapter III. The nodal lines are nearly coincident, but the ascending node of the one is at the descending node of the other.

nearest corresponding dates at which comets were seen are also appended:

Former returns of the comet of 1812.	Corresponding dates at which comets were seen.	Former returns of the comet of 1812.	Corresponding dates at which comets were seen.
1741	1742	1456	1457
1670	. . .	1384	1382
1598	....	1313	1313
1527	1529	1241	1240

No comets are recorded for 1670 and 1598, and very little is known of those seen in 1742 and 1529. Some of the preceding may have been returns of the Pons-Brooks comet. The comets of 1812 and 1846, as has been shown, are both liable to great perturbation by Venus.

HOW WE SNEEZE, LAUGH, STAMMER, AND SIGH.

By FREDERIC A. FERNALD.

THE nose is an organ in more senses than one. From its resonant pipes proceed the sonorous tones which tell of blissful slumber, and the convulsive snort, varying from the mere "cat-sneeze" to the tremendous "Horatio," that has less definite meaning; while the Frenchman and the typical New-Englander (who is nearly as rare as the aborigine in New England, by-the-way) give it an important share in the production of speech. To give some physiological explanation of these and other involuntary actions of the respiratory mechanism is the object of the present article.

Snoring is produced in sleep by the passage of the breath through the pharynx when the tongue and soft palate are in certain positions. The soft palate must have fallen back in such a manner as to nearly or quite close the entrance to the nasal cavity from the throat, and the tongue must also be thrown back so far as to leave only a narrow opening between it and the soft palate. It is by the air being forced either inward or outward through this opening that the noise is produced. A snore results also when, with a closed mouth, the air is forced between the soft palate and the back wall of the pharynx into the nasal cavity. With deep breathing, perhaps accompanied by a variation in the position of the soft palate, a rattling noise may be heard in addition to the snoring, which is due to a vibration of the soft palate. Hence it is evident how flinging a pillow at a snorer, or poking him in the ribs, will often cause him to be silent even when the disciplinary measure does not awaken him, for a change of position that lets the tongue and soft palate fall a little forward secures a free passage for the air.

Grunting is a noise which is produced when, after the larynx has been perfectly closed, whether spasmodically or as a voluntary action with the object of holding the breath, the current of air thus interrupted is suddenly resumed. In the grunt we must distinguish two elements: the first is a clicking sound, and the other an explosive sound or slight report. The click is the noise produced by the meeting of air in the space left vacant when two moistened bodies are suddenly separated. It forms, however, but a very small part of the noise of grunting, and can scarcely be experimentally demonstrated. The "report" is the well-known phenomenon connected with the sudden expansion of a body of compressed air.

"*Talking through the nose*" when a person has a cold is in reality talking with the nose so stopped that less rather than more than the usual quantity of vibrating air can pass through the nasal cavity. In producing certain articulate sounds—those which occur in English are represented by *m*, *n*, and *ng*—all the vocal air escapes from the pharynx by the nose. The nasal air-passage has the general form of a resonator, and there can be no doubt but that it has a corresponding influence, and that the sounds produced by the air passing through it are strengthened by its resonance. The larger the nasal cavity the more powerful the resonance, and consequently the re-enforcement experienced by the tone. Sounds uttered with the nasal resonance, particularly the nasal vowels, are fuller and more ample than the same sounds when strengthened by the resonance of the cavity of the mouth, and it is for this reason that third-rate tragic actors like to give a nasal resonance to all the vowels in the pathetic speeches of their heroic parts. The resonance of the nasal cavity plays a part also in the formation of non-nasal articulate sounds; then, however, appearing only as a re-enforcement of the resonance of the cavity of the mouth. The directly excited nasal resonance sometimes plays an immediate part in the formation of all articulate sounds, producing the nasal "twang." But the general conception of this mode of speaking is by no means scientifically correct, every species of pronunciation in which the nasal element asserts itself with undue prominence being called "talking through the nose." It may, however, arise from two unlike causes: firstly, from a stoppage of the nasal cavity; or, secondly, from incomplete closure of the posterior entrance to this cavity. If the nasal cavity is obstructed, as when a child's nose is pinched and he is told to say "pudding," an accumulation of air forms in the back of the mouth, being unable to escape through the nose, and in the end is obliged to find exit through the mouth. The resonance is also altered, and the nasal sounds are, therefore, formed imperfectly and falsely. The same disturbance is produced by the partial obstruction of the nasal cavity which is experienced from the swollen condition of the mucous membrane, and from its increased secretion, during a "cold in the head."

A nasal twang from improper escape of air through the nasal cavity may be due to a cleft palate, or to some less grave defect which prevents insufficient contact between the soft palate and the back wall of the pharynx. Various other noises emanate from the mouth and nose, accompanying certain unusual and mainly involuntary forms of respiration. These are classified by Von Meyer, from whose "Organs of Speech," in the "International Scientific Series," most of the material for this article has been obtained, as disturbances of inspiration, to which class belong hiccough, gaping, and stammering, and disturbances of expiration, under which he enumerates sneezing, coughing, laughing, and sighing.

Hiccough is the simplest of the former class, and is merely a violent inspiration caused by a convulsive contraction of the diaphragm. The ensuing expiration then takes place quietly. The air inhaled may enter principally either through the mouth or the nose, or through both equally, and in each case the accompanying noise is different. A contraction of the glottis may also take place at the same time, and in this case the entering stream of air creates, in passing between the vocal chords, a sharp, clear tone. During an attack, one inspiration in about four or five is convulsive. Hiccough arises from over-irritation of the nerves of the diaphragm, the cause of which we know to be either psychical conditions or overfilling of the stomach. When the stomach is overladen with food or with effervescing or alcoholic drinks, it resists to a greater or less extent the fall of the diaphragm; the contractions of the diaphragm necessarily become more labored, and occasionally, like other over-irritated muscles, assume a convulsive character. Frequently, however, the hiccough appears as a sign of the general over-irritation of the nervous system in hysteria, and, probably from the same reason, it may not uncommonly be observed in otherwise healthy young persons, particularly children. The above explanation of hiccough as a convulsive contraction of the diaphragm is further confirmed by the manner in which it may be stopped. It is, namely, only necessary to allow an exceedingly protracted and, at the end, forcible expiration to follow a long and quiet inspiration. The slow inspiration, especially when it is chiefly performed by the wall of the chest, prevents the phrenic nerve from being too powerfully irritated, while the long expiration gives this nerve time to recover from its over-irritation. A remedy which the writer has tested many times without a failure can always be used upon a person who has "the hiccoughs" by some one else, and generally by the sufferer himself. You say to your friend something like this: "See how close together you can hold the tips of your forefingers without their touching. No, keep your elbows out free from your sides. You can get your fingers closer than that. They are touching now. There, now hold them so. Steady." By this time you can generally ask, "Now, why don't you hiccough?" The involuntary tendency to breathe slowly and steadily when the attention is fixed on performing a delicate manipulation is here what counteracts the convulsive action of the diaphragm.

Gaping is also a convulsive form of inspiration, which, however, is not so short and violent as the hiccough. In gaping, moreover, those muscles which raise the walls of the chest are at once brought into prominent action ; while, further, a rapid contraction of the diaphragm is necessary before the climax can be reached, after which a somewhat rapid fall of the thorax produces a quick expiration. The important part which is played by the rise of the chest is particularly shown by the fact that in very violent gaping the head is thrown backward, and the shoulders raised, in addition to which even the arms are sometimes stretched upward. During the gaping inspiratory process the mouth is opened spasmodically, and at the same time the soft palate is spasmodically raised, closing the air-passage of the nose. The whole phenomenon, including the sense of satisfaction after the inspiration, seems an indication of a strong desire for air, and the existence of this desire under those circumstances in which gaping is generally observed—sleepiness, for instance, or weariness—is readily explainable. Such circumstances are accompanied by a general inactivity of the nervous system, from which results a weak respiratory action, insufficient for the body when awake.

Stammering results from efforts to talk while a similar action to that which produces hiccough is going on. The difference is that, in stammering, the contractile spasm of the diaphragm is longer. During its continuance no expiration can take place, and, as speech depends upon the existence of an issuing stream of air, it is impossible for a person while suffering such a spasm to produce any sound. Ineffectual and therefore exaggerated efforts to create sound with the organs of the mouth and throat give rise to distressed grimaces, and this distressed expression must necessarily be augmented by the fact that, by so long delaying expiration, a want of breath is felt and the circulation of the blood interrupted. When at length the spasm ceases, and is followed by a quick expiration, the natural condition is restored till again destroyed by a fresh spasm. But there may be no attempt to speak, and yet the cause of the phenomenon (the spasm in the diaphragm) may be experienced ; in this case it will not cause stammering, and may be quite imperceptible to the observer. If, now, as appears from the above, stammering is only an occasionally observed symptom of a contractile spasm in the diaphragm, it must be clear that all attempts to cure stammering by exercising the organs of the mouth and throat must be unsuccessful, and that this defect can be efficiently treated only by following rules already given for the treatment of hiccough. A quiet, unhurried inspiration must be followed by an expiration as slow and long as possible, the issuing stream either being employed in speech or not. With this treatment the motor nerves of the diaphragm can most effectually recover from their state of over-irritation, and return to their normal condition. We must, however, be careful not to fall into the common error of confounding *stuttering* with stammering. In stuttering the process of breathing is quite normal, and the defective speech arises only from inaptitude in the formation of sound ; this defect of speech is, therefore, peculiar to children, idiots, and persons suffering from apoplexy.

Sighing, which is classed by Von Meyer as an unusual form of expiration, is better regarded as including the preceding inspiration also. A sigh is in fact a long breath, and, like a gape, is an involuntary spurt made to catch up with the demand for air. This is true even when it arises from depressing emotion. The expiration is often the more prominent part of the action, the rapidity with which the air flows out being due to a sudden cessation of the activity of the expiratory muscles, which commonly regulate, by retarding, the issuing stream of air. In *sobbing*, air is obtained by short, abrupt inspirations, and the tears which overflow into the nasal cavity assist in causing this air to produce sound.

Sneezing is the simplest of the purely expiratory noises. Just as the hiccough depends upon a single violent spasm during inspiration, so the sneeze is due to a single violent spasm during expiration, generally of the abdominal muscles, but, when very violent, of the other expiratory muscles also. It is a reflex action which occurs after an irritation of the mucous membrane lining the air-passages of the nose, and also after irritation of the optic nerve by a bright light. A few slight contractions of the abdominal muscles are at first suppressed by some short inspirations rapidly following each other without any intervening expiration ; then follows a vigorous contraction of the abdominal muscles, by means of which the stream of air is violently driven out through the mouth and nose. In its passage through the nose, the air produces a well-known noise, which may, however, be connected with a sound produced in the vocal chords. We recognize the same peculiarity, though the action is voluntarily performed, in blowing the nose. Sneezing is not an observer of times and seasons, and often seems to choose the most inopportune moment for exhibiting its power. In such a case the impending catastrophe may be averted by pressing firmly upon some branch of the fifth nerve, say in the upper lip close under the nose.

Coughing and *laughing* are also due to a spasmodic contraction of the expiratory muscles. These acts differ from sneezing only in this respect, that, while in the latter expiration is accomplished by a single violent action, it is here characterized by a number of separate impulses of the expiratory muscles with small intervening pauses. In long-continued coughing or laughing, short inspirations, which, on account of their shortness and violence, often approach the verge of hiccoughing, are taken between the separate expirations, and, indeed, laughing after a full meal frequently leads to a fit of hiccoughs. Coughing most closely resembles sneezing, not only as regards its origin, but also as regards its execution. This is a reflex action which follows an irritation of the air-passages, particularly of the windpipe and the larynx, but also of the pharynx and the nasal cavity. Stimulation of other nerves, as those of the skin by a draught of cold air, may also produce coughing. The expiratory impulses induced may attain great violence, so as in this respect to resemble the single impulse of sneezing. While, however, in sneezing, the stream of air escapes, as a rule, through the nose, in coughing it escapes through the cavity of the mouth, which is shut off by the raised soft palate from the nasal cavity, and enlarged by dropping the lower jaw, and by the depression of the floor of the cavity, the tongue at the same time being pushed forward. The closed glottis holds this air back for an instant against the pressure of the abdominal muscles, and then suddenly opens part way, letting it escape with an explosive noise, generally accompanied by a sound, shrill or deep as the case may be, produced by the vocal chords. Performed voluntarily, and with less violence, coughing assumes the form known to us as "clearing the throat." In laughing, the separate expiratory impulses are not so violent, and the stream of air passes through the fairly open mouth, or, when the mouth is shut, through the nose. It is accompanied by contractions of the muscles of the face, and is mainly involuntary, being generally caused by an impression produced upon the higher parts of the brain. Violent laughing may be caused by tickling some parts of the body. Characteristic sounds are produced in the same way as already described in coughing, and in both, when long continued, the air which from time to time is quickly inspired may produce a clear, shrill note in passing through the glottis.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXII.

I NOW come to a very important constituent of animal food, although it is not contained in beef, mutton, pork, poultry, game, fish, or any other organized animal substance. It is not even proved satisfactorily to exist in the blood, although it is somehow obtained from the blood by special glands at certain periods. I refer to *casein*, the substantial basis of cheese, which, as everybody knows, is the consolidated curd of milk.

It is evident at once that casein must exist in two forms, the soluble and insoluble, so far as the common solvent, water, is concerned. It exists in the soluble form, and completely dissolved in milk, and insoluble in cheese. When precipitated in its insoluble or coagulated form, as the curd of new milk, it carries with it the fatty matter, or cream, and therefore, in order to study its properties in a state of purity, we must obtain it otherwise. This may be done by allowing the fat-globules of the milk to float to the surface, and then remove them—i. e., by separating the cream as by the ordinary dairy method. We thus obtain in the skimmed milk a solution of casein, but there still remains some of the fat. This may be removed by evaporating it down to solidity, and then dissolving out the fat by means of ether, which leaves the soluble casein behind. The adhering ether being evaporated, we have a fairly pure specimen of casein in its original or soluble form.

This, when dry, is an amber-colored, translucent substance, devoid of odor, and insipid. This insipidity and absence of odor of the pure and separated casein is noteworthy, as it is evidently the condition in which it exists in milk, but very different from that of the casein of cheese. My object in pointing this out is to show that in the course of the manufacture of cheese new properties are developed. Skim milk—a solution of casein—is tasteless and inodorous, while cheese, whether made from skimmed or whole milk, has a very decided flavor and odor.

If we now add some of our dry casein to water, it dissolves, forming a yellowish, viscid fluid, which, on evaporation, becomes covered with a slight film of insoluble casein, which may be readily drawn off. Some of my readers will recognize in this description the resemblance of a now well-known domestic preparation of soluble casein, condensed milk, where it is mixed with much cream, and in the ordinary preparation also much sugar. The cream dilutes the yellowness, but does not quite mask it, and the viscidity is shown by the strings which follow the spoon when a spoonful is lifted. If a concentrated solution of pure casein is exposed to the air it rapidly putrefies, and passes through a series of changes that I must not tarry to describe, beyond stating that ammonia is given off, and some crystalline substances, such as *leucine*, *tyrosine*, etc., very interesting to the physiological chemist, but not important in the kitchen, are formed.

A solution of casein in water is not coagulated by boiling ; it may be repeatedly evaporated to dryness and redissolved. Upon this depends the practicability of preserving milk by evaporating it down, or "condensing." This condensed milk, however, loses a little ; its albumen is sacrificed, as everybody will understand who has dipped a spoon in freshly-boiled milk and observed the skin which the spoon removes from the surface. This is coagulated albumen.

If alcohol is added to a concentrated solution of casein in water, a pseudo-coagulation occurs ; the casein is precipitated as a white substance like coagulated albumen, but, if only a little alcohol is used, the solid may be redissolved in water ; if, however, it is thus treated with strong alcohol, the casein becomes difficult of solution, or even quite insoluble. Alcohol added to solid soluble casein renders it opaque, and gives it the appearance of coagulated albumen. The alcohol itself dissolves a little of this.

The characteristic coagulation of casein, or its conversion from the soluble to the insoluble form, is produced rather mysteriously by rennet. Acids precipitate it from an aqueous solution, producing an apparent coagulation, but it is not a true and complete coagulation like that effected by the rennet, for on neutralizing the acid precipitant with an alkali or metallic oxide the casein again dissolves. Excepting in the cases of acetic and lactic acids (vinegar and the acid of sour milk), which precipitate pure casein, the acid precipitates appear to be a compound of casein with the acids, and the casein is set free in its original state when the acid goes over to the alkali or basic metallic oxide. The action of rennet in the coagulation of casein is still a chemical mystery, especially when we consider the smallness of the quantity of coagulating agent required for the rapid and complete conversion.

A calf has four stomachs, the fourth being that which corresponds to ours, both in structure and functions. It is lined with a membrane, from which are secreted the gastric juice and other fluids concerned in effecting the conversion of food into chyme. A weak infusion made from a small piece of this "mucous membrane" will coagulate the casein of two or three thousand times its own quantity of milk, or the coagulation may be effected by placing a small piece of the stomach (usually salted and dried for the purpose) in the milk, and warming it for a few hours.

Many theoretical attempts have been made to explain this action of the rennet. Simon and Liebig supposed that it acts primarily as a ferment, converting the sugar of milk into lactic acid, and that this lactic acid coagulates the casein; but Selmi has shown that alkaline milk may be coagulated by rennet in the course of ten minutes, and that after the coagulation it still has an alkaline reaction. This is the case whether fresh naturally alkaline milk is used, or milk that has been artificially rendered alkaline by the addition of soda.

Casein, when thoroughly coagulated by rennet, then purified and dried, is a hard and yellowish horn-like substance. It softens and swells in water, but does not dissolve therein, nor in alcohol nor weak acids. Strong mineral acids decompose it. Alkalies dissolve it readily, and, if concentrated, decompose it on the application of heat. When moderately heated, it softens, and may be drawn into threads, and becomes elastic; at a higher temperature it fuses, swells up, carbonizes, and develops nearly the same products of distillation as the other protein compounds.

I have good and sufficient reasons for thus specifying the properties of this constituent of food. I regard it as the most important of all that I have to describe in connection with my subject—the science of cookery. It contains (as I shall presently show) more nutritious material than any other food that is ordinarily obtainable, and its cookery is singularly neglected, is practically an unknown art, especially in this country. We commonly eat it raw, although in its raw state it is peculiarly indigestible; and in the only cooked form familiarly known among us here, that of a Welsh rabbit, or rare-bit, it is too often rendered still more indigestible, though this need not be the case.

Here, in this densely populated country, where we import so much of our food, cheese demands our most profound attention. The difficulties and cost of importing all kinds of meat, fish, and poultry, are great, while cheese may be cheaply and deliberately brought to us from any part of the world where cows or goats can be fed, and it can be stored more readily and kept longer than other kinds of animal food. All that is required to render it, next to bread, the staple food of Britons, is scientific cookery.

If I shall be able, in what is to follow, to impart to my fellow-countrymen, and more especially countrywomen, my own convictions concerning the cookability, and consequent improved digestibility, of cheese, these papers will have "done the state some service!"

XXIII.

In my last I referred generally to the high nutritive value of cheese. I will now state particulars. First, as regards the water. Taking muscular fiber without bone, i. e., selected best part of the meat, beef contains on an average $72\frac{1}{2}$ per cent of water; mutton, $73\frac{1}{2}$; veal, $74\frac{1}{2}$; pork, $69\frac{3}{4}$; fowl, $73\frac{3}{4}$; while Cheshire cheese contains only $30\frac{1}{3}$, and other cheeses about the same. Thus, at starting, we have in every pound of cheese rather more than twice as much solid food as in a pound of the best meat, or comparing with the average of the whole carcass, including bone, tendons, etc., the cheese has an advantage of three to one.

The following results of Mulder's analysis of casein, when compared with those by the same chemist of albumen, gelatine, and fibrin, show that there is but little difference in the ultimate chemical composition of these, so far as the constituents there named are concerned:

Carbon	53·83	Casein.
Hydrogen	7·15	
Nitrogen	15·65	
Oxygen, Sulphur	23·37	

	Albumen.	Gelatine.	Fibrin.
Carbon	53·5	50·40	52·7
Hydrogen	7·0	6·64	6·9
Nitrogen	15·5	18·34	15·4
Oxygen	22·0	24·62	23·5
Sulphur	1·6	"	1·2
Phosphorus	0·4	"	0·3

We may therefore conclude that, regarding these from the point of view of nitrogenous or flesh-forming, and carbonaceous or heat-giving constituents, these chief materials of flesh and of cheese are about equal.

The same is the case as regards the fat. The quantity in the carcass of oxen, calves, sheep, lambs, and pigs varies, according to Dr. Edward Smith, from 16 per cent to 31·3 per cent in moderately-fatted animals, while in whole-milk cheeses it varies from 21·68 per cent to 32·31 per cent, coming down in skim-milk cheeses as low as 6·3. Dr. Smith includes Neufchâtel cheese, containing 18·74 per cent among the whole-milk cheeses. He does not seem to be aware that the cheese made up between straws and sold under that name is a *ricotta*, or crude curd of skim-milk cheese. Its just value is about threepence per pound. In Italy, where it forms the basis of some delicious dishes (such as *budino di ricotta*, of which anon), it is sold for about twopence per pound or less.

There is a discrepancy in the published analyses of casein which demands explanation here, as it is of great practical importance. They generally correspond to the above of Mulder within small fractions, as shown below in those of Scherer and Dumas:

	Scherer.	Dumas.
Carbon	54·665	53·7
Hydrogen	7·465	7·2
Nitrogen	15·724	16·6
Oxygen, sulphur	22·146	22·5

In these the one hundred parts are made up without any phosphate of lime, while, according to Lehmann ("Physiological Chemistry," vol. i, p. 379, Cavendish edition), "casein that has not been treated with acids contains about six per cent of phosphate of lime; more, consequently, than is contained in any of the protein compounds we have hitherto considered."

From this it appears that we may have casein with, and casein without, this necessary constituent of food. In precipitating casein for laboratory analysis, acids are commonly used, and thus the phosphate of lime is dissolved out; but I am unable at present to tell my readers the precise extent to which this actually occurs in practical cheese-making where rennet is used. What I have at present learned only indicates generally that this constituent of cheese is very variable; and I hereby suggest to those chemists who are professionally concerned in the analysis of food, that they may supply a valuable contribution to our knowledge of this subject by simply determining the phosphate of lime contained in the ash of different kinds of cheese. I would do this myself, but, having during some ten years past forsaken the laboratory for the writing-table, I have neither the tools nor the leisure for such work; and, worse still, I have not that prime essential to practical research (especially of endowed research), a staff of obedient assistants to do the drudgery.

The comparison specially demanded is between cheeses made with rennet and those Dutch and factory cheeses the curd of which has been precipitated by hydrochloric acid. Theoretical considerations point to the conclusion that in the latter much or even all of the phosphate of lime may be left in solution in the whey, and thus the food-value of the cheese seriously lowered. We must, however, suspend judgment in the mean time.

In comparing the nutritive value of cheese with that of flesh, the retention of this phosphate of lime nearly corresponds with the retention of the juices of the meat, among which are the phosphates of the flesh.

These phosphates of lime are the bone-making material of food, and have something to do in building up the brain and nervous matter, though not to the extent that is supposed by those who imagine that there is a special connection between phosphorus and the brain, or phosphorescence and spirituality. Bone contains about eleven per cent of phosphorus, brain less than one per cent.

The value of food in reference to its phosphate of lime is not merely a matter of percentage, as this salt may exist in a state of solution, as in milk, or as a solid very difficult of assimilation, as in bones. That retained in cheese is probably in an intermediate condition—not actually in solution, but so finely divided as to be readily dissolved by the acid of the gastric juice.

I may mention, in reference to this, that, when a child or other young animal takes its natural food in the form of milk, the milk is converted into unpressed cheese, or curd, prior to its digestion.

Supposing that on an average cheese contains only one half of the six per cent of phosphate of lime found, as above, in the casein, and taking into consideration the water contained in flesh, the bone, etc., we may conclude generally that one pound of average cheese contains as much nutriment as three pounds of the average material of the carcass of an ox or sheep as prepared for sale by the butcher; or, otherwise stated, a cheese of twenty pounds weight contains as much food as a sheep weighing sixty pounds as it hangs in the butcher's shop.

Now comes the practical question. Can we assimilate or convert into our own substance the cheese-food as easily as we may the flesh-food?

I reply that we certainly can not if the cheese is eaten raw; but have no doubt that we may if it be suitably cooked. Hence the paramount importance of this part of my subject. A Swiss or Scandinavian mountaineer can and does digest and assimilate raw cheese as a staple article of food, and proves its nutritive value by the result; but feebler bipeds of the plains and towns can not do the like.

I may here mention that I have recently made some experiments on the dissolving of cheese by adding sufficient alkali (carbonate of potash) to neutralize the acid it contains, thus converting the casein into its original soluble form as it existed in the milk, and have partially succeeded both with water and milk as solvents; but before reporting these results in detail I will describe some of the practically established methods of cooking cheese that are so curiously unknown or little known in this country.

In the fatherland of my grandfather, Louis Gabriel Mattieu, one of the commonest dishes of the peasant who tills his own freehold and grows his own food is a "fondevin" (I can not explain the etymology of the word, and spell it only by ear, never having seen it in print or writing). This is a mixture of cheese and eggs, the cheese grated and beaten into the egg as in making omelets, with a small addition of new milk or butter. It is placed in a little pan like a flower-pot saucer, cooked gently, served as it comes off the fire, and eaten from the vessel in which it is cooked. I have made many a hearty dinner on one of these, *plus* a lump of black bread and a small bottle of genuine but thin wine; the cost of the whole banquet at a little *auberge* being usually less than sixpence. The cheese is in a pasty condition, and partly dissolved in the milk or butter. I have tested the sustaining power of such a meal by doing some very stiff mountain-climbing and long fasting after it. It is rather too good—over-nutritious—for a man only doing sedentary work.

A diluted and delicate modification of this may be made by taking slices of bread, or bread and butter, soaking them in a batter made of eggs or milk—without flour—then placing the slices of soaked bread in a pie-dish, covering each with a thick coating of grated cheese, and thus building up a stratified deposit to fill the dish. The surplus batter may be poured over the top; or, if time is allowed for saturation, the trouble of preliminary soaking may be saved by simply pouring all the batter thus. This, when gently baked, supplies a delicious and highly nutritious dish. We call it cheese-pudding at home, but my own experience convinces me that we make a mistake in using it to supplement the joint. It is far too nutritious for this; its savory character tempts one to eat it so freely that it would be far wiser to use it as the Swiss peasant uses his *fondevin*, i. e., as the one and only dish of a good wholesome dinner.

I have tested its digestibility by eating it heartily for supper. No nightmare has followed. If I sup on a corresponding quantity of raw cheese, my sleep is miserably eventful.—*Knowledge.*

UNDER-GROUND WIRES.

By Dr. WILLIAM W. JACQUES,
ELECTRICIAN OF THE AMERICAN BELL TELEPHONE COMPANY.

THE first telegraph line constructed in this country, from Baltimore to Washington, in 1843, was intended to be laid underground, and the first nine miles was so laid. Four copper wires were each wound with cotton, soaked in shellac, and the whole drawn into a lead tube. This tube was laid in a trench by the side of the railroad. Hardly was the section completed, however, when water found its way into the joints, destroying the insulation, and the conductors failed. They were accordingly replaced by wires strung on poles, and the rest of the line was constructed in this way.

In England a very similar line was built, along the line of the Great Western Railway, for a distance of thirteen miles out from the city of London. This line failed in exactly the same way as the American lines, and the pipes were dug up and placed on short posts six inches above the ground. They were, however, soon replaced by pole lines.

At various places on the Continent similar experiments were tried, and everywhere with the same results. Thus it happened that, though the first idea of telegraph engineers the world over was to run electric wires under-ground, they were everywhere obliged to string the wires on poles. In England and on the Continent there has always been a strong desire to have a part, at least, of the electric wires under-ground. In the cities, pole lines have been considered objectionable, because they disfigure the streets. Between cities, under-ground lines have been desired, because of their great safety in case of invasion, great secrecy, and reliability in case of storms.

The introduction of gutta-percha, in 1846, accordingly gave a new impetus to under-ground construction, and, though it took years of experimenting and millions of dollars, and though system after system failed in England, Germany, and the rest of Europe, there exists to-day a successful and durable system of under-ground telegraph wires connecting together the principal cities of the German Empire, besides many other under-ground lines in various parts of Europe. Many of the European cities have the telegraph lines carried from the center of the city to the outskirts, under-ground; and, in Paris, not only all of the telegraph lines, but those for electric lights, telephones, and the various other private and municipal lines, are carried in the sewers under the streets of the city.

It must be remembered, however, that these various systems have cost from ten to twenty times as much as similar overhead lines; that, for every mile of under-ground wire, there are many miles on poles;

and that in Paris, which is the only city in the world having a *complete* under-ground system, there are unusual facilities for the running of wires, as sewers large enough to walk about in extend even under the less important streets of the city. Moreover, it has been found that, for delicate and quick-working apparatus, such as automatic telegraphs, polarized relays, and, above all, the telephone, long underground lines are far less efficient than pole lines. There are two reasons, apart from the difficulty of securing good insulation, why these long under-ground lines are comparatively inefficient :

1. If an electric conductor be brought near to a large mass of conducting matter, as is a wire when it is taken down from a pole and buried in the earth, there appears in the current the phenomenon of *retardation*, by which each signal, instead of being sharp and distinct, is partly kept back, so that it overlaps and mingles with the next ; the result is to limit the speed of working of the apparatus ; or if, like the telephone, it be an apparatus in which the currents are necessarily extremely frequent, to confuse and destroy the signals altogether. With ordinary Morse telegraphic apparatus, this is not very troublesome on under-ground lines a hundred miles long. With delicate relays, and more especially with quick working printing telegraphs, or automatic telegraphs, such lines are very troublesome ; and, with telephones, the retardation is a very troublesome matter on under-ground lines ten miles long.

2. The second difficulty is called *induction*, and is noticed when two or more wires are run side by side and near together, as they necessarily are in an under-ground cable.

If the signals on one wire of such a cable be sharp and quick, they cause fac-simile signals on all of the neighboring wires, and this too, though the insulation may be absolutely perfect ; indeed, above a certain point, the more perfect the insulation the greater the induction. The result of this phenomenon is, that messages sent over one wire are liable to be received on all of the other wires, and, in the case of the telephone, this phenomenon is noticeable on cables one thousand feet long, and on a cable one mile long the parties on one wire can easily understand what those on the other wires are saying. For any other instrument, however, the interference only becomes annoying on much longer lines. Steady currents, like those used with electric lights, are, of course, not affected either by retardation or induction.

In our own country there is little doubt that the proper method of constructing electrical wires *between cities* is, to string them on poles in mid-air. A brief review of some of the European systems that have been constructed will convince us of this. Between the years 1847 and 1850 a system of cables, containing 2,648 miles of wire, was laid under-ground to connect Berlin with the other principal cities of Prussia. Gutta-percha-covered wires were drawn into lead tubes, which were then buried in trenches two feet deep. The cost of this system was at least ten times that of well-constructed overhead lines. By 1850 the earliest of these lines had failed, and by 1853 the entire system was replaced by pole lines. In 1852 asimilar cable was laid in Russia, between St. Petersburg and Moscow; this worked a few years and then failed. Between 1846 and 1852 many miles of somewhat similar cables were laid in France, but, excepting those laid in the sewers of Paris, they universally failed.

In 1854 quite a number of lead-covered cables were laid in Denmark, but these were soon obliged to be abandoned in favor of overhead lines. In 1853 the Telegraph Company of England laid down a cable of ten gutta-percha-covered wires, in wooden troughs, along the high-road between London and Manchester, a distance of two hundred miles. Although neither expense nor pains were spared in the construction of this line, the cost being comparable with that of the Prussian system, two years had not elapsed before some of the wires ceased to work, and, though these were replaced and workmen kept constantly busy on the line, at the end of seven years the line was wholly abandoned in favor of overhead wires.

During the same year the Electric Telegraph Company laid down a somewhat similar system between London, Manchester, and Liverpool, though iron and earthenware pipes were substituted for the wooden troughs. Some of these lines began to fail almost as soon as completed, while others were, by constant repairing and attention, kept working for nearly ten years, when the whole was finally abandoned and overhead lines put up.

The great trouble with all of these systems, whether in England or on the Continent, was due to water, which found its way to the conductors, and of course destroyed the insulation. It was difficult to handle the wires without abrading the gutta-percha; and, when safely laid, the gutta-percha was attacked by coal-gas, vegetable growths, and the constituents of the soil. During this time many other shorter lines were constructed, but invariably with the same results.

In 1855 the French government, having failed in their attempt to use gutta-percha wires, laid down a large number of bare wires in a trench filled in with bituminous compounds. The details of this work were very carefully carried out, and the experiment is of interest because similar plans are constantly being proposed to-day. This system, costing from eight to ten times that of a thoroughly built pole line, never worked satisfactorily, and soon had to be abandoned. In 1858 the administration decided to return to gutta-percha-covered cables laid in lead tubes. The reason of this was, that some of these cables laid in the sewers of Paris, in 1846, were still in good condition. Many miles of this cable were laid, some with the lead pipe laid directly in the earth, some with it drawn again into iron pipes, and some carried through the sewers of the principal cities. Those cables laid directly in the earth soon failed, but those in iron pipes and the sewers continued to work, and from this grew the system now used in Paris. Up to 1870 the above-described attempts, as well as many others (not recounted), had proved a series of complete failures. Since that, however, several lines have been built in England that have continued to work successfully; and in Germany successful under-ground cables have been laid down connecting together all of the principal cities of the empire. The present complete system, as used between Liverpool and Manchester, was constructed as follows: Iron or stoneware pipes were laid from one to two feet below the level of the road-side with flush-boxes coming to the surface every two hundred yards. Into these was drawn a cable of gutta-percha-covered wires. The joints were carefully made in the pipes, and they were smoothed inside to prevent any possible abrading of the cable. The route was especially selected through a low and marshy section of country, so that the pipes were almost constantly filled with water—this being the best possible condition for the preservation of the gutta-percha. The present European system dates from 1875. The cable is similar to that used for submarine purposes. It consists of seven copper wires, each coated with two layers of gutta-percha and two of Chatterton's compound, and the whole covered with an armor of galvanized-iron wires. This cable is laid in a trench by the road-side, and comes to the surface only inside the telegraph-offices in the cities. Its cost was nearly twenty times the cost of a well-built pole line.

Although both the English and the German systems are successfully working lines of telegraph, they are far less efficient than pole lines of the same length. The speed of working even the ordinary instruments is limited; serious trouble appears in attempting to use fast-working machines, or automatic senders, and the use of the telephone is impossible.

I think these facts have sufficiently demonstrated that for long lines of telegraph, stretching from city to city, here in America, pole lines, which can be cheaply built, easily repaired, and where the wires can be removed from the retarding influence of the earth and the inductive influences on each other, are decidedly superior to underground lines.

Within our large cities the problem presented is somewhat different. During the last few years the number of electric wires has rapidly increased, especially since the introduction of the telephone and electric light, and the probability is that the next few years will show a further large increase. If these wires are run on poles, they not only disfigure the streets, but seriously interfere with the operations of firemen in case of fire, as we have repeatedly seen during the last few years. A cobweb of wires running over the house-tops requires the linemen to continually tramp through the houses and over the roofs, causing annoyance to the tenants and damage to the buildings. Moreover, wires fixed to house-tops are subject to removal at the whim of the owner, and they have to be continually removed from building to building as the good-will of each owner is exhausted.

In almost all of the large cities the question is now being asked, Why can not all of these wires be buried along with the gas and water pipes under the streets? In answer, I propose to describe briefly what has been done in this direction in European cities, then to look at some experiments lately made in this country, and thus to show how far such a plan is and how far it is not practicable.

In Paris, *all* the wires are carried in the sewers under-ground.

In London, the *telegraph* wires are carried from the central office to many of the branch offices and to the railways leading out of the city under-ground.

In Vienna, Prague, Brünn, Munich, Augsburg, Nuremberg, and many other cities, the telegraph-wires are carried under-ground by armored cables to the outside of the city.

In the German cities we have seen that many of the telegraph-wires are carried under-ground from the center of the city to connect with cables running to other cities.

Telephone wires, electric-light wires, and a large majority of telegraph wires in European cities are, however, as in America, carried over house-tops or on poles.

The cable most generally made in Paris consists of seven gutta-percha-covered wires laid into a cable covered with tarred hemp and drawn into a lead pipe; this pipe is fastened by hooks to the side-wall of the sewer. The cables are thus easy of access, and any new cables may be added as required without disturbing those already in use. In some of the newer cables wires covered with cotton soaked in paraffine are used instead of gutta-percha-covered wires. The distances within this city are so short that neither induction nor retardation has to be considered in the telegraph wires. Electric-lighting wires, we have seen, are not affected. The telephone wires are in Paris protected from these evils by an extremely simple though expensive device. Instead of a single wire for each circuit, two wires twisted together are used, the current going out over one and returning over the other. Such a device is called a "metallic circuit." Any outside disturbing circuit tends to induce, in the two wires of the metallic circuit, equal and opposite currents, which neutralize and disappear. In such an arrangement, too, there is a minimum of retardation.

There are several thousand miles of wire in the sewers of Paris, and the cost of the gutta-percha-covered cables is about $140 per mile of wire, or about five times the cost of a pole line to do the same work. As telephone cables require two wires for each circuit, this estimate would have to be doubled. The paraffined cables are, however, considerably cheaper, though their durability has not yet been proved. The cost for repairs is very small, and some cables have not been touched for twenty years. In any other city than Paris, the above figures would be very greatly increased by the cost of underground piping and chambers to contain the cables.

It is thus demonstrated that it is *technically* possible to place all of the wires in a city under-ground. It is also demonstrated that the cost, even when a large number of wires run side by side, is enormously increased. For many purposes, as telephony or electric lighting, a considerable number of wires start out from a central office together, but continually bifurcate until single wires run to the houses of the subscribers. The cost of one wire by itself is vastly larger than where many are run together, the cost of the pipe and for laying being not much greater for fifty wires than for one, and the cost of single wire cables being greater per mile of wire than multiple wire cables, so that the expense of putting such a system as one of our telephone exchanges entirely under-ground would place the cost of the instruments entirely out of reach of the subscribers. If telephones were required in every house, as are gas and water, such a system might be practicable, but at present that is not likely to be the case.

The American Bell Telephone Company has recently constructed two short lines of under-ground wires in the business section of Boston, and these give us excellent data from which to judge of the extent of technical practicability and the expense of putting all wires underground. We have seen that in Paris the retardation and induction are both obviated by the use of double and twisted wires in metallic circuit. It is necessary that *all* of the wires be in metallic circuit, for, if a metallic circuit be connected to a single-line circuit, the disturbances are not removed. If a subscriber in one city wishes to talk with a subscriber in a neighboring city, both cities must have metallic-circuit systems and metallic circuits between the two cities. As the two lines constructed in Boston are short, only about one quarter of a mile each, it was deemed best to use single-line circuits, hoping that the induction and retardation on so short lines would not be serious.

The system is constructed as follows: Eight wrought-iron pipes, three inches in diameter, are laid side by side in two rows, about four feet below the surface. At each street corner is built a brick chamber, large enough to admit a man, and with a cover flush with the street. The cables, of which several kinds are in use, run out from the basement of the central office through these pipes and up the side of buildings to roofs, from which they spread out to the subscribers by means of ordinary overhead lines.

Conversation over these lines is not so easily carried on as by means of overhead wires, and it is frequently possible to overhear other conversation. This prohibits further extension of the single-wire system under-ground, for technical reasons. The cost of the piping and chambers is in round numbers $50,000 per mile, and these pipes are intended to accommodate one thousand wires. The cost of the cables is from

$60 to $150 per mile for each circuit, according to the kind of cable used.

In round numbers we may estimate the total cost for one thousand wires at $150,000 per mile, or $150 per mile per circuit. The cost of piping and chambers would be nearly as great for one hundred circuits as for one thousand, as the cost of chambers and the labor of excavating and filling would be the same; so that the cost for one hundred wires may be estimated at $50,000 per mile, or $500 per mile per conductor. The cost per conductor thus increases enormously as the number of conductors diminishes, so that it would be clearly impossible to follow out the wires of an exchange system in all of their bifurcations.

It may be argued that cheaper methods of laying wires may be devised; but the experience of forty years has led continually to more and more expensive systems. If, then, the present method of running wires overhead is objectionable, and the expense of running them under-ground is so great as to put the cost of telephones, electric lights, and other electrical appliances out of the reach of would-be users, how are the wires to be run?

It seems to the writer that much of the inconvenience may be obviated, and without greatly increasing the expense, by adopting the following plan: From each telephone exchange, electric-lighting station, or other center of electric wires, run overhead cables out to a considerable number of points about the city, some one of which would be quite near to each subscriber. From each of these points to the various subscribers run short stretches of ordinary house-top wire. In this way hundreds of single wires would be gathered into small and inoffensive cables, and the enormous wooden structures would be replaced by small cable supports of brick or iron. In no place would there be the offensive multiplicity of wires. Such a system would be more durable, needing fewer repairs, than the present, and would not be much more expensive. For any other apparatus than telephones, retardation and induction would not be felt on so short cables. With telephone cables of moderate length these troubles would not be serious, and, if longer cables were necessary, metallic circuits could be used.

AN OVERDOSE OF HASHEESH.

By MARY C. HUNGERFORD.

BEING one of the grand army of sufferers from headache, I took, last summer, by order of my physician, three small daily doses of Indian hemp (hasheesh), in the hope of holding my intimate enemy in check. Not discovering any of the stimulative effects of the drug, even after continual increase of the dose, I grew to regard it as a very harmless and inactive medicine, and one day, when I was assured by some familiar symptoms that my perpetual dull headache was about to assume an aggravated and acute form, such as usually sent me to bed for a number of days, I took, in the desperate hope of forestalling the attack, a much larger quantity of hasheesh than had ever been prescribed. Twenty minutes later I was seized with a strange sinking or faintness, which gave my family so much alarm that they telephoned at once for the doctor, who came in thirty minutes after the summons, bringing, as he had been requested, another practitioner with him.

I had just rallied from the third faint, as I call the sinking turns, for want of a more descriptive name, and was rapidly relapsing into another, when the doctors came. One of them asked at once if I had been taking anything unusual, and a friend who had been sent for remembered that I had been experimenting with hasheesh. The physicians asked then the size and time of the last dose, but I could not answer. I heard them distinctly, but my lips were sealed. Undoubtedly my looks conveyed a desire to speak, for Dr. G——, bending over me, asked if I had taken a much larger quantity than he ordered. I was half sitting up on the bed when he asked me that question, and, with all my energies bent upon giving him to understand that I had taken an overdose, I bowed my head, and at once became unconscious of everything except that bowing, which I kept up with ever-increasing force for seven or eight hours, according to my computation of time. I felt the veins of my throat swell nearly to bursting, and the cords tighten painfully, as, impelled by an irresistible force, I nodded like a wooden mandarin in a tea-store.

In the midst of it all I left my body, and quietly from the foot of the bed watched my unhappy self nodding with frightful velocity. I glanced indignantly at the shamefully indifferent group that did not even appear to notice the frantic motions, and resumed my place in my living temple of flesh in time to recover sufficiently to observe one doctor lift his finger from my wrist, where he had laid it to count the pulsations just as I lapsed into unconsciousness, and say to the other: "I think she moved her head. She means us to understand that she has taken largely of the cannabis Indica." So, in the long, interminable hours I had been nodding my head off, only time enough had elapsed to count my pulse, and the violent motions of my head had in fact been barely noticeable. This exaggerated appreciation of sight, motion, and sound is, I am told, a well-known effect of hasheesh, but I was ignorant of that fact then, and, even if I had not been, probably the mental torture I underwent during the time it enchained my faculties would not have been lessened, as I seemed to have no power to reason with myself, even in the semi-conscious intervals which came between the spells.

These intervals grew shorter, and in them I had no power to speak.

My lips and face seemed to myself to be rigid and stony. I thought that I was dying, and, instead of the peace which I had always hoped would wait on my last moments, I was filled with a bitter, dark despair. It was not only death that I feared with a wild, unreasoning terror, but there was a fearful expectation of judgment, which must, I think, be like the torture of lost souls. I felt half sundered from the flesh, and my spiritual sufferings seemed to have begun, although I was conscious of living still.

One terrible reality—I can hardly term it a fancy even now—that came to me again and again, was so painful that it must, I fear, always be a vividly remembered agony. Like dreams, its vagaries can be accounted for by association of ideas past and passing, but the suffering was so intense and the memory of it so haunting that I have acquired a horror of death unknown to me before. I died, as I believed, although by a strange double consciousness I knew that I should again reanimate the body I had left. In leaving it I did not soar away, as one delights to think of the freed spirits soaring. Neither did I linger around dear, familiar scenes. I sank, an intangible, impalpable shape, through the bed, the floors, the cellar, the earth, down, down, down! As if I had been a fragment of glass dropping through the ocean, I dropped uninterruptedly through the earth and its atmosphere, and then fell on and on forever. I was perfectly composed, and speculated curiously upon the strange circumstance that even in going through the solid earth there was no displacement of material, and in my descent I gathered no momentum. I discovered that I was transparent and deprived of all power of volition, as well as bereft of the faculties belonging to humanity. But in place of my lost senses I had a marvelously keen sixth sense or power, which I can only describe as an intense superhuman consciousness that in some way embraced all the five and went immeasurably beyond them. As time went on, and my dropping through space continued, I became filled with the most profound loneliness, and a desperate fear took hold of me that I should be thus alone for evermore, and fall and fall eternally without finding rest.

"Where," I thought, "is the Saviour, who has called his own to his side? Has he forsaken me now?" And I strove in my dumb agony to cry to him. There was, it seemed to me, a forgotten text which, if remembered, would be the spell to stop my fatal falling and secure my salvation. I sought in my memory for it, I prayed to recall it, I fought for it madly, wrestling against the terrible fate which seemed to withhold it. Single words of it came to me in disconnected mockery, but erased themselves instantaneously. Mentally, I writhed in such hopeless agony that, in thinking of it, I wonder I could have borne such excess of emotion and lived. It was not the small fact of life or death that was at stake, but a soul's everlasting weal.

Suddenly it came. The thick darkness through which I was sinking became illuminated with a strange lurid light, and the air, space, atmosphere, whatever it might be called, separated and formed a wide black-sided opening, like the deadly pit which shows itself in the center of a maelstrom. Then, as I sank slowly into this chasm, from an immeasurable distance above me, yet forcibly distinct, the words I longed for were uttered in a voice of heavenly sweetness: "He that believeth on *me* hath everlasting life, and shall not come unto condemnation." My intense over-natural consciousness took possession of these words, which were, I knew, my seal of safety, my passport to heaven. For one wild instant a flash of ineffable joy, the joy of a ransomed soul, was mine. I triumphed over sin and hell and the unutterable horrors of the second death. Then I plunged again into the outer darkness of the damned. For the talisman which had been so suddenly revealed was, as if in mockery, as suddenly snatched from me, and, as before, obliterated from my recollection.

Then all the chaos beyond the gap into which I was falling became convulsed, as if shaken by wind and storm. Hideous sounds of souls in torment, and still more hideous peals of mocking, fiendish laughter, took the place of the hitherto oppressive silence. I was consumed by a fearful, stinging remorse for the sins done in the body. Unlike the experience of the drowning, my sins did not present themselves to my remembrance in an array of mathematical accuracy. On the contrary, not one was specifically recalled, but, if my daily walk and conversation had through life been entirely reprobate, and the worst of crimes my constant pastimes, my consequent agony of self-reproach could not have been greater. My conscience, in its condition of exaggerated self-accusation, was not only the worm that never dieth, but a viper that would sting eternally, a ravening beast that, still insatiate, would rend and gnaw everlastingly.

I began then, without having reached any goal, and for no apparent reason, to ascend with neither more nor less swiftness than I had gone down, and in the same recumbent position in which my forsaken body lay upon the bed a fathomless distance above, and which I had been all the time powerless to change. Even the dress, a thin, figured Swiss muslin, was the same, although a hundred times more diaphanous. Even in my agonies of remorse I noticed how undisturbed by my falling were its filmy folds. There was not even a flutter in the delicate lace with which it was ornamented. As I rose, a great and terrible voice, from a vast distance, pronounced my doom in these words of startling import: "In life you declared the negation of the supernatural. For truth you took a false philosophy. You denied the power of Christ in time—you shall feel it in eternity. In life, you turned from him—in death, he turns from you. Fall, fall, fall, to rise again in hopeless misery, and sink again in lonely agony forever!" All space took up the last four words of my terrible sentence, and myriads of voices, some sweet and sad, some with wicked, vindictive glee, echoed and re-echoed like a refrain, "In lonely agony forever!" Then ensued a wild and terrible commingling of unsyllabled sounds, so unearthly that it is not in the power of language to fitly describe them. It was something like a mighty Niagara of shrieks and groans, combined with the fearful din and crash of thousands of battles and the thunderous roar of a stormy sea. Over it all came again the same grandly dominant voice, sternly reiterating the four last words of doom, "In lonely agony forever!" and all the universe seemed to vibrate with them.

Silence reigned again. A strange, brassy light prevailed; rapid and fierce lightning flashed incessantly in all directions, and the shaft-like opening about me closed together. Impelled by a resistless force I still rose, although now against a crushing pressure and an active resistance which seemed to beat me back, and I fought my upward way in an agony which resembled nothing so much as the terrible moment when, from strangling or suffocation, all the forces of life struggle against death, and wrestle madly for another breath. In place of the woful sounds now reigned a deadly stillness, broken only at long but regular intervals by a loud report, as if a cannon, louder than any I ever heard on earth, were discharged at my side, almost shot into me, I might say, for the sound appeared to rend me from head to foot, and then die away into the dark chaos about me in strange, shuddering reverberations. Even in the misery of my ascending I was filled with a dread expectancy of the cruel sound. It gave me a feeling of acute physical torture, with a lingering intensity that bodily suffering could not have. It was repeated an incredible number of times, and always with the same suffering and shock to me. At last the sound came oftener, but with less force, and I seemed again nearing the shores of time. Dimly in the far distance I saw the room I had left, myself lying still and death-like upon the bed, and the friends watching me. I knew, with no pleasure in the knowledge, that I should presently reanimate the form I had left. Then, silently and invisibly, I floated into the room, and was one with myself again.

Faint and exhausted, but conscious, the seal of silence still on my lips, with all the energy I was capable of I struggled to speak, to move, to make some sign which my friends would understand; but I was as mutely powerless as if in the clutch of paralysis. I could hear every word that was spoken, but the sound seemed strangely far away. I could not open my eyes without a stupendous effort, and then only for an instant. "She is conscious now," I heard one of the doctors say, and he gently lifted the lids of my eyes and looked into them. I tried my best then to throw all the intelligence I could into them, and returned his look with one of recognition. But, even with my eyes fixed on his, I felt myself going again in spite of my craving to stay. I longed to implore the doctor to save me, to keep me from the unutterable anguish of falling into the vastness and vagueness of that shadowy sea of nothingness again. I clasped my hands in wild entreaty ; I was shaken by horrible convulsions—so, at least, it seemed to me at the time—but, beyond a slight quivering of the fingers, no movement was discernible by the others. I was unable to account for the apathy with which my dearest friends regarded my violent movements, and could only suppose it was because my condition was so hopeless that they knew any effort to help me would be futile.

For five hours I remained in the same condition—short intervals of half-consciousness, and then long lapses into the agonizing experience I have described. Six times the door of time seemed to close on me, and I was thrust shuddering into a hopeless eternity, each time falling, as at first, into that terrible abyss wrapped in the fearful dread of the unknown. Always there were the same utter helplessness and the same harrowing desire to rest upon something, to stop, if but for an instant, to feel some support beneath ; and through all the horrors of my sinking the same solemn and remorseful certainty penetrated my consciousness that, had I not in life questioned the power of Christ to save, I should have felt under me the "everlasting arms" bearing me safely to an immortality of bliss. There was no variation in my trances ; always the same horror came, and each time when sensibility partially returned I fought against my fate and struggled to avert it. But I never could compel my lips to speak, and the violent paroxysms my agonizing dread threw me into were all unseen by my friends, for in reality, as I was afterward told, I made no motion except a slight muscular twitching of the fingers.

Later on, when the effect of the drug was lessening, although the spells or trances recurred, the intervals were long, and in them I seemed to regain clearer reasoning power and was able to account for some of my hallucinations. Even when my returns to consciousness were very partial, Dr. G—— had made me inhale small quantities of nitrite of amyl to maintain the action of the heart, which it was the tendency of the excess of hasheesh to diminish. Coming out of the last trance, I discovered that the measured rending report like the discharge of a cannon which attended my upward way was the throbbing of my own heart. As I sank I was probably too unconscious to notice it, but always, as it made itself heard, my falling ceased and the pain of my ascending began. The immense time between the throbs gives me as I remember it an idea of infinite duration that was impossible to me before.

For several days I had slight relapses into the trance-like state I have tried to describe, each being preceded by a feeling of profound dejection. I felt myself going as before, but by a desperate effort of will saved myself from falling far into the shadowy horrors which I saw before me. I dragged myself back from my fate, faint and exhausted and with a melancholy belief that I was cut off from human sympathy, and my wretched destiny must always be unsuspected by my friends, for I could not bring myself to speak to any one of the dreadful foretaste of the hereafter I firmly believed I had experienced. On one of these occasions, when I felt myself falling from life, I saw a great black ocean like a rocky wall bounding the formless chaos into which I sank. As I watched in descending the long line of towering, tumultuous waves break against some invisible barrier, a sighing whisper by my side told me each tiny drop of spray was a human existence which in that passing instant had its birth, life, and death.

"How short a life!" was my unspoken thought.

"Not short in time," was the answer. "A lifetime there is shorter than the breaking of a bubble here. Each wave is a world, a piece of here, that serves its purpose in the universal system, then returns again to be reabsorbed into infinity."

"How pitifully sad is life!" were the words I formed in my mind as I felt myself going back to the frame I had quitted.

"How pitifully sadder to have had no life, for only through life can the gate of this bliss be entered!" was the whispered answer. "I never lived—I never shall."

"What are you, then?"

I had taken my place again among the living when the answer came, a sighing whisper still, but so vividly distinct that I looked about me suddenly to see if others besides myself could hear the strange words:

"Woe, woe! I am an unreal actual, a formless atom, and of such as I am is chaos made."

THE CAUSES OF EARTHQUAKES.

By M. DAUBRÉE,

OF THE INSTITUTE OF FRANCE.

THE causes of earthquakes have long been the subject of many conjectures. The numerous investigations of later years have contributed much to define their characters; and several data recently acquired tend further to make their mechanism clear. It is known that the shocks are by no means distributed at hap-hazard over the surface of the globe. The countries where the strata have preserved their original horizontal position, like the north of France, a part of Belgium, and the most of Russia, are privileged with tranquillity. Violent commotions are manifested particularly in regions that have suffered considerable mechanical accidents, and have acquired their last relief at a recent epoch, like the region of the Alps, Italy, and Sicily.

The tracts that are simultaneously disturbed by the same shock most frequently comprise arcs of from 5° to 15°, or from 300 to 1,500 kilometres. They rarely include a much more considerable fraction of the globe; although the celebrated catastrophe at Lisbon on the 1st of November, 1755, extended over some 17° or 18°, into Africa and the two Americas, or over a surface equal to about four times that of Europe.

The detailed examination of many earthquakes has enabled us to determine the center of the shocks as well as the contours of the disturbed areas. From the manner in which the latter surfaces agree with the lines of pre-existing dislocations, several of the most distinguished geologists, including Mr. Dana, M. Suess, and Albert Heim, have considered the shocks in question as connected with the formation of chains of mountains, of which they may be a kind of continuation.

In fact, the crust of the earth everywhere shows the enormous effects exercised by the lateral pressures that have been in operation at all epochs. The strata, bent and bent over again many times through thousands of metres of thickness, as well as the great fractures that traverse them, are the eloquent witnesses of these mechanical actions. Notwithstanding the apparent tranquillity now reigning on the surface of the globe, equilibrium does not exist in the earth, and commotions have not been arrested in its depths. The proof of this is found, not only in earthquakes, but also in the slow movements of the soil, of elevation and depression—a kind of warping, which has continued to manifest itself within historical times in all parts of the globe. It is conceivable that slow actions of this kind, after more or less prolonged strains, may end in abrupt movements, as Élie de Beaumont supposed. We can see, also, in experiments intended to imitate the bending of strata, how gradual inflections lead all at once to fractures and outbursts. Simple cavings-in, in deep cavities, have also been regarded as possibly giving rise to earthquakes; and this opinion has been adopted by M. Boussingault after the well-known observations he made in the Andes. There is, in fact, nothing to prove that disturbances of these different kinds do not take place in the interior of the globe; but we may certainly consider them as the general cause of earthquakes. These shocks are, however, most commonly in evident connection with volcanoes; and it is in the neighborhood of the latter that they are especially frequent. As is well known, every volcanic eruption is announced by precursory earthquakes, the violence of which is stilled when an outlet is opened for the vapor of water which is successively the cause of the subterranean agitations and the projecting agent of all the eruptions. The tension of the vapor in the volcanic reservoirs must be very high. Thus, that pressure which forces the lava up to more than 3,000 metres above the sea, to the top of Etna, can not be less than a thousand atmospheres.

An attentive study of the phenomena confirms the attribution of the cause of the shocks, however violent they may be, to the vapor of water. It is sufficient for this to be the case for vaporization to take place at a temperature of 1,000° C. (1,800° Fahr.), approximately that of lava, and under a volume equivalent to that of the water in the liquid state whence the vapor is derived. Under these conditions, we must suppose the vaporization to be total, for the critical temperature, above which the liquefaction of vapor can not be realized, is, according to M. Clausius, 332° C. (629° F.). The pressure, of which it is also possible to make an approximate estimate, then becomes comparable to that of the most powerfully explosive gases, and is, consequently, capable of producing very considerable dynamic effects. These effects may also be produced at a much lower temperature than that of lavas at 500° C. (900° F.) ; for example, if we suppose that the volume imposed upon the vapor is so limited as to correspond to a density of 0·8 or 0·9. No doubt such conditions are realized in the lower regions of the globe, where water is confined within limited spaces, and as hot as the melted rocks which we see gushing out from the surface at a temperature of 1,000° C. (1,800° F.) or more. We shall see, however, that such depths and such a temperature are not necessary.

The vapor of water when superheated acquires a power of which the most terrible boiler-explosions could give no idea if we had not the result before our eyes. The tubes of the best quality of iron that I used in observing the action of superheated water in the formation of silicates had an inside diameter of twenty-one millimetres and were eleven millimetres thick. They sometimes exploded, and were projected into the air with a noise like that of the firing of a cannon. Before bursting, the tubes swelled out into bulbous forms, and rents were opened in the middle of the bulbs. If the iron had no flaws and according to the estimate that it would preserve up to 450° C. (810° F.), the temperature to which it was raised, the same tenacity it had when cold, such rents must have indicated a pressure of several thousand atmospheres. A few cubic centimetres of water were sufficient to produce an effect like that ; and, considering the small dimensions of the inside of the tubes as compared with the volume of the water, the vapor must have reached a density of about 0·9. If we apply the data we possess to the depths of the globe, it is not difficult to conceive very simple dispositions in which the vapor of water, under the conditions we have just determined, will suddenly provoke shocks or series of shocks that will too often make themselves felt on the surface. Whatever conception we may form of the volcanic reservoirs, we must admit it to be very probable that solutions of continuity exist between the soft or fluid masses in fusion and the solid masses superposed over them. Moreover, cavities may also exist in the solid rocks themselves that lie over the soft masses. On the other hand, the incessant losses, which these internal reservoirs suffer in consequence of the enormous volumes of water in the condition of vapor which they disengage every day, are probably repaired by supplies from the surface.

I have shown by experiment that these supplies may be transmitted through the pores of some kinds of rocks. Simple capillary action, in conjunction with gravity, may force water to penetrate against very strong counter-pressure, from the superficial and cooler regions of the globe, to deep and hot regions, where, by reason of the temperature and pressure it acquires there, it becomes capable of producing very great mechanical and chemical effects. If we suppose that water penetrates, either directly or after a halt in a reservoir where it has remained liquid, to masses in fusion, so as to acquire there an enormous tension and an explosive force, we shall have the cause of the anterior real explosions and of the instantaneous shocks due to gases at high pressure. If the cavities, instead of forming a single reservoir, are divided into several parts or distinct compartments, there is no reason why the tension of the vapor should be the same in the different receivers, provided they are separated by walls of rock. The pressure may even be very different in two or more of them. This admitted, if a separating wall is broken by excess of pressure or melted by the heat, vapor at high pressure will be set in motion, and in the presence of the solid masses upon which it will strike it will behave just as if there had been an instantaneous formation of vapor, as we supposed in the former case.

It is very hard to establish, as has been attempted, a clear line of demarkation between the character of the earthquakes of volcanic regions proper and of regions without volcanoes, such as Portugal, Asia Minor (Chios, April 3, 1881, five thousand victims), Syria, Algeria, and the rim of the Mediterranean generally. In both classes, the characteristic manifestations which we perceive are the same. If, as some assume, the internal movements of the rocks were a cause of real earthquakes, it could only be because those internal movements mechanically developed heat, and in that way provoked the formation of vapor. But, in the recently disturbed regions we have especially in view, which are the seat of so frequent shocks, another cause is much more probable. There doubtless remain in them interstices and interior cavities that permit the access of water to the hot regions. The depth of the centers of disturbance of earthquakes has been estimated, in different cases, by calculations only grossly approximate, at eleven kilometres, twenty-seven kilometres, and thirty-eight kilometres. In any case, such depth, though very slight in comparison with the length of the radius of the earth, is great enough for the temperature at the normal rate of increase to be very high; and the same will also be the case with the water that may be present there. Now, as we have already seen, a temperature of 500° C. (900° Fahr.) is sufficient to cause water to explode with violence.

It is certainly in the largest number of cases very difficult to admit collisions of solid bodies in the interior as the moving causes of earthquakes. How, for instance, can we conceive that so violent and extensive an earthquake as that of Lisbon on the 1st of November, 1755, was produced in this way? John Mitchell (Royal Society, 1760, vol. x, p. 751) drew from this memorable example the conclusion that the vapor of water intervenes in these shocks as well as in the eruptions of volcanoes. Manifest effects of a class of internal explosions, undoubtedly due to the production or sudden moving of a great quantity of superheated vapor, are exhibited at the present epoch, and are not rare. Such explosions, for instance, are exceptionally formidable in the region of Java, and the mind is naturally led to the one which has just convulsed the zone between that island and Sumatra, which has caused the disappearance of the island of Krakatoa and its mountains, has raised other mountains, and has claimed more than forty thousand victims.

At a period more remote from us, the explosive force of interior gases gave rise to very remarkable circular cavities, which have been called "craters of explosion," and are well known. Examples of them are found in Auvergne (Lake Pavin) and in the district of the Eifel, where the stratified beds have been sharply cut as if with a punch. What gases thus put in motion are capable of, as a mechanical power, could hardly have been suspected till since the explosive effects of guncotton, nitroglycerine, and dynamite, have been known. The effects of compressed air in the air-gun and of the powder-gases in fire-arms have been wonderfully surpassed, for we now measure explosive pressures of six thousand atmospheres and more. In the experiments in which I have had occasion to observe gases at high pressure in order to explain the action that a meteor coming with planetary speed is subjected to on the part of the atmosphere into which it plunges, I have been surprised at witnessing the great energy of gaseous masses. They engrave themselves deeply, as if with a burner, into the pieces of steel that are opposed to them, and of themselves reduce a part of it to an impalpable dust shot into the atmosphere as if it were volcanic ashes. It is no less surprising—and this observation is of much importance in explaining the problem that occupies us—to remark the tenuity of the gaseous mass that produces such results. Yet its force causes ruptures which the pressure of a weight six hundred thousand times heavier than the gas could not effect!

In short, gaseous movements under high pressure, put in operation from time to time by a simple mechanism like what Nature can and does present, will account for all the essential features of earthquakes. Much better than the hypothesis of interior collisions of solid bodies, they explain the effect of the shock, resembling the blows of a ram, their violence, their frequent succession, and their recurrence in the same regions after many centuries; they explain also the production of earthquakes in regions of dislocation, especially in those in which the disturbance is recent, and their subordination to deep fractures of the crust of the earth.

Earthquakes seem to be volcanic eruptions that are suppressed because they can not find any outlet, nearly as Dolomieu thought. The motive power of gases, the immense effects of which we can see in the protuberances or jets shot out from the sun with prodigious speed and of enormous dimensions, appears to be sufficiently considerable in the depths of the globe also to explain all the effects of earthquakes.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

LAST WILLS AND TESTAMENTS.

By JOSEPH W. SUTPHEN.

CAN a will of real or personal property be so prepared and executed as, barring questions of incapacity and undue influence, to be incontestable? Protracted and expensive litigation, frequently involving a period of years, often eating up large portions of estates, and finally resulting in the defeat of a testator's wishes, suggests this oft-repeated question. Considering the matter of execution first, nothing would appear simpler. Our statutory requirements are few and explicit, and, if properly observed, the inquiry, so far as execution is concerned, is easily answered. The provisions of the New York Revised Statutes are—

1. That the will shall be in writing, and subscribed by the testator at the end.

2. That such subscription shall be made by the testator in the presence of each of the attesting witnesses, or shall be acknowledged by him to have been so made to each of the attesting witnesses.

3. The testator at the time of making such subscription, or at the time of acknowledging the same, shall declare the instrument so subscribed to be his last will and testament.

4. There shall be at least two attesting witnesses, each of whom shall sign his name as a witness, at the end of the will, at the request of the testator.

These provisions are practically the same in most of the United States, with the exception, perhaps, of Louisiana, unless it be that some of the States require three or more in the place of two witnesses. An intelligent compliance with the above directions would seem in no wise difficult, yet many an intended will has proved an abortion, solely from lack of their observance, ignorance, and carelessness, and in some instances, no doubt, forgetfulness on the part of witnesses as to what actually transpired at the execution, explaining the circumstance. A witness's stupidity or forgetfulness can not easily be guarded against,. except by the selection of intelligent witnesses. This sometimes, as in the case where the testator is *in extremis*, is impossible; but a stupid or forgetful witness to a will is a great misfortune, for he may utterly destroy its value. Unless proof *aliunde* is obtainable, showing that the requirements of the statute were duly observed, there is great probability that the will will be rejected by the surrogate, and his decree sustained by appellate tribunals.

In November, 1850, an instrument, dated February 2, 1849, was offered for probate to the Surrogate of Kings County, New York, as the last will and testament of Thomas Lewis. It devised all his real and personal estate to his wife ; but its probate was opposed by the heirs of the deceased. This document was signed in the proper handwriting of Mr. Lewis ; it had two subscribing witnesses, while attached to the will and above the signatures of the witnesses was an attestation clause in the following words :

"The above-written instrument was subscribed by the said Thomas Lewis in our presence, and acknowledged by him to each of us, and he at the same time declared the above instrument so subscribed to be his last will and testament, and we, at his request, have signed our names as witnesses hereto."

On the contest, Ferris Tripp, one of the witnesses, swore that he was a clerk in the store of the deceased at the date of the will, and that Wing, the other witness, was also a clerk ; that he (the witness) signed his name at the end of the attestation clause, at the request of the testator ; that, on the occasion when he did so, Wing and he were called by the deceased into his private office, where he had a paper, of which he turned up so much as would allow them to write their names thereon, requesting them to sign the same and add their residences ; that he also then said, "I declare the within to be my free will and deed" ; that this was all that was said, according to his recollection, and that he and Wing then signed their names to the instrument where they appeared ; that he did not then know to a certainty what the instrument was, but thought it a will from the fact that the deceased had that morning sent out and procured a blank will. On cross-examination this witness testified that at the time he signed his name to the instrument it was so folded or placed upon the desk that he saw no part of the contents, and that neither the same nor any part of it was read to him ; that he did not see the testator sign it, nor did he see his signature to it when he signed as a witness.

The other witness testified in substance that he signed his name to the alleged will in the office of the deceased ; that he was unable to say what occurred on that occasion, but that, according to his recollection, he signed at the request of the deceased ; that he had no recollection that the deceased said anything else to him at the time he signed, unless it was "to see him sign the document" ; that he did not recollect that the deceased signed the instrument in his presence ; that he had no recollection that Tripp, the other witness, was present when he signed, and could not state anything further which occurred or was said or done by the deceased on the occasion. On his cross-examination he further testified that he did not read nor was any part of the instrument read to him when he signed it, and that he had no recollection that he then knew what the paper was.

Here was an instrument which on its face met all the requirements of the law. It was in writing; it was subscribed by the testator at the end; it had two subscribing witnesses, and a full attestation clause. The testimony of Tripp and Wing completely nullified it; their want of recollection, although less than two years had elapsed since its execution, effectually prevented its probate. The probabilities are, that all legal technicalities had been observed, but the particular facts had escaped the memories of the witnesses. The surrogate adjudged it no will; the widow appealed to the General Term, which affirmed the decree of the surrogate, and then to the Court of Appeals, which affirmed the General Term (Lewis *vs.* Lewis, 11 N. Y., 220).

Ignorance and carelessness are even more reprehensible than stupidity or forgetfulness, and each has proved a prolific source of evil to testators' intentions, of expense to suitors, and of disappointment to apparent legatees. Assumption of the sufficiency of one's own knowledge regarding matters concerning which he has little or no information has caused the wishes of more than one testator to utterly fail, or ruined his estate in costly litigation. Books entitled "Every Man his own Lawyer," "Legal Directory," "Legal Remembrancer," are not, as a rule, the best fountains from which to quench legal thirst. Their accuracy is often subject to impeachment, and their pages have more than once proved to the layman a stumbling-block. Nor should relations complain of the courts if carelessness has led him into the execution of an instrument which proves either to be no will at all, or only such after much of his estate has been squandered to ascertain the fact. It is always wise to prepare and execute such a document in the leisure moments of life, for to do so *in articulo mortis* is a serious matter in more senses than one, concerning which a man should think twice, for, if he leave it until then, he will have little time to think at all. Mr. Gordon undoubtedly thought he knew how to draw a will well enough when he executed the following:

"Dear old Nance, I wish to give you my watch, two shawls, and also $5,000. Your old friend, E. A. Gordon."

After much litigation this was established as a will, but it is likely that "old Nance" was obliged to content herself with the watch and two shawls (Clarke *vs.* Ransom, 50 Cal., 595).

So, too, with Ehrenberg's will, who was the author of the following laconic testament—a model of brevity:

"Mrs. Sophie Loper is my heiress."

(Signature.)

Following which appeared:

"The legatee's name is correctly spelled Loeper."

To this there were no witnesses, the law of Louisiana requiring none. After ten years' litigation or controversy this was also sustained as a will (Succession of Ehrenberg, 21 La. Ann., 280). The sufficiency of the legal attainments of each testator in these instances, it is true, was enough, but to establish that fact old Nance and Mrs. Loper undoubtedly paid handsomely. In the following case the success of the would-be testator was not so signal:

In 1876 an instrument purporting to be the last will and testament of John Kelly was offered for probate to the Surrogate of the County of New York. It was partly written and partly printed, and was apparently a short form of will such as may be purchased at a stationer's. After disposing of his property, this document ran as follows:

"Likewise I make, constitute, and appoint Edward McCarthy to be executor, *J. Kelly*, of this my last will and testament, hereby revoking all former wills by me made. In witness whereof I have hereunto subscribed my name and affixed my seal the 24th day of July, 1874, in the year of our Lord one thousand eight hundred and sixty.

Witnesses:

EDWARD MCCARTHY,
DANIEL VAN CLIEF.

Subscribed by *John Kelly*, the testator named, etc."

When the deceased requested the witnesses to sign the instrument, the name *J. Kelly* had already been written by him where it first appears. The witnesses then signed it, and afterward the deceased wrote his name where it appears in the attestation clause. The point in dispute touched the first requirement of the statute: Was the subscription *J. Kelly* in the body of the instrument a "subscribing at the end of the will"? The subscription *John Kelly* in the attestation clause was, of course, bad, being made after the witnesses had signed. It appeared from the evidence that the testator presented the instrument to the witnesses, saying: "I drawed up a will for fear anything might happen me before coming back; in case there was any dispute about the trifle of money I have, I want you to witness this will." The name *J. Kelly* had been written in before this was said. The surrogate rejected the instrument, as not executed and attested in the manner prescribed by law. The General Term reversed his decree, directed that the will be admitted to probate, and that letters testamentary issue thereon (7 Huec, 290). The Court of Appeals then finally settled the law in the case by reversing the Supreme Court and setting aside the instrument as absolutely void (67 N. Y., 409). A curious circumstance in connection with the proof of this instrument is the fact that the Supreme Court were unanimously of the opinion that this document was a will, while the Court of Appeals were unanimously of the opinion that it was not! Even when, by a mistake in turning over the paper, the signature is put on the back of a blank page occurring in the middle of the will, it can not be sustained (Heady's Will, 15 Abb. Pr., N. S., 211).

Instances might be multiplied to illustrate the serious consequences resulting from ignorance, carelessness, stupidity, or forgetfulness in the execution and proof of wills, but these are sufficient to emphasize the necessity of intelligence, accuracy, and forethought in the matter. Returning to the discussion of execution:

1. The will must be in writing, and subscribed by the testator at the end.

Apparently this is plain and concise enough, and adapted to the comprehension of a child, yet a long list of expensive appeals attest to the difficulty experienced in solving the meaning of this phraseology. What is writing? What is a signature? Where is the end of a will? are questions which appellate courts have been called upon to determine. If a will be printed; if it be done by a type-writer; if it be executed wholly in lead-pencil, instead of ink; if the signature be by a mark, or if it be made by another at the request of and for the testator; if the signature, as in the case of the will of *J. Kelly* (*supra*), be not immediately at the foot of the instrument—these and similar inquiries call for an answer to the *quære*, "Have the requirements of the statute been complied with?" It has already appeared that *J. Kelly's* will was not a will. The Court of Appeals, it is true, decided this case on other grounds than the single fact that the signature occurred before reaching the end of the document. Perhaps, if nothing of importance had followed the signature (McGuire *vs.* Kerr, 2 Brad., 244), the court would have sustained the decision of the General Term, and held the will to have been properly executed; but the fate of this instrument conclusively shows that it is not safe to tamper with a statute, and that the end of a will *is at the end;* in other words, the testator should have signed immediately above the witnesses, at the conclusion of the document.

Printed wills and wills executed by a type-writer have been held to be written within the meaning of the statute. On March 9, 1883, Judge York, at New Haven, Connecticut, admitted the will of James Willey, which was in type-writing, to probate, holding that the legal definition of writing included printing. The Supreme Court of Pennsylvania, in the case of Myers *vs.* Vanderbilt (1 Schuylkill Leg. Reg., 55), recently decided that ink was not essential, by recognizing as valid a will which was wholly written in lead-pencil and so subscribed. This agrees with the views of ex-Surrogate D. C. Calvin, of New York, who, in October, 1878, admitted the will of Henry J. Mann, otherwise and better known as the actor Montague, to probate. This will was written and signed wholly in pencil, upon a leaf torn from an ordinary diary or small memorandum-book, and was as follows:

"If anything happens to me, I make this my last will and testament in favor of my mother, who is to take everything I possess; in case of her death, then my sister inherits all my effects. L. Simon and Arthur Sewell I appoint executors.

H. J. MONTAGUE."

On the back of this scrap, also in pencil, occurs:

"Witnessed by T. R. EDWARDS,
LOUIS M. SIMON."

In cases of contracts, lead-pencil agreements have repeatedly been held sufficient (Merrit *vs.* Clason, 12 Johns., 102; Clason *vs.* Bailey, 14 id., 484; Brown *vs.* Butchers' and Drovers' Bank, 6 Hill, 443), and the same reasoning applicable to such applies also to testaments. It is certainly to be hoped that the tendency of the decisions in this respect will change. The door for the admission of fraud is here opened too wide. To erase and rewrite in the body of the will is much too easily and cleverly accomplished, and this temptation should be removed by statutory enactment or judicial interpretation.

A mark or cross has been held a good subscription. Some years ago Moses W. Jackson left a will signed—

his
MOSES W. × JACKSON.
mark.

The surrogate adjudged this sufficiently subscribed; the Supreme Court upheld the surrogate, and the Court of Appeals sustained the Supreme Court, holding that it was not even necessary that the words "Moses W. Jackson, his mark" should have been written *before* he made the ×. The law would undoubtedly admit the cross if the words were entirely wanting, under proper evidence (Jackson *vs.* Jackson, 39 U. S., 153). If the testator requests a third person to subscribe the will for him, and it be done in the presence of the witnesses, it comes within the statute (Campbell *vs.* Logan, 2 Brad., 90; Van Hanswyck *vs.* Wiesl, 44 Barb., 494). But such third person must himself also sign as a witness.

2. Such subscription shall be made by the testator in the presence of each of the attesting witnesses, or shall be acknowledged by him to have been so made to each of the attesting witnesses.

On December 1, 1865, William Baskin made a last will, and five weeks afterward died at the age of eighty-nine years. Thirteen years before he had made a previous will, which still continued in existence. At his death the will of 1865 was offered for probate to the Surrogate of Yates County, New York, but its admission was contested. The evidence showed that the last will was drawn by one Henry Smith on the morning of December 1, 1865, at the bedside of the deceased; that the whole was read over to him, clause by clause, and that Mr. Baskin at the completion of the reading sat up on the side of the bed and wrote his name at the foot of the will without assistance and without spectacles. Mr. Smith then affixed his own signature at the request of the deceased, as an attesting witness. Mr. Wilsey, the other witness, was then called in from the adjoining room, when the testator said, "I want you to sign this will," Mr. Smith at the same time handing it to him. While still in Smith's hand, the latter asked the testator if he acknowledged it to be his last will and testament. He said "Yes." Wilsey then signed, when Mr. Baskin said, "That kills the other will." No conflict of evidence existed. Both witnesses agreed that the signature of the testator was affixed *before* Wilsey came into the room, and that Mr. Baskin did not expressly state in his presence that he had signed the will. The surrogate said this was no will, for it had not been *signed* in the presence of *each* attesting witness, but the Supreme Court reversed his decree, and the Court of Appeals affirmed the Supreme Court, holding: "Where the testator produces a paper bearing his personal signature, requests the witnesses to attest it, and declares it to be his last will and testament, he thereby *acknowledges* the subscription within the meaning of the statute" (Baskin *vs.* Baskin, 36 N. Y., 416). In fact, it is not even necessary that the subscribing witnesses should be shown the signature of the testator to the will at the time of acknowledging its execution.

In 1866 the will of Samuel Mott came before the Surrogate of Queens County, Long Island, for probate. It was contested upon the ground, among others, that it had not been signed in the presence of each witness, they signing after the testator but on different days, and that at least one of them had not so much as seen Mr. Mott's signature, the document being so folded when executed as to hide the name. The surrogate admitted it, however, the Supreme Court and Court of Appeals affirming his decision (Willis *vs.* Mott, 36 N. Y., 486; Hoystradt *vs.* Kingman, 22 N. Y., 372). So in the case of Ellis *vs.* Smith, decided in 1754 (1 Vesey, Jr., 11) by Lord Chancellor Hardwicke, assisted by Sir John Strange and the Chief-Justice of the Common Pleas and Chief Baron of the Exchequer, it was held that a testator's declaration was equivalent to an actual signing in the presence of the witnesses, a rule unchanged by the statute under consideration.

These cases show that considerable latitude is tolerated under this section, but that one of two facts must transpire in order to comply with its terms—either an actual subscribing by the testator in the presence of each of the witnesses before they sign; or a clear, indisputable acknowledgment to each of them that the instrument has been already so subscribed by him (Chaffee *vs.* Baptist Missionary Convention, 10 Paige, R. 85). Of course, in the latter case, if the subscription subsequently appears wanting, such acknowledgment amounts to nothing; there is no will.

3. The testator, at the time of making such subscription, or at the time of acknowledging the same, shall declare the instrument, so subscribed, to be his last will and testament.

Here, again, nice questions have arisen. What is a declaration that "this is my last will and testament"? Is it sufficient that the question be asked me and that I assent thereto by "yes" or a nod? If I say "This is my free will and deed," have I fulfilled the requirement, or must I use the precise words "This is my last will and testament"? These and kindred inquiries have perplexed the courts, and weary litigants have been forced to possess their souls in patience, awaiting the interpretation of blunders which could easily have been avoided in this particular of execution. The courts say it is not imperative that the word "declare" should be employed—I "acknowledge" this paper to be my last will and testament is enough (Seguine *vs.* Seguine, 2 Barb., 385). But a mere nod of assent to the inquiry, "Is this your last will and testament?" observed only by one of the persons present, is not enough (Burritt *vs.* Silliman, 16 Barb., 198), while an answer "yes" to the inquiry has been held sufficient (Coffin *vs.* Coffin, 23 N. Y., 9). To say "This is my free will and deed" is not good, for, as above appeared, the Court of Appeals has held that Thomas Lewis failed to acknowledge his will, although he used these particular words, and rejected his final testamentary disposition as a nullity. What apparently could be easier than to say "This is my last will and testament" at the proper time and under the proper circumstances? yet that many fail to either use these simple words, or to know the proprieties of time or circumstance, is shown by the foregoing cases.

4. There shall be at least two attesting witnesses, each of whom shall sign his name as a witness at the end of the will, at the request of the testator.

A will with but one witness is bad on its face—it is no will; it is a plain failure to observe an all-important formality, but questions "What is a signing by a witness?" "Where is the end of a will?" and "What constitutes a testator's request?" have been before the courts for determination. To answer the first two inquiries briefly, it is enough to state that the same rules which apply to the testator's signature and to the place of his subscription apply with equal force to witnesses. A witness's mark is good (Meehan *vs.* Rourke, 2 Brad., 385; Morris *vs.* Kniffen, 37 Barb., 336), and he should sign after the testator, immediately at the conclusion of the instrument. Concerning the third "inquiry" as to the request, some contrariety of opinion has existed as to what shall be deemed sufficient. The following cases are in point:

A request may be implied; it need not be in express terms, as, if the testatrix be told in the presence of the witnesses that they have come to witness her will, and she then bow assent and they sign it, it is a request (Brown *vs.* De Selding, 4 Sand., 10; Peck *vs.* Carey, 27 N. Y., 9). Handing a will to the witnesses, at the same time evincing a desire to have them sign it, is enough (Gamble *vs.* Gamble, 39 Barb., 373). But a mere request to sign, without in some way disclosing the nature of the paper, is bad (Harris's Estate, 1 Tuck., 293). Such questions as, "Will you witness my will?" or "I want you to witness my will," if addressed to *both* witnesses, are good (Van Hooser *vs.* Van Hooser, 5 N. Y. Surr., 365), but bad if addressed to only *one* of them (Rutherford *vs.* Rutherford, 1 Denio, 33).

Touching the question of the formalities of execution, a word on *foreign* wills is in place. All wills of residents of this State executed in foreign countries in accordance with the laws of the country where executed, but not in accordance with the law of New York, and all wills of foreigners executed in accordance with the law of their foreign domicile, if not also in accordance with the law of this State, who die leaving no property situated or which afterward comes here, are not admissible to probate, not because they are necessarily illegal, but because the statute-book declares this to be the law. The importance of this provision must particularly commend itself to the mind of every citizen intending to make a will, and contemplating a visit beyond the jurisdiction of his own domicile. Sometimes an action in the Supreme Court to establish such succeeds; but who can be found willing to unnecessarily involve his estate in litigation to ascertain the validity of a will when it can easily be avoided? The surrogate has certainly no power to admit such wills.

In concluding this discussion on the execution of a will, it may properly be said that the instrument must be fully completed before death—that is, it must have been subscribed by the testator at its foot, in the presence of the witnesses, or the subscription so acknowledged; it must have been declared to them to be his last will and testament, and the witnesses must actually have signed it, at his request, for, if he die ere this is accomplished, there is no will (Vernon *vs.* Spencer, 3 Brad., 16). Simple as these statutory requirements are, the instances cited prove that even the question of execution is not free from serious snares. Yet a literal compliance with the formalities of the statute is not required, a substantial observance of them being sufficient (Coffin *vs.* Coffin, *supra*).

It is entirely possible to execute a will so as to be technically incontestable.

Touching the graver question as to preparing or drawing the will—in other words, considering its contents, whether its provisions offend the law or not—the scope of the inquiry broadens and becomes very comprehensive. It presupposes on the part of the draftsman a knowledge of the law as determined in unnumbered decisions adjudicated both in England and the United States. The common law, principles of international comity, and statute-books, all must be resorted to in answering the question. It assumes in the writer of the will an accurate and extended fund of information upon the subject of trusts, powers, and uses, and generally an intimate acquaintance with all the nice details relating to that great branch of jurisprudence—real estate.

It suggests a familiarity with laws past and laws present, and it means, if it means anything, that competent intelligence must guide the hand which guides the pen.

In view of these facts, there is small reason to complain at the litigation so frequently entailed in connection with estates. To prepare or draw a will is not the simple matter some imagine it to be, even when short and free from intricate questions of law. The slightest ambiguity in language, giving opportunity for dispute as to the testator's real intentions; ignorance of the legal effect of certain dispositions made in the instrument; wishes imperfectly expressed; illegible writing; erasures; interlineations, and circumstances similar in character, are all fruitful of evil consequences. The books are full of instances where instruments have been propounded as wills, but which have proved to be still-born, or, if initiated into existence as living, genuine wills, only so after the ordeal of many years' litigation to determine their genuineness, sufficiency, or construction, has been endured. Like surgery, law is a science. The unscientific man may with equal propriety endeavor to amputate his own limb as draw his own will. In each case he has ventured upon a field in which he has neither knowledge, experience, nor skill. He may succeed, but every probability points to a fatal result.

The antiquity of testaments is such that many imagine that to prepare and execute one is a matter of general information—one concerning which all are competent to speak. It is true that this mode of transferring title or ownership dates far back into remote ages. Writers assert that abundant evidence exists that wills were in use among the Hebrews in the earliest times. Plutarch speaks of their introduction by Solon into Athens, some six hundred years before the Christian era. The Twelve Tables gave to the Romans the right of *bequeathing* their property, a power which in England is coeval with the invasion of the Saxon, for no record or memorial exists of a period when this right did not obtain. But this antiquity proves nothing. Other sciences are equally old.

To prepare or draw a will can only safely be undertaken by him whose intelligence and experience have earned him the right to assume the task.

The subject of incapacity and undue influence is not embraced in this inquiry, but a word in reference to it may not be out of place. No will was ever yet drawn, nor can one be, which was or will be proof against attack from this quarter. That many have been disgracefully contested by shameless relatives is true; for, to forget such in his will, even if related to the deceased but in the remotest degree, is conclusive evidence to the minds of some that the sanest or most self-willed man while living has proved, in spite of all, weak and insane at death. Because contests frequently arise, however, from this cause, it does not follow that this is not at times a very proper ground to take in resisting the probate of a will. To do so would be to fly directly in the face of the decision of Delafield *vs.* Parrish (22 N. Y., 9), where the question of incapacity was so ably and exhaustively presented to the Court of Appeals by Mr. Evarts, Mr. O'Conor, and other illustrious counsel. No one can fairly doubt, after reading the able opinion of the Court in that celebrated case, that Henry Parrish was incompetent to execute the last two codicils to his will. It is true he had been a keenly intelligent man; he had amassed a large fortune; he had never acted in life from impulse, for wisdom, discretion, and reflection prevailed in his counsels. Yet, after his paralytic stroke, he became a changed man. The quiet, urbane gentleman became a fretful invalid, forgetful of even the proprieties of life. Idiotic dementia took possession of his once-active brain. It was in this condition, and after the stroke of paralysis, that the last two codicils were executed. It should occasion no surprise that the courts utterly refused to receive them. Still, that much abuse of this objection to the probate of a will is prevalent, is undeniable. Nor does there seem to be any cure for the disease, unless the theory "*omne testamentum morte consummatum est; et voluntas testatoris est ambulatoria usque ad mortem*," be changed, and every man allowed to probate his own will before he dies, if he desire. Let him summon all who have the right to contest his ability, etc., to execute a will, and, if they do not appear, or if they do not succeed in showing his inability so to do, they shall be forever estopped from attacking the will thereafter. Of course, there are serious objections to this course, for all beneficiaries would then know the contents of the document, and few men care to let the world into the secret of their final intentions or ulterior purposes; still this law has been tried in some of the States successfully and satisfactorily. Whatever is contained in this paper on last wills and testaments applies with equal force to codicils.

FIFTY YEARS OF MECHANICAL ENGINEERING.*

By ABNER C. HARDING.

I WILL begin by referring to the steam-plant employed for manufacturing purposes. In 1832 the stationary engine was commonly the beam-engine, often condensing but seldom compounded. Steam was supplied by boilers having but little resemblance to the boilers which most of us are familiar with. The name given the boilers explains their form; they were variously called tun, hay-stack, balloon, elephant, chimney, and ring boiler, to each of which they severally bore a striking resemblance. They were built in utter disregard of all

* Read before the Peoria Scientific Society, March 24, 1883.

laws relating to the strength of material, but were well adapted for the convenience of the firemen, in that the flues were of such size that a man could pass through them to remove accumulated soot.

The result was, that the boilers were incapable of withstanding an internal pressure of more than four or five pounds to the square inch. The low pressure made a large cylinder necessary to secure the required power, and the size of the cylinder restricted the speed, which rarely exceeded 250 feet a minute. The boilers were commonly fed by a tank situated high enough to enable the water to overcome the pressure of the steam. The low pressure and slow piston-speed necessitated very large cylinders relatively to the power obtained. The consumption of fuel was about ten pounds to the one horse-power per hour.

The governing was done by slowly-revolving pendulum-arms scarcely securing centrifugal force enough to raise the balls and actuate the butterfly-valve in the steam supply-pipe, thus making a very poor and inefficient governor. The low speed made a very heavy fly-wheel necessary to secure uniformity of motion, also costly trains of gear-wheels to secure the rotative speed required for factory-work.

In 1882 the boilers are cylindrical, frequently internally fired, and, thanks to Sir William Fairbairn's circumferential bands, the flue, subjected to external pressure, is so strengthened that the danger of collapse is removed even with our present high pressures. The tendency of the day seems to incline toward the water-tube sectional type of boiler and a rational system of inspection and test. The pressures in use to-day vary from 80 to 150 pounds. The piston-speed is nearer 500 feet per minute, often 800 and 1,000. An engine of 1832 capable of exerting 25 one horse-power to-day would indicate about 250 working under fair conditions. The same expenditure of fuel to-day would give nearly four times the power.

The decrease in size of the cylinder due to the higher pressures has made higher rotative speeds possible; hence, the engine requires a much lighter fly-wheel, and the governing is made more effective. The most efficient engines of to-day are found in our city pumping-stations. Here the conditions are favorable for securing the highest economy, a duty of 100,000,000 foot-pounds being frequently secured. The engine of to-day for mill-use is, comparatively speaking, a portable engine requiring nothing but a foundation to bolt it to. The engine of fifty years ago was not self-contained or self-supporting, but required to be built from the ground up, and the support of walls and timbers.

To-day the practice is to make large engines condensing and often compound, expanding the steam in some instances ten volumes. The higher pressures and rotative speeds of to-day have made the use of high expansions possible in comparatively small engines, and economies are secured which, but a few years ago, would have been wonderful for large engines. The governing is done by quick-running governors which either throttle the supply-pipe or alter the point of cut-off, and thus secure uniformity of motion with the highest expansive use of the steam.

In 1832 no steamship had essayed the passage across the Atlantic. The marine boilers of 1832 were unfit for resisting any considerable pressure, in fact, so weak were they that they have been known to collapse when steam had been let down. The engine and boilers took up so much of the tonnage of the vessel, and used such enormous quantities of coal, that it was predicted that it would never be possible to cross the Atlantic unaided by sail. In fact, the prediction held good for a long time, for transatlantic steamship lines were compelled to establish coaling-stations at Halifax and Queenstown in order to reduce the coal carried, and allow of a little cargo being taken on. In 1832 all hulls were wood, and salt-water was invariably used in the boilers, much to their injury. The speed rarely exceeded eight knots an hour.

In 1882 the ships are almost invariably of iron or mild steel, and this enables the introduction of an element of safety impossible with the use of wood : I refer to the compartment and cellular system of naval construction. The use of iron and steel has made the construction of ships of great length possible.

The boilers are of enormous strength, and carry from 80 to 125 pounds pressure. The cylinder or cylinders are now adapted to the economical utilization of all the expansive force due to the pressure used. To secure this, more than one cylinder, is used ; all the expansion could be had in one cylinder, but the difference in temperature of the cylinder, due to the temperature of the steam before and after expansion, would cause undue condensation. The substitution of the propeller for the paddle-wheel for sea-navigation and the high speeds required by the former have done much to reduce the size and weight of the marine engine ; and have also had a marked effect on the economy. The paddle-wheel has practically disappeared, except on rivers.

A piston-speed of 800 feet a minute is often attained in daily practice. Hence, enormous powers are secured with comparatively little loss of carrying-space.

The marine governor of to-day is almost endowed with prophecy. It anticipates the pitching of the ship and withdrawal of the screw from the water, and cuts off steam just before its occurrence, thus avoiding the dangerous racing of the engine when the screw leaves its work. This, for a long time, has been almost the only danger in bad weather ; the racing of the engines subjected the screw-shaft to strains for resisting which the shaft was inadequate. The twisting off of the propeller-shaft of an Atlantic steamer is not an uncommon occurrence. Condensation is now had almost in all cases by the surface condenser, thus returning all the water to the boiler to be used again. It might be well to speak here of a steamship built in 1882. Steamships are now making long voyages at a high rate of speed, voyages which till a short time ago had been left to sailing-vessels. This steamship has some points of interest, and illustrates the most advanced ideas on steam-engineering as applied to the mercantile marine. The engines of this steamer are triple expansive, having one high-pressure, one intermediate, and one low-pressure cylinder, using steam at 125 pounds pressure, generated by boilers whose only peculiarity consists in the fact that they are capable of withstanding such a pressure. On trial these engines gave one horse-power for 1·28 pound of coal burned per hour. This would, according to the usual analogy, indicate a daily working efficiency of about 1·50 pound to the one horse-power. This steamer can carry coal for a voyage of 12,000 miles, and, with proper use of sails, could probably keep under steam for two months without coaling. The weight of the engine and boilers of 1832 was about 1,000 pounds to the horse-power; to-day it is about 300, and in some instances has been reduced to forty-five pounds to the horse power.

An English firm have recently completed a small light compound engine, which, in point of weight, eclipses anything heretofore built. This engine is made of steel and phosphor-bronze; all parts are built as light as possible, the rods and shafting and all parts possible being bored out to reduce weight. At a speed of only 300 revolutions a minute they indicate over twenty horse-power, and weigh but 105 pounds all told. This engine would give fully thirty horse-power actual at a piston-speed of 500 feet a minute. The size is three and three quarters high pressure, seven and a half low pressure, and five stroke. That thirty horse-power can be had from a proper utilization of steam and proper distribution of 105 pounds of metal is certainly most astonishing, especially so, considering that the engine is compound. A ship of 2,500 tons displacement was almost unknown fifty years ago; to-day the transatlantic steamer, the highest class of the mercantile marine, has from 8,000 to 13,500 tons displacement, and engines of 5,000 to 10,000 one horse-power. Several of the transatlantic liners have shown a mean ocean-speed of twenty miles an hour, and make the passage in less than seven days.

The present generation has grown so accustomed to the results of the progress of mechanical science that it has long ceased to wonder at its greatest works.

It may be well here to speak of the torpedo-boats which have been recently built for the English Government; they indicate the extreme limit of naval construction of this day. These little instruments of destruction are only eighty-seven feet in length, ten and a half feet in beam, forward draught eighteen inches, aft fifty-two inches, total displacement thirty-three tons. The engines are compound condensing, of the intermediate receiver type, high-pressure cylinder twelve and three fourths inches, low-pressure twenty and three fourths, stroke twelve inches, and indicated over 500 horse-power, with a gross weight of only eleven tons, boiler, water, engine, condenser, propeller, and shaft included.

The special feature of the boat is the enormous power developed per hundredweight of propelling machinery. The boilers evaporate eighteen pounds of water per hour per square foot of heating surface, and 120 pounds of coal per square foot of grate-surface. This is fully six times the amount of water and coal usually dealt with per square foot of surface in furnace and boiler. Such a forced combustion precludes all thought of economy, yet a one horse-power is secured at full speed with an expenditure of three and a half pounds of coal. The forced draught is secured by maintaining in the stoke-hole an air-pressure corresponding to a column of water six inches high; this renders the stoke-hole quite cool and comfortable.

One ton of coal will last for a run of 100 miles at a ten-knot speed. A speed of twenty-two and a half knots has been secured in trials lasting three hours. This is a speed of 2,250 feet a minute, or thirty-seven and a half feet a second, and seems almost incredible.

But, remarkable and important as these results are in the phase of steam-engineering, these little vessels have revealed in their performances under speed-trials facts of equal importance to another department. The speeds attained are high even for large steam-vessels, but enormously high for such small vessels. It is found that passing the ten and twelve knot point, which bears about the same ratio to these little boats that eighteen knots an hour does to large steamers, the ratio of resistance to the speed decreases, and at the fifteen-knot point it is about the $3\frac{1}{2}$-power, at the eighteen-knot point about the 3-power, and sometimes at the twenty-two-knot point is as low as the $1\frac{1}{2}$-power of the speed.

Effort has been frequently made to utilize steam at much higher pressures than I have mentioned, but, owing to the solvent nature of steam or water at a high temperature, the results have not been satisfactory; among many difficulties encountered was that of lubricating the cylinders.

Loftus Perkins, an English engine-builder of prominence, is devoting much time to the use of steam at about five hundred pounds pressure, and with some success. Unfortunately, the gain to be anticipated from the use of these exceedingly high pressures does not seem to be very great on trial. The Anthracite, a small steamer fitted with engines and boilers specially adapted to the utilization of steam at five hundred pounds pressure, was more wasteful than many steamers using steam at one hundred pounds. However, here is a wide field and one that promises well.

Should the same change of law as to the resistance increasing as the square of the speed be found to hold good in large steamers as in the little torpedo-boats, we shall most of us live to see locomotive speeds at sea. There is now building in this country an engine which will exert the greatest power as yet secured from one cylinder. The stroke is fourteen feet and the diameter of the cylinder is nine feet two inches, and the engine is expected to develop eight thousand horse-power. As an illustration of the size of the engine, the wrist-pin is almost exactly the size of a flour-barrel.

We now come to the engines and boilers used for railways. The year 1832 was the beginning of our present passenger and railway system on this side of the water, and, if the engines imported in that year to run on American roads are any indication of the state of the science of steam-engineering abroad, they could not have been much in advance. At this time the engine and boiler weighed about eight tons, carried forty pounds pressure, and could make about twenty miles an hour under light load and favorable conditions. The engine of that date could not pull more than three or four times its own weight, and had to stop at stations to fill boilers, as they could not pump while running.

The speed to-day is from forty to sixty miles an hour, and the engines weigh from thirty-five to eighty tons, and draw as high as eight hundred tons of paying freight in addition to the weight of the train. To-day the pressures run from one hundred and thirty-five to two hundred pounds. The latter pressure is used in Switzerland. The automatic and continuous breaks now stop a heavy train within four hundred yards at a speed of sixty miles an hour. Recent trials show that these breaks will absorb twenty miles of speed in one minute.

In 1832 the transmission of power was by flat tumbling-rods and cast-iron shafting of great weight and little strength. To-day we have smooth, light, rapidly revolving steel or iron shafting, supplemented and aided with rubber and leather belting where the latter will serve and the former can not. Where power has to be transmitted at a great distance, wire ropes, moving at a high rate of speed, are used. Wire-rope transmission commences at the point where the belt and shafting become too long or heavy to be useful. It is much cheaper than its equivalent of shafting or belting. In fact, a long line of shafting would cost more for oil in a year than a wire rope would in fifteen.

At the Rhine-fall, in Switzerland, eight hundred horse-power is transmitted a distance of two miles to a village where fifty small manufacturing industries, situated in every conceivable position relative to the cable-line, secure power. For ten years the cable street-railway system has been in use in San Francisco. The same system, slightly modified, is being adopted in many Eastern cities.

Fifty years ago compressed air had not been successfully employed in engineering, though its application as a blast to forges is coextant with history. Sir Henry Bessemer's steel process was made possible only upon the ability of engineers to furnish air under pressure in the converter. The importance of compressed air and the part it has taken in recent engineering undertakings can not be overestimated.

Without it the boring of most of our tunnels and the placing of masonry foundations under water could not have been accomplished. In 1832 the turbine wheel had just been invented, but not brought into use; in fact, hydro-mechanics has made as great steps forward in the last fifty years as any of her sister sciences.

A recent invention of Sir W. Armstrong deserves mention. A steam-engine actuating a pump is used to secure an artificial head of water, which water is afterward employed in driving various hydraulic motors operating cranes, lifts, driving riveting machinery, and the artificial head is secured by loading a ram of sufficient size with weight enough to place a pressure of seven or eight hundred pounds to the inch in the cylinder. The pumping-engine pumps against this ram, the chamber of which is connected with each of the machines requiring to be driven; whenever the work done in the various motors is less than the work of the engine, the surplus is expended in raising the ram, and when the ram is fully extended an automatic device stops the pump, which again resumes work on the withdrawal of water from the ram by leakage or use in motors. By the aid of this system of storing power, a small steam-pump attached to an accumulator is capable of furnishing three hundred or more horse-power for a short time. This arrangement is adopted in all docks and ship-yards of any pretensions.

Our modern turreted man-of-war handles its eighty and one hundred ton guns, and all the loading machinery, by the aid of similar hydraulic devices. These accumulators give an efficiency of ninety-eight per cent in practice, which amounts to perfection.

In 1832 rolled plates such as are now rolled were unknown, and the rolling of armor-plates twenty-two inches thick, weighing thirty tons, was not thought of.

The process of making wrought-iron by puddling has not changed much, though larger masses are handled. The manufacture of iron by puddling seems doomed; steel is taking its place rapidly; in 1832 masses of steel of over sixty pounds were not made; steel was dealt in by the pound for cutlery-use. Thanks to Sir Henry Bessemer and Dr. Siemens, steel is made on the Bessemer and open-hearth process, and in masses of many tons' weight. The rapid advancement made in engineering skill is due in a great measure to the cheapening of iron and steel making. Never in the history of the iron industry were there so many partially developed processes, the completion of which will revolutionize the industry, and furnish iron and steel at a cost much below present prices.

The unprecedented expanding of our railway interests since 1865 has had much to do with the development of the iron interests. Inventors of prominence promise us steel at one cent a pound, and in the light of the past it is not safe to assert that it will not be done. Steel rails have been sold within a few years at one hundred dollars a ton ; to-day they are worth thirty-eight dollars. It is confidently predicted by those who have made it a study, that the downward tendency can not be checked, and that one cent a pound will be reached as soon as the experimenters have worked out plans now in hand.

Considering the many improvements which are now proposed and tested, we can safely assume that the steel-plant of the future will differ widely from the plant of to-day. All the available heat and all the useful elements in the ore will be used. Briefly this is as follows : The ores, limestone, and fuel will be placed in the furnace, the molten metal will be run to converters, and there the foreign elements will be removed by a blast, the metal then recarbonized and cast into ingots, the ingots will be rolled into blooms, then the bloom into rails, and the rails will then be placed on small cars, and, while at a temperature of about 1,000° Fahr., will be placed in the flues of steam-boilers until they have given up about 700° Fahr., and then passed on as finished. The slag flowing from the blast-furnace will be placed on cars, and, while at a temperature of 3,000° Fahr., be run into the flues of other boilers used to generate steam for operating the blowers, rolls, etc. This, in brief, is one of the proposed steps in steel-making, viz., the utilization of all the heat in the coal, and afterward all the heat given to the iron and slag by the coal ; by so placing the iron and slag as to give up their heat again to boilers used to generate steam for the roller-mills and blowing-engines, which in turn aid the smelting of the iron.

A rail-mill of 500 tons a day, at a low estimate, would secure heat to run a 1,000 horse-power battery of boilers from the cooling rails alone, and 4,000 horse-power in heat from the slag. Hence the steel-plant of the future will have no heating-furnaces, no gas-producers, no coal-consuming boilers, no cupolas, no ash-piles, and no fuel to be consumed except that required to melt the iron. The converter-slag can now be used instead of limestone by the new process. This, in brief, will be, it is confidently predicted, the new rail-mill of the immediate future. Everything is done by the aid of air, steam, and water. Muscle will be in little demand, brains at a premium. In 1832 cast-iron bridges existed of short span, but wrought-iron had not been used. To-day we think little of trusses of 500 feet span, and suspension-bridges of 1,000 feet ; while it is proposed to build a steel truss-bridge over a mile long, with two spans of 1,700 feet each. In the power-printing press, an invention of the eighteenth century, we find that the last half-century has wrought wonders. In 1832 the best presses could turn out about 1,000 poorly printed sheets of printed matter ; to-day, thanks to Hoe's revolving type and the processes of electro-plating and stereotyping, we have presses capable of printing 50,000 impressions an hour ; and, what is almost as wonderful, it will number, fold, and stick together the whole. Such a machine costs about $100,000.

We live in an age of progress. The additions to our knowledge made during the last fifty years seem to excel in utility and lasting benefits the knowledge acquired in centuries. Popular belief is that the possibilities of progress in all directions are unlimited. Those who should know, think that in mechanics we have nearly reached the limit which theory, well established, places before us. The steam-engine, using but one tenth of the power to be obtained from the coal, is nearer its limit than most people imagine.

The science of the future is undoubtedly in chemistry, and our great discoveries and greatest progress will be in that science. Mechanics may hereafter expect to take a secondary part. In the iron industry chemistry and mechanics have stood side by side; chemistry generally propounds the problems, pointing the way to the chemical solution, and calling upon mechanics to devise means for carrying out the undertaking.

One of the most notable features of modern industrial progress is the utilization of what has always been considered waste material. This is done by devising and constructing special machinery to meet the case. Sometimes costly experiments are necessary; but, in this age of speculation, those who gain the prizes offered in legitimate business are those who are willing to accept ventures involving large risks. There is no limit to human wants, and the industrial expansion we are engaged in will not be restricted except by the impossible.

Photography and the electric sciences are two arts of which nothing was known fifty years ago: what a gap the removal of one of these would make in our civilization to-day!

Sir Henry Bessemer's steel process has had a very marked influence on the mechanical advancement of the last half-century. Yet so closely allied are all the great steps in progress, that one can not be taken without the other, and Sir Henry was himself compelled to seek or invent numerous devices before his original steel process merited the name.

We daily complete engineering works which, in the amount of human labor they represent, far exceed the labor represented by the great Pyramid of Cheops. Undoubtedly the progress of the age, which is so largely engineering progress, does greatly increase the welfare of man. The forces of Nature now do the hard work, and the labor of the toiling millions is lightened many fold. The laboring-man now works with brain and eye, and his occupation is to direct and apply some principle of science. He now has time for improvement, comfort, and refinement; the forces of Nature having become obedient to the will of man, are made to produce for him not only plenty, but conveniences and luxuries formerly undreamed of.

A PREHISTORIC WATER-SYSTEM.

By M. A. LÜDERS.

THE canton of Valais, though not so much frequented by travelers as some of the others, is really one of the most attractive cantons of Switzerland, and possesses, in its Alpine heights and its temperate valleys, many beauties peculiarly its own. There are also many features worthy of notice in the customs and the economical devices of its population. One of the most interesting features of the latter class is its system of conduits for watering the pasturage and tillage lands. This canton, in fact, possesses the model system of water-supply in the Alps. The people have maintained it from primitive times, and have by it, during the whole period of their history, drawn the water from the glaciers and mountain-springs, to be applied directly to every part of their farms and garden-plots. Without such watering as it makes practicable, the production of the district would fall off one half. This was exemplified in the experience of some of the towns during the building of the Simplon road in 1802, when their canals were interrupted and their water-supply was cut off. The grass-crop was so greatly diminished that the number of cattle fell off to one fourth of what it had been, and the former productiveness of the fields was not restored till new canals were made in 1810. In the little town of Zenegger, also, the springs were dried up, in consequence of an earthquake in 1855, and the number of cattle that could be maintained was reduced from two hundred to fifty. New conduits had to be made for this place also, with much labor and at great expense.

The maintenance of the water-system of the Canton Valais is intimately associated with the communal and family life of the people. The water is brought down in wooden flumes, that have to cross precipitous clefts at hundreds of metres above the bottom. A watchman has to go over them daily, and sometimes at night. His pay is very small, and his office is rather one of honor, full of dangers, to which some fall victims in nearly every year. By an ancient prescription, no one can hold a public office till he has served for some time as a guard of the aqueducts. It is not unusual, when repairs are to be made in particularly dangerous places, to send a priest along with the workmen, so that, if any of them meet with an accident, they may be provided with the consolations of religion.

The water is drawn from glaciers, lakes, or reservoirs, springs, and melted snow. Glacier-water is best esteemed, and is preferred if it is turbid, for then it holds valuable mineral constituents; lake or reservoir water contains less of such matters, for they have settled. Spring-water is least in favor, because it is most deficient in mineral substances, and because the time it occupies in running down the conduits is so short that it does not become warm enough to be used with advantage. The same objection is alleged against snow-water. The glacier-water, however, which is exposed to the sun for hours while running down the flumes, reaches the fields at an agreeable temperature, and ready for immediate application. This water is here free from oxide of iron, and is entirely fertilizing ; but additional richness is sometimes given to it by carrying it around through the barn-yards, and making it the means for transporting manure directly to the fields.

The chief canals which bring the water down from the mountains vary in length from one thousand to fifty-five thousand metres ; or, measured by the time it takes the water to run through them, from a quarter of an hour to six hours. The total length of the canals in the canton is one million five hundred thousand metres, or two hundred and fifty hours. The skill with which they have been located and constructed excites an admiration that is increased when it is remembered that they date from a remote antiquity and are the work of a simple country-people. Beginning often in the immediate neighborhood of the glaciers, crossing treacherous hills and lofty precipices, and spanning deep abysses, passing through tunnels and cuts, led along artificial terraces, that sometimes require additional embankments or walls to support them, these canals are really formidable works. They furnish the life-blood of civilization to the canton, and stand for a capital of incalculable value. They have been built and are kept up by the villages ; and a badly kept one is an exception. In most of the valley-slopes they lie in groups of three or four, the uppermost one being the longest, and reaching far up toward the glacier-source, and have an average descent of about 0·5 per cent. The subordinate ditches are of a simpler character, till finally a mere mark on the ground is all that directs the water to the particular spot where it is wanted.

The application of the water begins at about the first of April in the valleys, and later as the height of the locality increases, till, on the highest cultivated grounds, it is delayed till the middle of June, and is continued for from two and a half to three months. The right to draw off the water is apportioned out by village officers into turns, of which there are from four to twelve in the season, of from eight to twenty-one days or more each, according to the number of land-owners claiming to share in it.

Among the most remarkable of the main aqueducts are those of the Gradetsch Valley, where the water is led down by eleven canals, the highest of which starts from an altitude of 2,300 metres, or nearly 7,500 feet above the sea. Some of the canals require wooden conduits three or four thousand metres long, that have at times to be supported by poles for six hundred metres at a stretch. To reach them for repairs the workmen have in some places to be let down the perpendicular rock-walls with ropes.

The oldest of the canals date unquestionably from pre-Roman times. The "Roth" Canal supplies three villages with water, and is 19,200 metres (more than eleven miles), or four hours and twenty-three minutes long. It starts from "La Plaine Morte" glacier, on the Weisshorn, 2,673 metres above the sea, crosses several clefts, is conducted through a tunnel more than three hundred metres long, is covered for 9,600 metres, exhibits other features of high engineering skill, has an average section of a metre and three tenths, and delivers nearly a cubic metre of water a second. An artificial lake, or reservoir, has been built in the same district, to hold the water that is not wanted for immediate use. Its water, however, has not the same value as that taken directly from the glaciers, because it has lost most of its mineral constituents by settling; but, as it has become thoroughly warmed, it is admirably adapted to those applications in which water is wanted simply to refresh vegetation, and make the soil more friable.

The villages of Ried and Bietsch have three aqueducts (Kehrwasser, Bietscherrinne, and Riederrinne), severally 8,400, 2,400, and 12,000 metres long, to bring down the muddy water from the great Aletsch glacier, which are led for long distances along vertical cliffs and over giddy chasms. At one point on the "Kehrwasser" three men have been killed, within twenty-five years, by falling into the gorge. The water of the Bietscherrinne issues foaming from a fearful-looking chasm. The canal, having a border formed of stones laid with sods, and masked by bushes from the Massa ravine that yawns beneath it, is safe to walk along at first. The bushes soon disappear, and the aqueduct becomes simply a wooden conduit, made of planks that have to be drawn to the place, and adjusted there with great danger, while the narrow, slippery gang-plank, which is the only walk, offers but the most precarious footing to one who has to look down through the high trestles or into the steep ravine of the wild Massa, on one side, while he must watch on the other side lest he hit his head against the overhanging rocks and lose his balance. The highest of the three canals, the Riederrinne, is distinguished from the others by its loftier rock-walls and deeper chasms. It reaches to the foot of the Aletsch glacier, and draws the water from its source. Near it may be seen older, abandoned canals.

Near where these three canals start is the Marjälen Lake, having its surface covered, even in summer, with floating ice. Its natural outlet is by the valley of Viesch into the Rhône, but occasionally, in seasons of extraordinarily high water, it overflows in the opposite direction, and pours its floods into the Massa, causing breaks in the canals and stopping the conveyance of water. The existence of the villages of Bietsch and Ried depends upon their obviating the mischievous effects of these overflows, and it is customary to give a pair of shoes to the mountaineer who first notifies the dwellers in the valley of the occurrence of a break. A canal has been built to reduce the level of the lake, but it is not sufficient for the purpose.

The irrigation-canals of Lombardy and Lucca are more scientifically constructed, and display more technical skill, but they are not laid out on a more extensive scale than those of the Canton Valais. It is a fact deserving admiration that all of these colossal works have been and are still being built without the aid of technical knowledge, without any expensive instruments, by the people of the country; and that these people not only make great sacrifices of money and labor, but put their lives at stake, to assure themselves of a supply of water. Certainly a real struggle for existence is going on here; for, without a system of water-supply, there would be in many of the villages no grass, no vegetable crops, no corn, and no wine.—*Translated for the Popular Science Monthly from Das Ausland.*

WORKING CAPACITY OF UNSHOD HORSES.

By ARTHUR F. ASTLEY.

I SEND herewith a photograph of the near fore-foot of my *unshod*, white-hoofed, low-heeled chestnut horse "Tommy." This photograph was taken after I had driven the old horse (he may be twenty years old), in a phaeton, a hundred miles on hard roads in and around London. This does not include drives for exercise. It is impossible to say that the hoofs of this old horse (bought chiefly in order to test this question) are exceptionally good. The reverse is the case, as any of your readers, who may favor me with a call, shall see for themselves. That this animal, after having been for years "the victim of the farrier," should work, as he does, *barefoot*, is, I think, remarkable. As the old horse is nearly, if not quite, thorough-bred, he must have been shod (as is the vicious custom on the turf) very early; yet over all these evil influences, incidental to "the miserable coerced *shod* foot," the *unshod* foot has triumphed. *Shod*, my horse "brushed" and stumbled badly, but *barefoot* he does neither.

In Africa, a horse working in a post-cart does *barefoot*, over bad ground, twenty-four miles in two hours. In New Mexico, horses are ridden *barefoot* forty miles day after day, and perhaps twenty miles of this will be over a rough mountain-track. In Brazil, little horses (they seldom exceed fourteen hands) carry, slung across pack-saddles, *barefoot* (they have never been shod) *some thirty-two stone!* Thus loaded (or, rather, overloaded) they do twenty to thirty miles a day. Their journey may be some three hundred miles, and they load back the same. In England, *even race-horses* are shod! To gallop over a race-course, which no doubt may be hard at times, it is actually thought necessary to shoe a horse! Here, where *weight* is of the very utmost consequence, the heels of the English race-horse must be weighted with plates! The *fact* that Marden, when he ran *barefoot* in the Sandown Derby on June 2, 1882, beat, in the deciding heat, his two shod opponents by three lengths (though in his first race with them that day Marden, *with his plates on*, could only dead heat them), such a fact as this weighs little with the horsey Englishman, who will still be found to set his thoughts or opinions against facts! After all that can be said as far as *argument* goes, he will still be found to prefer mere *assertion;* it will still be the "I *think* this," and "I don't *think* the other," with him! But then is not the horsey (and for the most part *untraveled*) Englishman, as a rule, in the language of "Freelance" in "Horses and Roads," "*energetically conservative*"?

Any one who will read this book will thereby much increase his knowledge as to the *real* capability of the horse's hoof. "Horses and Roads" was published in 1880, by Longman, Paternoster Row. I find quoted in it the saying, "An ounce at the heel tells more than a pound on the back." This explains Marden's success when, by removal of "plates," his heels were lightened for the deciding heat.

But many of our countrymen connected with horses, deeming themselves practical men, are too apt to think that they have, as Mr. Ransom ("Freelance") says, "gone into everything," and they may consider their knowledge as to the *real* capability of the horse's hoof complete. Now, is it complete? Is not shoeing horses very much a matter of *routine* with us? I will give two instances in order to prove this:

1. Some weeks ago I received a letter in which the writer said that he had been told by a veterinary surgeon that if a horse were worked barefoot his hoofs "would wear down to the quick *in a few hours.*" Now, I saw the other day a horse which has been doing the work of his master, a doctor, *barefoot*, not for "a few hours," but for *over five years!* During this time the horse must have traveled, shoeless as he is, some thirteen thousand miles over the not too good roads of the east of London, and often with a heavy brougham behind him. The hoofs of this horse are the admiration of veterinary surgeons, and they show no sign of undue wear. *This horse was unshod when eight years old.*

2. I recently saw a pony seventeen or eighteen years old, never shod, except for a short time when in the breaker's hands. This breaker shod the pony. This was done against the master's wish and

without his knowledge. The breaker was, I dare say, practical enough in *other* details of his calling, but, like the majority of his countrymen, he "had always seen horses shod, and he thought they always must be shod." The pony was sure-footed *without* shoes, but *with* them she nearly fell with her master as he rode her home from the breaker's. The shoes were taken off, and the pony did her work admirably without them for years. She has done plenty of work, for her owner tells me that he has frequently driven her, and also ridden her, *over* forty miles in the day. The saying, "One horse can wear out four sets of legs," does not, of course, apply to this pony. The application of this saying is to the *shod* horse, *whose every step is made upon iron.* As a writer has well said, "It is the *shoe*, not the *road*, that hurts the horse."

Now, we see that both veterinarian and breaker mistook the nail-lacerated, contracted, unused foot for the natural healthy foot. The former, raised off the ground with an iron ring called a shoe, and with the insensitive sole and frog pared away, is not (when the shoe is *first* pulled off) fit for contact with the ground. In such a case *time* must be given for the foot to *recover* before the unshod horse can be asked to *work* barefoot.

I have a cast of the off fore-foot of a mare belonging to Mr. Whitmore Baker. This cast was taken in December, 1882, after the mare had worked barefoot on stony, hilly Devon roads for *two years.* She was unshod in December, 1880, being then seven years old. This foot shows no signs of undue wear, and I shall be happy to show the cast to any one.—*Land and Water.*

HOUSE-BUILDING IN THE EAST.

IN England house-building is a matter on which, in spite of "jerry" builders, one can look with comparative equanimity. In Indo-China it is a very different affair. Everything that is a source of trouble in the West disappears in those comfortable latitudes. A site can be found practically anywhere. The jungle furnishes, for the trouble of cutting it, as much material as may be required. Comparatively so little skill is wanted to start as an architect that every man can be his own house-builder, and, if he is tolerably diligent and not too ambitious, might finish his house in a few days. But, as a set-off to all these advantages, it is a very difficult matter to raise up a house which is not rendered dangerous or ineligible by the nature of the soil, the idiosyncrasies of the surrounding spirits, or the revolutionary character of the timber used. Building houses is, therefore, a very critical operation, and not to be undertaken without very considerable Sabaistic lore and an intimate acquaintance with all the animistic peculiarities of the neighborhood. Otherwise the house-builder simply courts disaster, and may involve not only his own family, as well as himself, in overwhelming difficulties, but may actually render a whole district uninhabitable by his unwarrantable irritation of the spirits dwelling in the soil, in the air, and in the very logs of timber which are recklessly used, or are put up with an improper exposure to the south instead of to the north, or set in position at a time of year when presiding demons hold that such things ought not to be done. It is, however, a necessity, even of Indo-Chinese existence, that mankind should have houses to live in. For the instruction, therefore, of those who are forced by necessity, or are foolhardy enough to believe that they can build themselves houses without coming to any particular harm, there are elaborate text-books, both in Burmese and Siamese. The Burman Dehtton is a bulky treatise, containing a farrago of omens and signs with regard to all possible events and circumstances, and not merely to the process of building. The Siamese "Tamra," or "Manual of House-Building," is considerably more systematic, and, in addition, possesses the advantage that it sticks to the subject of which it professes to treat. The theories in both works are based on and elaborated from the Shastras which record the customs of the Brahmans. Notwithstanding their Buddhism, which prohibits all such beliefs, the Indo-Chinese have a very strong regard for the Brahmanical observances. They are much easier to comprehend, or at any rate more fitted to seize on the imagination, than the abstruse problems of the faith of the Buddha. Buddhist metaphysical positions are fine things to confound hostile controversialists with, but the common Indo-Chinese mind yearns for something more concrete. The house-building code is, therefore, a very popular institution. It persuades a man that he is pious when he has an internal conviction that he ought to be damned.

The first thing the would-be house-builder has to do is to find out the situation of the great dragon that encircles the earth with his body, like the Midgard serpent of Northern mythology. This must be ascertained before operations are begun at all, for it will have a great influence, not only on the time of beginning the building, but on the way in which the foundations must be dug and the method of hoisting the posts into position. This the Burmese have recorded for them in a rhyme which every school-boy can repeat. The Siamese are not less alive to the necessity of accurate information on the subject, and it is fully set out in the "Tamra." The reason of this is that when you come to dig the hole for the main post of the house you must heap up the earth on the side toward the Nagah's belly. Terrible consequences follow if you do not observe this preliminary precaution. If you should pile up your mound in the direction of the head of the dragon, your negligence or ignorance will involve the death of your parents, your brothers, and the patrons of your house.

To be without a patron in Siam or Cambodia is to get your name put down on the list of royal slaves. Insulting the dragon's tail is even more calamitous, for the tail is a most touchy member, and would as soon create an earthquake and ruin the whole township as not. The reckless builder who did such a thing would, therefore, be stoned out of the community as a public enemy. Touching the dragon's back is simple *lèse-majesté*. The lord of the house will soon find out his crime, but the knowledge will come too late. He will die. The belly is the only safe part. If you choose that quarter toward which to heap up your earth, then, subject to a number of other precautions to be mentioned, you are comparatively safe. It is to be observed, however, that you have only three months to do your digging in. The Nagah, for all that he is so testy, sleeps during that period, or, rather, it is the disturbing him in his sleep that causes all the mischief. When the quarter-year has passed he rouses himself, and shifts round to the next point of the compass, and there, like the Norway kraken, composes himself to sleep again. Digging operations must then be conducted according to the new rules. Still, the time allowed is not unreasonable. Even an average Indo-Chinese can dig a hole for a house-post in three months. When you have settled generally how you ought to dig, there are a number of special rules to be observed in the digging itself. It will never do to go blindly ahead, for all the world as if you were a navvy on piece-work. In the first place, it is well to dig at large all over the space your house is intended to cover. In fact, if you have any regard for yourself, you certainly will. There are divers reasons for this. If you find costly articles, silver or gold, or the images of men and deities, it is a most happy sign, and will go far to counteract all but willful remissness in other matters. On the other hand, when bones or ashes or the figures of wild animals are found, the deductions are most unpropitious, and, if you persist in going on, the house will have neither luck nor peace. If the remains of previous house-posts are found still lying buried in the ground, they must be carefully dug out and carried away, for if this were not done, and a new building were to be run up over the old remains, sickness and quarrelings would be the certain result.

In addition to such elementary rules, which are matters of universal knowledge in Indo-China, there are so many others that every one but a very self-sufficient person will submit his surface soil to the inspection of a regular professional man, an expert in the science of foundation-digging, before he makes a final decision. For example, though it is undoubtedly most lucky to find silver or old bricks in your excavations, you may at the same time come upon a colony of ants or other living creatures settled upon the spot. It is one of the fundamental rules of Buddhism that the breath of no living thing is to be taken, and to dispossess them is not by any means a creditable proceeding. Moreover, irrespectively of this objection, ants can bite through even sun-toughened skins, so that there is a direct personal argument to support the sentimental objection. Then, again, you may find lead in your soil-turning. There is not the smallest hesitation in the books on a question like this. If you go on and build you will lose slaves and goods. But, for all the lead that is there, the turned-up earth may smell of beans, or may have the fragrance of the sacred lotus itself. This is a most happy omen. The dwellers in a house raised on such land will be most fortunate, and the soil round about is the best possible for cultivation. In such a dilemma there is nothing for it but to call in a Sayah and pay him to work out the problem, to make a resolution of forces for you. There are certain amateur ways of arriving at a conclusion by means of split bamboos and heaps of paddy, but they are apt to be fallacious and afford no real satisfaction to a well-constituted mind. It is not surprising to be told that sand is not a good foundation on which to raise a house, or that a soil which is mainly composed of small stones is undesirable; but when it comes to the slope of the ground, or the friability or stiffness of the earth, none but a thoroughly reckless man will trust to his own unaided intelligence.

At any rate, whether you get the advice of an expert or not, it is imperative that you should carefully turn over all the ground where the new building is to be. Having done this, it is a matter of reasonable precaution to make offerings to the earth-spirit. Acquaintance with this Phra Phum and his belongings is no light matter, and is likely to be as good as an annuity to the man who has mastered the details. As he is an earthy spirit he is especially liable to mortal failings, and notably possesses a very short temper, which will brook no deficiency in reverence. It will not do to be ignorant of the names of his father and mother and of his nine children. Forgetfulness of his possessions is equally likely to cause trouble. There must be no hesitation as to the proper titles of his house and the tower on it, his cattle-shed, his granary, his bridal chamber, his thrashing-floor, his lands, his garden, his monastery, and his three chief servants. Remissness in any one of these particulars is apt to make an offering dangerous rather than otherwise. This offering, by whomsoever brought, must be set down at the extremity of the toes of the Phra, who thereupon graciously takes up his broom and sweeps the place clean, and gives the pious votary his blessing. If an ignorant or presumptuous man should place his gifts near the head, the earth-spirit would curse him with terrible imprecations, and brush everything away, worshiper and all. Negotiations with this deity are therefore rather ticklish work, but it is perilous to leave them undone. The site being settled, and things made right with the guardian spirit of the earth, the next thing to be done is to dig holes for the reception of the posts. It is necessary to begin with that for the chief post, and the hole for this must not be dug square, but in the form of a triangle. This may imply more work, but that can not be helped. When the hole for the main post is finished, go on with the others, but be sure to do it in regular order, working round in circles from right to left, so as to follow the line of the dragon's body from head to tail. When it comes to the hoisting of the posts into position, the face must throughout be turned toward the back of the Nagah, a little inclining toward the tail, and the post must be heaved up toward this point of the compass. Thus in the first three months of the year you must face west-south-west, and haul up the beam from the northeast, and so on for the other quarters. It is also necessary to be very careful in the selection of the timber for the house. Trees especially to be avoided are those which have no flowers, those which have no leaves, trees which grow on ant-hills, trees with birds' nests on them, and those from which the bark has been torn off from whatever cause. Unhappily these distinctions are not obvious in timber which you have not cut yourself, and rascally Chinese carpenters will not hesitate to palm off upon the unwary wood from a tree on which scores of egrets—the Byeing, or sacred paddy-bird of the Talaings—have nested. Chinamen in their way are nearly as unscrupulous as Manchester piece-goods manufacturers, and have as little regard for the comfort and ultimate opinion of their customers. The beams for the house must all be measured with the standard of your own hand. This, however, is a detail which hardly needs to be strongly urged in a country where the three-foot rule is unknown. After you have got the posts up, the surface of the ground must be smoothed down, and then the posts are decorated with little bags of shells, coins, husked rice, and the like. These must be hung up by the hands of a maiden, and not by any rude male. The heads of the posts are also covered over with cloth, for the safe keeping of the guardian spirit of the house. It would be neither seemly nor safe to leave him exposed to the elements. The final ramming in of the posts is done at an hour fixed by the astrologers, the culminating point of some happy constellation. There is much shouting and feasting on the occasion.

With the foundation of his house settled satisfactorily, the sensibilities of the great world-dragon and the guardian spirit of the earth soothed and conciliated, and the house-posts raised and decorated with proper profusion, the house-builder may consider himself past all his troubles. If anything has been done wrong, it is now too late to repair the error. If everything has been carried out in seemly and orderly fashion, he may deem himself particularly fortunate. The putting on of the roof and the fitting up of the plank or split bamboo matting walls is a simple matter, and may be done according to the light of nature and with what dilatoriness and adornments the builder pleases, so long as he does not depart from the mundane laws of use and wont and infringe upon the sumptuary regulations. That is even a greater offense than flouting the great Nakh, or setting up posts in defiance of the angel of the soil. It certainly meets with swifter and more obvious, if not more exemplary, punishment. "There are two chances in the stare of a demon," says the Burmese proverb, "there is none in that of a king." One formality, indeed, remains, which is often omitted, it is true, but which no man of well-ordered mind should fail to observe. It relates to the setting up of the stair, or rather ladder, by which the house is entered, all the dwellings in Indo-China being raised off the ground on piles. If this stair is turned to the south, let a cat be the first living creature to ascend. If you manage this, then you will always have abundance in your house. The difficulty is to make the cat see the matter in the same light. If your steps face the west the question is simpler. All you have to do is to take some iron in your hand along with a few lotus-leaves and a wisp of kaing, or elephant-grass. Everything you attempt will thereafter come easy to you. A cock should crow at the top to inaugurate the stair ascending on the north side of the house. This also is a matter likely to keep you out of your dwelling for a long time if you persist in waiting for it. Stairs never ascend from the east, for the same reason that no Buddhist should sleep with his feet pointing to that quarter. It was from the east that the Lord Buddha came, and it would be scandalous to show to that quarter a disrespect that would entail severe punishment if it were exhibited toward the king or a great man. It will hardly be necessary to mention that there is only one set of stairs and one entrance to the house, if built according to the national model.

It will thus be seen that, though a wooden house or a walled hut does not seem to imply much expenditure of time, labor, or capital in its construction, yet, in reality, what with the perplexing rules to be attended to, the dangers to be avoided, and the spirits to be propitiated, the Eastern house-builder has emphatically a hard time of it, and is not to be envied by Westerns who have no greater grievances than damp walls, defective drainage, perpetual draughts, and chimneys that will not draw.—*Saturday Review.*

SKETCH OF SIR CHARLES WILLIAM SIEMENS.

IN a paper giving an account of the British Association of 1882, of which Dr. Siemens was president, Professor Emil du Bois-Reymond referred, with some expressions of admiration, to the many ways in which the name of Siemens is identified with the most important of the recent advances in technical science. What Krupp is among German industrials in warlike arts, he said, the collective name of Siemens is in the arts of peace. Siemens telegraph wires gird the earth, and the Siemens cable-steamer Faraday is continually engaged in laying new ones. By the Siemens method has been solved the problem, by the side of which that of finding a needle in a hay-stack is one of childish simplicity, of fishing out in the stormy ocean, from a depth comparable to that of the vale of Chamouni, the ends of a broken cable. Electrical resistance is measured by the Siemens mercury unit. "Siemens" is written on water-metres, and Russian and German revenue officers are assisted by Siemens apparatus in levying their assessments. The Siemens processes for gilding and silvering and the Siemens anastatic printing mark stages in the development of those branches of industry. Siemens differential regulators control the action of the steam-engines that forge English arms at Woolwich and that of the chronographs on which the transit of the stars is marked at Greenwich. The Siemens cast-steel works and glass-houses, with their regenerative furnaces, are admired by all artisans. The Siemens electric light shines in assembly-rooms and public places, and the Siemens gas-light competes with it; while the Siemens electro-culture in greenhouses bids defiance to our long winter nights. The Siemens electric railway is destined to rule in cities and tunnels. The Siemens electric crucible, melting three pounds of platinum in twenty minutes, was a wonder of the Paris Exposition, which might well have been called an exposition of Siemens apparatus and productions, so prominent were they there. It is a rare phenomenon when a whole family becomes so distinguished by eminent talent in a particular field of activity as the four Siemens brothers have been. They all seem to share their peculiar talent in a nearly equal degree, and to use it for a common purpose; and so heartily have they assisted each other that in the list of their inventions it is often hard to draw the line between what shall be accredited to one, what to another of the brothers. They all worked so harmoniously together, says the biographer of Sir William in the London "Times"—"the idea suggested by one being taken up and elaborated by another—that it is hardly possible to attribute to each his own proper credit for their joint labor. The task, too, is rendered all the harder by the fact that each brother was always ready to attribute a successful invention to any of the family rather than to himself." William was most appreciated in England because he lived and worked there; Werner, in Germany, because there was his home and field of activity.

Charles William Siemens was born at Lenthe, in Hanover, April 4, 1823. He received his early education at the "Catharinum," in Lübeck; then studied engineering in the Polytechnical School at Magdeburg; and in 1841 and 1842 studied in the University of Göttingen, where he enjoyed the instructions of Wöhler and Himly. Having finished his academical career at the age of nineteen, and displaying already some of that inventive faculty by which his brother, six years older, was distinguished, he entered the engine-works of Count Stolberg, where his attention was directed in the line of the practical applications of science to industry. He and Werner having devised an improved process in electro-plating with silver and gold, William went to England in 1843 to dispose of the invention. In his lack of knowledge of the strange land, and his ignorance of our language, he made his first visit to an undertaker, thinking that he must be the proper person to take up, or "undertake," and push the new application. A call upon Mr. Elkington, who then controlled the gilding industry in England, was attended by a more satisfactory result, and Siemens went home so well paid for his trouble that he came back the next year with his chronometric regulator for steam-engines. This invention was less successful, commercially, than the other had been, but it made Siemens known to the engineering world, and it has been applied to the regulation of the great transit instrument at the Greenwich Observatory. The process of anastatic printing, another of the earlier inventions of the brothers, was made the subject of a lecture at the Royal Institution, by Faraday, in 1845. It is worthy of remark that the last lecture by Faraday at this Institution was on the advantages of the Siemens furnace. Another of the inventions of this period was the water-metre, which, according to Sir William Thomson, "exactly met an important practical requirement, and has had a splendid thirty years' success." The adoption of England as his home by William Siemens was determined by the fact that he found the patent laws of that country more favorable to the inventor than those of his own land.

Turning his attention to finding means for recovering the heat which is allowed to go to waste in engineering and manufacturing processes, William Siemens constructed a four horse-power steam-engine with regenerative condensers, which he set up, in 1847, in the factory of Mr. John Hicks at Bolton. This machine failed to become commercially successful; but Mr. Siemens, continuing his studies in the same direction, and having become acquainted and impressed with the dynamical theory of heat, read a paper before the Institution of Civil Engineers in 1853, "On the Conversion of Heat into Mechanical Effect," for which he obtained the Telford prize. In this paper he defined a perfect engine as one in which all the heat applied to the elastic medium is consumed in its expansion behind a working piston, leaving no portion to be thrown into a condenser or into the atmosphere, and advised that expansion should be carried to the utmost possible limit. Two years afterward he exhibited two steam-engines, with regenerative condensers, at the Paris Exhibition.

The greatest of the inventions with which the name of Siemens is associated is that of the regenerative furnace for glass-making and metallurgical operations, which he worked out in connection with his brother Frederick, who was also his pupil. By its means the defects of the discharge of the products of combustion at a very high temperature, and in an incompletely combined state, are remedied; a nearer approach is made to saving and applying to the work all the heat which the combustibles are capable of affording; a very high temperature is attained, and steel is produced on the open hearth. Having matured his process at his experimental works in Birmingham, he laid the foundations of an industry which has attained a very great development in England, and lies at the base of extensive factories all over the world. The application of the principle of the regenerative furnace has been extended to numerous industrial purposes in which great heat is required; for the powers of the furnace are limited in practice only by the nature of the materials of which it is constructed. For the kind of services exemplified in this invention the Society of Arts awarded to Dr. Siemens, in 1874, its Albert medal "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the arts, and for his improvements in the manufacture of iron, and generally for the services rendered by him in connection with economization of fuel in its various applications to manufactures and the arts." Only a week before his death, the Council of the Institution of Civil Engineers awarded him the Howard quinquennial prize, which had been previously awarded only to Sir Henry Bessemer for a similar meritorious service.

Sir William Siemens and his brother Werner have co-operated in electrical invention, beginning with the Siemens armature, which they introduced about twenty-five years ago. The brothers, with Mr. Halske, of Berlin, established the Siemens telegraph-works in London, whence the most important telegraph and cable lines in the world have been supplied, and where valuable improvements have originated. The house has constructed four transatlantic cables—the Indo-European line, the North China Cable, the Platino-Brazilian Cable, and others. The want of a suitable vessel had been a serious difficulty in laying the long cables across the Atlantic, and Dr. Siemens had the Faraday constructed, with novel features that made it admirably adapted for its work. In 1860, while experimenting with the Malta and Alexandria Cable, he devised a pyrometer for measuring temperature through the amount of resistance developed in conductors by increasing heat. In 1867 he read before the Royal Society a paper on the conversion of dynamical into chemical force, at the same meeting at which Sir Charles Wheatstone announced his simultaneous discovery of the same principle, while Mr. Cromwell Varley had applied for a patent embodying the idea. Subsequently the Siemens dynamo was developed. We next find Dr. Siemens's name associated with the electric light, electric railways, and the electrical transmission of power. A fine illustration of the latter application is given by the Portrush and Bushmills Railway in the north of Ireland, opened last September, where passengers are carried on a line six and a half miles long of steep gradients and sharp curves "at a good ten miles an hour," solely by the water-power of the river Bush, applied through turbines to a dynamo at a distance of seven miles. At his own residence, near Tunbridge Wells, "not only did electricity perform a large part of the actual work of the farm, sawing wood and pumping water, but it was made to supply in part the place of the sun itself, and assist the growth of plants and fruits."

The latest research having a practical bearing, with which Dr. Siemens's name is associated, was that which had for its ultimate end economy of the fuel used in domestic consumption and the abolition of smoke. With these purposes he was studying plans for extracting the gas from coal, and burning the gas and the coke separately, with a promise of successful realization which Sir William Thomson has well indicated in relating an incident that happened on the day of Dr. Siemens's death. On the 19th of November Sir William was accosted in a manner of which most persons occupied with science have not infrequent experience ; "Can you scientific people not save us from these black and yellow city fogs ?" The instant answer was : "Sir William Siemens is going to do it ; and I hope, if we live a few years longer, we shall have seen almost the last of them." An apparatus which he had devised for the application of his plan to steam-machinery was to have been set in operation at the end of November.

Another research in which Dr. Siemens was engaged, all theoretical, was into the manner in which the solar heat is kept up ; and he sought to show that, as in his own regenerative furnaces, none of the heat is lost, but that all is kept alive in some form, ultimately to be returned to the sun and to renew its energies in perpetuity,

One of Sir William Siemens's biographers well says of him that, in whatever direction he turned, his thoughts seemed to perceive new methods of working out old problems, or to discover new problems which it immediately became his province to solve ; and it is said to have been a common saying in his workshops, that as soon as any particular problem had been given up by everybody as a bad job, it had only to be taken to Dr. Siemens for him to suggest half a dozen ways of solving it, two of which would be complicated and impracticable, two difficult, and two perfectly satisfactory.

Sir William Siemens was not a voluminous writer, but thirty-five papers are attributed to him in the Royal Society's catalogue of scientific papers, published in 1873. He has done much since, which is probably represented by literary results. His last public lecture was delivered March 13, 1883, and was on "The Electrical Transmission and Storage of Power." He was fully supplied with honors and titles, scientific and civil, and was a member of numerous learned societies.

Sir William Thomson says that "in private life, Sir William Siemens, with his lively, bright intelligence, always present, and eager to give pleasure and benefit to those around him, was a most lovable man, singularly unselfish, and full of kind thought and care for others."

Dr. Siemens died on the 19th of November last, of ossification of the heart, in connection with the results of a fall which he had suffered on the 5th. His funeral was held in Westminster Abbey.

CORRESPONDENCE.

THE AGE OF TREES.

Messrs. Editors:

HAVING been a regular reader of "The Popular Science Monthly" from its commencement, I have, of course, noticed the various articles having reference to the value of the concentric rings in determining the age of trees which from time to time have appeared in its columns, the last of which, in your August issue, induces me to give you the result of my observations upon this subject. I have had my attention directed to it during a residence of over forty years in Florida, during which my views as to the value of the rings in determining the age of trees have undergone a change. For the first few years my efforts were directed toward securing a grateful shade for the streets of the city of Jacksonville, and for this purpose the water-oak was selected on account of its beauty, symmetry of form, and rapid growth. And now the appellation of "Forest City," applied to it by visitors, is in no sense inappropriate, for many of the older trees have attained a size which in the State of New York, whence I came, would have required a hundred years to reach. Strangers from the North are apt to overestimate the age of our trees, and the number of rings presented appears to confirm in many instances the correctness of their estimate. When first called upon to account for the discrepancy shown by the rings, and the known age of the tree, I was perplexed and at a loss to find a satisfactory solution of the problem. But, having from my first arrival here kept a careful record of the weather, an analysis of my tables, a comparison with the record made by Nature on her infallible tablets in the trees furnished me the key to it.

Here, as well as at the North, the cold of winter puts a stop to vegetable growth, and in all exogenous trees a concentric ring will be formed, embracing all woody matter deposited since the preceding stop to its growth; but here in this climate causes are in operation that frequently produce as complete a stop to vegetable growth as does the cold of winter.

Our spring begins in February, when growth commences a new deposit between the bark and wood, but often (not always) there comes so severe a drought during late spring and early summer as to produce as full and complete a stop to vegetable growth as does the cold of winter; immediately after comes on our rainy season, generally about the middle or last of June, producing a rapid and luxuriant growth, which continues until winter again puts a stop to it. Our rainy seasons, however, do not consist of deluges of rain that overflood the country, but of daily showers, occurring in the early part of the afternoon, lasting an hour or two, leaving the sky bright and clear, the air cool for the rest of the twenty-four hours, comfortable to man, and favorable to luxuriant vegetable growth. The rainy seasons, when regular, continue day after day, for about sixty days, but often there is an interval of clear, sunshiny weather, for about a fortnight, between the rainy periods, which carries the rainy season into the fall months. Upon examination of the tree, it will be found that, when those severe droughts have put a stop to vegetable growth, a concentric ring well defined has been produced, and the growth which has occurred during the rainy season and until winter's cold has formed another and perhaps a thicker ring, making two rings in one year. But the phenomena of such a year are not necessarily repeated each year, for considerable variation occurs.

What physiological meaning is attached to these rings? They simply mark the amount of growth of woody matter deposited day by day between the periods when a stop to vegetable growth has prevented daily deposit and produced a line of demarkation, whether from drought of summer or cold of winter.

For some two or three years before his lamented death, Professor Jeffries Wyman was exploring the mounds of Florida. It was my privilege to enjoy his acquaintance and learn his views on matters of science in which we were both interested. I have heard him express his belief that he had reached an approximate age of some of the mounds which he had explored, by the indications which the trees growing upon them had furnished. It so happened that we were one time walking down-town together and passed a lot where preparations for building a dwelling-house were going on, and a tree which stood upon the proposed site was being cut down. He remarked that it was sacrilege to cut down so noble a tree; he would have changed the site of the house and let the tree remain as a shade, "for," said he, "it would take a hundred years to produce such another tree." In that, I told him, he was mistaken, as I knew the age of that tree, and it was not yet thirty years old. "Impossible!" said he, and proposed, as the tree had been felled and lay on the ground, to go over and count the rings, to which I assented, and looked on while the professor undertook the task. I soon saw that he was under considerable perplexity. He said he found it no easy matter, as some of the rings were so indistinct that he was unable to decide whether they were single or double, "but," said he, "I can make out thirty or more, but how many more I will not venture to say." I carefully examined the rings, and saw what I had seen before. I have no doubt that at least forty rings could have been identified by a close and critical examination. I reiterated my statement as to the real age of the tree, for thirty years before I had seen corn growing on this spot.

I told him the tree which he had just examined presented a true record of the weather, so far as drought and rainfall were concerned, since it had been a tree, and invited him to call at my office and examine the records which I had kept during the same period, and he would find a confirmation of what I had stated. "This theory," says he, "is new to me, but it is plausible, and the facts here presented seem to substantiate it." His death, after his return North that year, put a stop to further scientific investigations in Florida on his part, but the reasons then given have induced many others to change their views as to the value of concentric rings in determining the age of trees. In a climate like that of Florida they certainly are not to be depended on; how it may be in a more northern latitude I will not undertake to assert or deny, but it seems to me probable that any arrest of growth, from climatic or other causes, will be indicated by some peculiarity in the formation of the concentric rings of the tree; and it may in some instances present two rings instead of one to mark an entire year's growth.

Very respectfully,

A. S. Baldwin, M. D.

Jacksonville, Fla., *September* 27, 1883.

BIRTH-RATE IN A NEW HAMPSHIRE TOWN.

Messrs. Editors:

While preparing a history of Chesterfield, Cheshire County, New Hampshire, the writer has had occasion to collect the birth-records of several hundred families, including both original settlers and their descendants. These families may be regarded as typical New England families, the original settlers having come, for the most part, from Massachusetts, Connecticut, and Rhode Island. The foreign element has always been very small in the town. A careful inspection of the birth-records in question (taking into account the children of *one* marriage only, in cases in which the father married more than once, and excluding the still-born) yields the following results:

1. The total number of births in 165 families, from 1750 to 1810, was 1,359, or an average number of $8\frac{13}{55}$ to each family.

2. The total number of births in 328 families, from 1810 to 1870, was 1,825, or an average number of $5\frac{185}{328}$ to each family.

3. The average number of births in 140 families, from 1810 to 1840, was $6\frac{43}{70}$.

These figures show that there was a marked decrease in the birth-rate of Chesterfield families between 1810 and 1840, and that in the period of sixty years, from 1810 to 1870, this decrease was still more marked.

If what is true of this town, in this respect, is also true of the majority of New England towns, as is quite probable, it would appear that the birth-rate in New England families has steadily decreased since the introduction of railroads and the extensive establishment of manufactories.

O. E. Randall.

West Chesterfield, N. H., *September* 3, 1883.

"TIDAL ANOMALIES."

Messrs. Editors:

In the January number of your journal there is a communication under the above-named title, from G. W. Grim, of the bark Coryphene. Referring to a preceding letter of mine, he says of my article, "After demonstrating, as a result of Professor Schneider's theory, a great inequality in the daily range of the tides," etc.

The gentleman entirely misconceives the purport of my criticism. I showed that Professor Schneider's theory is demonstrably false, and my reference to the New York tides was merely to show by them that the theory does not conform to the facts. The "daily inequality" is easy to explain: most of those given by Mr. Grim present no difficulty at all—with others, when the *facts* are established, the explanation will follow.

No theory of the tides is of any value except as based on facts—in which respect Mr. Grim's theory is worse off than Mr. Schneider's. A theory of the tides resting solely on one's inner consciousness is not a valuable contribution to knowledge.

R. W. McFarland.

Ohio State University, *December* 27, 1883.

CARRYING-POWER OF FLUID CURRENTS.

Messrs. Editors:

I see that in your November number, page 95, Mr. Carter applies the "law of carrying-power of currents" ($R \propto v^6$) to *blood-currents* carrying waste matter. Now, I make no objection to the general correctness of Mr. Carter's conclusions, but I am sure that this is an entire misapplication of the law.

The fact is, this law is so often misunderstood and misapplied that it becomes dangerous to use it without clear conceptions of its nature. By many good hydraulic engineers it has been confounded with the law of *erosive power* of currents; by others, with the quantity of material carried *in suspension;* and now Mr. Carter confounds it with quantity of matter carried *in solution.* It were well if, *in popular language*, the name of the law were changed. Perhaps it would be less liable to be misunderstood if it were called "*lifting-power of currents.*" It expresses only the *size* of the *largest transportable particle.* It is a law which concerns mainly the *geologist* and the *ore-dresser.* The geologist finds certain bowlders scattered about in the lower part of a valley. The question is, Were they brought by currents; and, if so, what was the velocity? It is applied thus, by Dana, in discussing the material brought down by the Connecticut River during the Champlain epoch. Again, the ore-dresser has crushed rock, which he wishes to sort by means of a current decreasing in velocity in its course. The question is, Where will the particles of different sizes drop? I do not know any other cases of practical application. Certainly it can have no application to matters in solution. JOSEPH LE CONTE.

BERKELEY, CAL., *November* 22, 1883.

EDITOR'S TABLE.

SCIENCE AS A HOPE IN POLITICS.

THE following paragraph has been circulating through the newspapers: "The Lord Mayor of London, in welcoming Professor Huxley to the city recently, suggested that the position of President of the Royal Society was really one of even greater importance than that of Prime Minister; Mr. Gladstone is chief Minister of England, but Professor Huxley was 'the head of the intellectual life of the world.'" The complaisant utterances of eminent officials, who are ever expected to say the agreeable thing that shall put their guests at ease, are not to be taken too seriously; yet there is considerable significance in this declaration of the Lord Mayor of London, both from its implication of the vast changes that have been wrought by science in the views of human affairs, and from the open recognition of these changes by so conspicuous a party.

The advance of science is evinced in numberless ways, but our weightiest proof of it is found in the gradual acceptance of enlarged in place of narrower views of the subject. New discoveries are important; the widening of the ranges of research is important; the extension of generalizations and the better organization of positive knowledge are important; but more important still is the growing general recognition that science is the grand agency in modern times for reshaping the common opinions of the community.

By the narrower view of science, we mean what may be called that professional conception of it by which it is restricted to certain definite experimental results. Our literary and theological friends are especially solicitous that the term science should be confined to *physical* science merely—laboratory science, observatory science, manipulatory science of any sort that can be regarded as belonging properly to specialists. But they grow jealous of it when it takes on that wider and deeper meaning which has been given to it by the growth of ideas in these later times, and when it is seen to involve a new method of thought, of the most comprehensive application, and bearing upon the whole circle of human interests. They are very commendatory of science, so long as it is busy establishing new physical facts and extending new physical truths, but they regard it as an impertinent usurper when it interferes with that old order of conceptions which pervades the common life.

But it has long been seen by the more discerning that one of the great results of the striking advance and widening influence of modern scientific knowledge must be a sharp revision of the ancient and current valuations of great men. The old standards can not continue to be accepted, and the declaration of the Lord Mayor of London is a clear admission of it. He represents the position of Professor Huxley as President of the Royal Society not merely as the head of an eminent body of English investigators, distinguished as that position would be, but as "the head of the intellectual life of the world," and he gives greater emphasis to the statement by affirming that Huxley's position is "really one of even greater importance" than that of Gladstone, Prime Minister of England. This is in no sense a comparison of the talents or genius of two distinguished personalities, but a comparison of their positions as representative men, and an affirmation of the superiority of the illustrious scientist to the illustrious politician. The deeper meaning of this averment is that it brings into contrast two types of character—that formed under scientific influences and embodying its spirit, and that formed under political influences and embodying its spirit. The immense import of the statement arises from its recognition that a new order of men has arisen in these times and worked its way to acknowledged supereminence as leaders in "the intellectual life of the world." This means a great deal.

Undoubtedly the great changes of modern thought which threaten to displace an old ideal of great men, and to substitute a new ideal, have far-reaching consequences, which may turn out to be of the most practical kind. It would be folly to deny that in recent years there has been a rapid decline in the respect generally entertained for eminent political men. The world has always worshiped successful politicians, and will no doubt long continue to worship them as the embodiments of power in society; but, as the possession of political power becomes more and more a matter of accident, there will be increasing hollowness in the homage rendered to those who have had the good luck to get possession of official places. Already political success has altogether ceased to imply greatness of character; the machinery of partisan politics may give prominence to a wary and skillful manager—the tricky manœuvring of a convention may furnish a President—but nobody is deceived into supposing that distinguished merit is thereby disclosed, or that genuine greatness has met with the honor to which it is entitled. Incontestably, there are no such shams and humbugs in modern society as successful politicians. We do not expect them to be men of solid acquisitions, to have mastered the knowledge that is needful for statesmen, or to exemplify anything like manliness and independence of character. These traits are all in the way of political success. Transparency and uprightness of mind are not wanted, insincerity and crookedness of mind are indispensable to the political manager. He views all things with reference to immediate results, and holds any expedients justifiable that will enable him to win in partisan conflict. The school of politics, in short, gives us men that are not entitled to public respect, and this scandalous fact is universally understood.

But are we to regard this as the hopeless finality of things in the political and public sphere? There are strong reasons for taking a different view and indulging in better anticipations. Agencies are at work which will form men of more elevated character. We look to the extension of science and the deepening of scientific influences to give us minds capable of improving the existing state of things. It is impossible to overestimate the good that may be hoped from this scientific influence, as it becomes strengthened and organized and brought to bear upon public affairs, because science is allegiance to truth, while current politics is little else than allegiance to lies. No man expects that a politician will be honest, or candid, or truthful, or make a bold and honorable avowal of principles; nor is there any possible ground to hope that our politics will purify themselves by any working of their internal elements so that men of probity, high character, and real greatness will be put in the positions of power. The regenerative influence, if it comes at all, must come from other sources, and we expect it to come sooner or later from the great movement of modern science, which must bring with it a new training in the intellectual virtues. It is to the new conceptions and new culture of science that we look for the production of men of a higher quality for public use to replace that lower quality which has ceased to command the admiration of intelligent and honorable-minded people. Our politics is to-day the despair of our most earnest citizens, and we can see no possible escape from its corruption and its degradation but by the supply of new men animated by higher ideas, qualified by superior intelligence, and trained in reverence for truth, and these men are to be produced by the slowly ripening influence of science, as it comes gradually to pervade our educational systems. Of course, no great change of this kind can be suddenly precipitated; it must be a slow growth, to work effectual results; but science advances with its work, and gives us some ground of hope even in the most discouraging of all the fields of human effort.

EDUCATION WITHOUT DEAD LANGUAGES.

One would think that the advocates of the classics, as the one superior system for the unfolding of the human mind, would have long ago abated their exclusive pretensions in face of the fact that such multitudes fail with it, and that so many succeed without it. It is not found difficult to evade the force of the first objection that great numbers of dead-language students come to nothing with their classics, because it is said that they neglect their opportunities, or get far more good from this source than they are ever aware of. But it is not so easy to escape the objection to the wonderful worth of defunct speech in the cultivation of the human faculties with such multiplying evidence as we have of great intellectual power acquired by a mental cultivation into which the dead languages have never entered. That these studies have declined in consideration, and are put upon the defensive, and fall back upon tradition and authority for backing, is simply because other instruments of culture in these modern times are not only competing with them but are beating them everywhere. Accompanying the decline of the classics, there has arisen an outside education, irregular in form, unguided by institutions, self-inspired and self-shaped, which is full of great results. The past generation has abounded in men who have either turned their backs upon the universities, after trying them, or who have never gone near them, but who have become leaders of thought in all departments of intellectual activity. The unfortunate creatures who have been enticed to college, and there loaded down with a knapsack of dead languages have found, as was very natural, that they were overweighted in the competitive race of practical life, and left behind by those whose acquisitions are better adapted to the new requirements of the age. Charles Darwin went to the university, neglected the classics, and made what he could out of it for the promotion of his natural history studies; and Herbert Spencer refused to be lured there at all. Yet these are the men who are guiding the mind of the age, while for twenty years we have been afflicted with the pitiful protestations of classical graduates (with their incomparable "mental discipline") that they could not even understand the epoch-making books of these great thinkers.

From this point of view, the English experience with classical studies is especially rich in instruction. Every public influence in that old, aristocratic, tradition-ridden country has favored the ascendency and the perpetuity of dead languages in all grades of education. Whatever benefits could be got from them have been there obtained in abounding measure. Modern knowledge has been hindered and repressed that the classics might have free course and undisputed sway; and yet, as we have before observed, the system worked out such miserable and scandalous results that the state was compelled to look into the subject and do what it could to expose if not to correct the abuses. The Government reports on the condition of education in the universities and great public schools revealed a state of things which will be the wonder of all future ages. Some twenty years ago, Prof. W. P. Atkinson, of Boston, printed a very valuable pamphlet devoted to these English educational reports. We regret to say that it is now out of print, for it would be an invaluable contribution to the discussion now going forward upon this question. As its contents will be new to many, we reprint some passages illustrating the extent to which, even at that time, the classical university education had been practically superseded by forms of culture more suited to the necessities of the times:

This view [that the English universities have lost the hold they once had on the educated classes] will be corroborated if we consider how many of the most influential minds of the century, in science, literature, art, and politics, have either had no connection whatever with the universities, or are under small obligation to them for any connection they may have had. In politics, and political economy, we might name, among others, Romilly, Bentham, Ricardo, Bright, Cobden, Stuart Mill. Though the government of England is monopolized by the aristocracy, the political thought which governs her governors comes daily more and more from the people. The list of "uneducated" men of science—if I may be allowed the absurdity of such a phrase—is far longer, as, after what has been said, might reasonably be expected, than any the universities can show—Davy, Wollaston, Dalton, Faraday, Wheatstone, De la Beche, Murchison, Hind, South, Fitzroy, Playfair, Carpenter—it might be indefinitely extended; and we shall find that the most eminent of her college-educated men of science are the foremost in denouncing her university system. Of course, all her great engineers, inventors, and builders, are uneducated men—Watt, Telford, Smeaton, Rennie, Brindley, the Brunels, the Stephensons, Sir Joseph Paxton—it is with these names that that sad but glorious volume, "The Pursuit of Knowledge under Difficulties," is filled. Her great artists are all "uneducated" men—Flaxman and Gibson, Landseer, Turner, and Stanfield, Kemble and Macready, and all the rest. And, when we turn to literature itself, the greatest English historical work of this generation—a work on classic history, too—was written by an "uneducated" London banker. The greatest, I might almost say the only, English attempt at a philosophy of history, a work which, with all its errors and paradoxes—and I shall not deny that they are many and great—is still one which can not be matched by any similar academic performance, was the work of the "uneducated" son of a London merchant. Her novelists—Dickens, Thackeray, Jerrold, Marryat—come from all quarters save the banks of the Cam and the Isis; not to mention so many of that sex which is excluded altogether from their sacred borders. Bulwer is, indeed, a Cambridge man, but I think Cambridge will be slow to put forward that pretentious charlatan as an example of the fruits of her classical training. Even of her poets, critics, and essayists, what a long list are among the wholly "uneducated," or must be classed among those who derived no benefit from their stay at a university, save that (undoubtedly great) one which comes from mere residence at a place of learning! The names at once occur of Crabbe, Rogers, Lamb, Moore, Montgomery, Hunt, Gifford, Hazlitt, Hood. Who would hesitate to say where Scott's real education lay? Who has criticised the education of Oxford so wittily as Sydney Smith, or so grimly as Carlyle? Wordsworth and Coleridge, in their short stay at the university, owed little or nothing to the studies of the place. Southey says he only learned to *swim* there—badly; Byron was ruined there; and the beautiful genius of Shelley found there, instead of the help and guidance it so much needed, only cruel and ignominious abuse. Keats, some of whose exquisite poems breathe the very spirit of classical antiquity, was a stable-keeper's son, and never studied at public school or university. England's eminent surgeons and physicians are not university men; and what is it that in that country keeps theology so far behind all other sciences, but the fact that the clergy are the only profession who are *compelled* to subject their minds to the full "dementalizing" power of Oxford training? What power less potent could produce the bigotry of an English High-Church bishop? I am not forgetful of the eminent names that may be produced on the other side; but, even in regard to these, the question must always be asked, How far was their eminence due to their education? The real relation in which the English schools and universities stand to her greatest minds, even in the past, and the share which university teaching really had in training them, is a problem that still needs elucidation. "We are not sure," says the present Lord Brougham, writing in 1826, "whether the result of the investigation would be so favorable as is commonly supposed to Oxford and Cambridge. And of this we are sure, that many persons, who, since they have risen to eminence, are perpetually cited as proofs of the beneficial tendency of English education, were at college never mentioned but as idle, frivolous men, fond of desultory reading, and negligent of the studies of the place. It would be indelicate to name the living; but we may venture to speak more particularly of the dead. It is truly curious to observe the use that is made, in such discussions, of names which we acknowledge to be glorious, but in which the colleges have no reason to glory—that of Bacon, who reprobated their fundamental constitution; of Dryden, who abjured his Alma Mater, and regretted that he had passed his youth under her care; of Locke, who was censured and expelled; of Milton, whose person was outraged at one university, and whose works were committed to the flames at the other.

It may, perhaps, be argued that many of the "uneducated" men whom I have been enumerating would have been the better for a university training. For a *true* university training, no doubt they would—one that would have developed all their powers harmoniously, while it gave full play to their special genius. With the advocates of such a training, I have here no controversy; I will even grant that many of these writers, in spite of their genius, betray the faults which are wont to mark the self-educated man. But would it have been better for Mr. Buckle himself if, by a long course of nonsense-verses, the attempt had been made to flatter and polish him down to the regulation standard of Oxford mediocrity? Mr. Buckle at least stimulates us to think; can as much be said of Oxford bishops? There is a passage in a recently published book of travels in Russia, by Professor Piazzi Smyth, the Astronomer-Royal for Scotland, which bears on this question and records a somewhat surprising conclusion. Describing a conversation he had with that eminent astronomer, Struve, as to the results of their experience in university teaching, both agreed that on many points further inquiry was greatly needed; but Professor Struve said that "this conclusion had been drawn independently by so many differently circumstanced men in the Russian and German-Baltic provinces, from the general impressions which their recollections gave them, that there could be little doubt of its containing much truth—truth, too, of a startling character: *the first boys at school disappear at the colleges, and those who are first in the colleges disappear in the world.*" I am not sure that a similar conclusion would not follow from a similar investigation into our own, as well as into English and German academical history, and that it would not be found that the men most useful and successful in after-life were not those who had placed themselves most fully under the influence of college training, or been stimulated to exertion by mere hope of college rewards, but those who had been most successful in *escaping* its narrowing influences, while, on the other hand, they had also escaped the still greater dangers of idleness and dissipation in the formative period of their history—men who had cast from them the trammels of pedantry, and with independent energy marked out their own career.

We publish the first of a series of articles on some of the political tendencies of the times, by Herbert Spencer. The present paper, though treating of affairs in England, and therefore full of English illustrations, will be found to have a bearing upon urgent questions in this country, and to involve, indeed, some of the most radical problems of popular government. We have been told that the price of liberty is eternal vigilance, and the truth is far more pregnant than is generally supposed. But we require to learn a still more elementary lesson, that is, what liberty is. Our common notion of slavery has come to be negroes sold at auction, and our notion of liberty has come to be the privilege of locomotion and of voting. A people with such notions of the subject will hardly be very vigilant in paying the price of liberty by strenuously resisting all encroachments upon individual rights. Therefore, every discussion which makes the subject clearer, and calls attention to considerations which are apt to be generally overlooked and forgotten, is important; and nowhere is it more important to guard against the indifference of citizens and the fallacies by which they are misled on the subject of liberty than where government is popularly administered. Mr. Spencer's future papers will probably bear much more directly upon American political problems than the present.

LITERARY NOTICES.

World-Life; or, Comparative Geology. By Alexander Winchell, LL. D., Professor of Geology and Paleontology in the University of Michigan. Chicago: S. C. Griggs & Co. Pp. 642. Price, $2.50.

In this compact but comprehensive book Professor Winchell has made a contribution to science that was greatly needed, and he has performed his task in a manner that well comports with the grandeur of the subject. A carefully prepared book, representing the present state of knowledge on "the processes of world-formation, world-growth, and world-decadence," has been urgently needed for some years. There is, no doubt, much shallow skepticism in many minds regarding the validity of inquiries in this field, which has been relegated to the sphere of scientific romance and fanciful speculation. But sober and well-instructed minds have not shared in this feeling. Our knowledge concerning the genesis of worlds is, of course, yet very incomplete, and there is necessarily much of that divergence of opinion in relation to it which always belongs to the stage of active advancing inquiry. But there is already a great body of assured and formulated knowledge bearing upon the problem of the genesis of worlds which is not to be gainsaid, and there has been the steadily increasing necessity that this knowledge should be collated, and organized into definite scientific form. But a somewhat special preparation was required to do anything like tolerable justice to this work. The factors of the discussion are of the largest import. Celestial mechanics has long been the fundamental element of the research, and within recent years celestial chemistry has come forward as of equal importance. Nebular cosmogony and nebular evolution are now established conceptions of science, and, in working them out, the sciences of geology and astronomy are of equal significance and application. Professor Winchell refers to his task as an attempt at "laying the foundations of a science which, from one point of view, may be styled the geology of the stars, and, from another, the astronomy of the earth. It is the science of comparative geology. It is astrogeology." In regard to the present position of the nebular view, the author remarks: "Nor can it be correctly said that the general theory remains still in the status of an hypothesis. In certain points of detail opinion may still remain divided; but, when an hypothesis has stood the scrutiny of three generations, and has become all but unanimously accepted, by those prepared to form original opinions, as the real expression of a method in nature, surely, then, the time has passed when any person can advantageously illustrate his learning and sagacity by continuing to reproach the conception as 'a mere hypothesis.' If any 'mere hypothesis' ever strengthened into the condition of a scientific doctrine, assuredly we find in the scientific world to-day the general features of a sound nebular doctrine."

Professor Winchell's geological studies, long carried on in connection with the cosmical problems which they involve, have well prepared him for the broad investigation which has led to the writing of the present volume; but the problems of the nebular hypothesis have long occupied a large amount of attention with him, and been made a subject of his college lectures, so that he has made it a point to master the various special questions that have recently come forward in connection with this subject. We know of no other work in which the reader can find a full, connected, and systematic presentation of the results of cosmical research that will compare with this, and we are especially glad to see that the publishers have put it at a reasonable and popular price.

No sufficient account of the contents of the book can be offered in the space at our command, but we give an imperfect outline of the main features of the exposition.

The book is divided into four parts, of which Part I, entitled "World-Stuff," treats of the process by which the constituent particles of worlds become aggregated into spheroidal masses. The meteoric matter which is constantly falling upon the earth in masses varying from dust-particles to meteorites of several tons weight, the zodiacal light, which polariscopic study shows to be reflected sunlight, comets, which are now known to be simply conglomerations of cosmical dust, the rings of Saturn, and the irresolvable nebulæ, all go to show that a vast amount of matter such as our earth is made of, must exist diffused in space. "All the moving bodies of our system must be continually pelted by these cosmical atoms, and the aggregate result of these collisions must, in thousands or millions of years, affect their motions. Supposing the motions of the cosmical atoms to have no prevailing direction, it is evident that the motions of the planets, satellites, and comets of our system would cause them to meet more of these atoms than the total number which would overtake them. The result would, therefore, be a resistance to the movement of these bodies, and the effect of this would be an acceleration of their motions and a shortening of their periods. I venture the opinion that this cause is a more efficient resistance than the supposed ethereal medium." These material particles are drawn by mutual attraction into groups, and any central attractive force, as of a sun or planet, would also cause them to aggregate, by deflecting their motions into converging lines. But, in the presence of two or more attractive centers, as in the present constitution of the cosmos, it is impossible that any mass shall fall directly upon its center of attraction; hence every body would tend to circulate about every other body. But the resulting movements would be so infinitely complex as to precipitate countless collisions of particles and masses. Each group or swarm which gradually forms will have a progressive motion along a path having the essential character of an orbit around some dominant center of attraction. If any condition of interplanetary matter exists in space, its resistance would cause the smaller particles to fall behind, and the whole swarm to assume an elongated fan-shape. The attractions that control these motions would be feeble; sometimes the controlling one would be only that of another cosmical swarm. Most of these swarms of cosmical dust would simply float poised in space, growing by accession of particles, and occasionally coalescing with other clouds, until an aggregation is formed large enough to be called a nebula. From these various attractions and collisions the nebula would have acquired a rotary motion. It would assume the form of an oblate spheroid, and, as the cloud-like mass cooled, the consequent contraction would increase the speed of rotation, until an equatorial ringlet of particles gained a centrifugal tendency equal to the centripetal. Further contraction would cause the main body of the spheroid to shrink away from this ring, which would then rotate independently. We might suppose that successive slender ringlets would become detached until the whole mass was converted into an essentially continuous disk, for the attraction of the ring first separated would be added to the centrifugal force of the circlet of particles nearest it, and so on. But every successive addition to the annular mass increases its distance from the next ringlet of particles, and upon this its influence, though increasing with the growth of the ring, diminishes as the square of the distance increases. As a result, "an annular mass of relatively considerable amount would separate, and a secular interval would intervene before the separation of another annular mass." None of these rings could long remain of uniform thickness. Each would attenuate in some part, and finally rupture, resolving itself into a mass that would possess a rotary motion, the direction of which would be determined by the relation of the velocities of the outer and inner zones of the ring.

Part II, "Planetology," occupies about half the volume. In the first chapter of it, certain observed phenomena of the solar system are enumerated which accord with the requirements of the nebular theory, and objections to the theory are answered. For the retrograde motions of the satellites of Uranus and Neptune our author advances several explanations: 1. It is entirely conceivable that both the Uranian and Neptunian systems should have suffered a tilting through more than a right angle by the influence of some powerfully attracting body passing in the neighborhood. 2. The coalescence of two or more spheroids may have tilted the axis of the resultant planet, and its whole system of satellites would be correspondingly tilted. 3. Certain relations of density, distance from the center of the nebulous mass, breadth of ring, and velocity might cause retrograde motion in the earlier stages of the evolution of a nebula of a certain magnitude. The next chapter describes the passage of a gaseous planet to the molten phase, the solidification of its core from pressure of the superincumbent portions, the incrustation of its surface, and the transformations of this crust. A large influence on planetary history is ascribed to tidal action, a tide being defined as "the prolateness of a body resulting from the attraction of another body." Coming to some special considerations of the planetary bodies in the solar system, Professor Winchell mentions three independent conceivable causes for the molten condition in which a part of the earth's substance evidently is: "There may be a zone too deep for solidification by cooling, and too shallow for solidification by pressure. . . . In the next place, we may suppose that at all depths beneath the surface the pressure is such that the fusing-point is higher than the actual temperature, so that a state of solidity exists. . . . We may conceive that heat and fusion result from some mechanical crushing pressure." In regard to this last theory he says, further: "But a cause of crushing pressure which seems to me more adequate than secular cooling is suggested by Sir William Thomson's and Archdeacon Pratt's, and, we may add, Professor G. H. Darwin's, demonstrations of tidal effects in a globe as rigid as steel or glass. May not the tidal deformations of the earth's crust be the source of the internal heat which manifests itself in fluidity? The whole value of the lunar tidal oscillation in a yielding globe should be about fifty-eight inches. In a globe as rigid as glass it should, therefore, be about 34·8 inches, and, in one as rigid as steel, 19·33 inches. The whole tidal oscillation under the joint maximum influence of the sun and moon in a perfectly yielding globe would be about 81·2 inches. The amount in a globe of glass would, therefore, be, when at a maximum, 48·72 inches, and, in a globe of steel, 27·06 inches. Should the terrestrial globe yield to the extent of any one of these amounts, the crushing effect experienced by the superior zones of the crust would not be uniformly distributed, since variations in structure and hardness and surface configuration would preserve certain portions from any change, and the whole amount of the interstitial displacements would be accumulated in the remaining portions. It does not seem at all improbable that the transformation of such enormous mechanical force into heat should suffice to bring to a state of fusion volumes considerable enough to answer all the requirements of the thermal manifestations of modern times, as well as the terrestrial movements of modern earthquakes." From an examination of the planetology of the moon he concludes that "lunar history must have presented characteristics widely divergent from those of terrestrial history; and in this divergence the tenuity of the moon's atmosphere has performed a part quite comparable with the energetic work of the tides. . . .

"The question of the habitability of other worlds has generally been discussed from the assumption that all other corporeal beings must be clothed in flesh and bones similar to those of terrestrial animals, and must be adapted to a similar physical environment. But it is manifest, on a moment's consideration, that corporeality may exist under very divergent conditions. It is not at all improbable that substances of a refractory nature might be so mixed with other substances, known or unknown to us, as to be capable of enduring vastly greater vicissitudes of heat and cold than is possible with terrestrial organisms. . . . There may be intelligences corporealized after some concept not involving the processes of ingestion, assimilation, and reproduction. Such bodies would not require daily food and warmth. They might be lost in the abysses of the ocean, or laid up on a stormy cliff through the tempests of an Arctic winter, or plunged in a volcano for a hundred years, and yet retain consciousness and thought. It is conceivable. Why might not psychic natures be enshrined in indestructible flint and platinum? These substances are no further from the nature of intelligence than carbon, hydrogen, oxygen, and lime."

"General Cosmogony" is the title of Part III, which consists of a short chapter on the condition of the fixed stars and nebulæ, with some general considerations on the whole system. "Evolution of Cosmogonic Doctrine" occupies the rest of the volume. In these concluding chapters the growth of man's view of the universe is traced from the partial conceptions of the Greek philosophers to the comprehensive system of modern astronomers. The theories of Kepler, Descartes, Leibnitz, Swedenborg, and Thomas Wright, are described briefly, and that of Kant is given with some detail. Then follow the views of Lambert, Sir William Herschel, and Laplace, and a brief "Systematic Résumé of Opinions."

Man a Creative First Cause: Two Discourses delivered at Concord, Mass., July, 1882. By Rowland G. Hazard, LL. D. Boston: Houghton, Mifflin & Co. Pp. 112.

In this instructive little volume we have a compact and very lucid restatement of the leading philosophical views of its veteran author, which were several years ago developed in an extended form in his more elaborate works. Mr. Hazard is well known as a man of original and versatile thought, and has dealt with a considerable variety of subjects, practical as well as theoretical, in his various publications; but he will probably be best known in the future by his comprehensive metaphysical treatise entitled "On the Freedom of the Mind in Willing." The origin of this work is, on various accounts, so interesting and significant, that it should not be forgotten.

The celebrated Dr. William Ellery Channing, whose reputation is world-wide as a gifted preacher, a discriminating philanthropist, and as the father of American liberal theology, is understood to have been in a somewhat unsettled state of mind upon what may be regarded as the logic of the old free-will controversy. He is said to have "confessed to an incapacity to form any satisfactory philosophical theory and defense of that moral freedom in which he devoutly and earnestly believed." Dissatisfied with all that had been written upon the problem, and confessedly unable himself to cope with its difficulties, and at the same time holding inflexibly by the doctrine of mental liberty in volition, he was very naturally solicitous to see the question handled by some powerful intellect, qualified for the research, and who could put the proofs of man's moral liberty on a firmer basis than they had hitherto occupied. But who was to be found competent to enter upon this formidable task? Learned scholars were sufficiently abundant. The colleges turned out their annual multitude of men who had been long steeped in recondite studies; whose intellects had been disciplined and sharpened by those marvelous instrumentalities destined from the foundations of the world "for the perpetual training of the minds of the later generations," the dead languages, but Dr. Channing did not find his man in this class. In his celebrated essay on "Self-Culture," there occurs the following passage: "I have known a man of vigorous intellect who had enjoyed few advantages of early education, whose mind was almost engrossed by the details of an extensive business, who composed a book of much originality of thought in steamboats, on horseback, while visiting distant customers."

The book here referred to was entitled "Language: an Essay," and was written forty-seven years ago by Mr. Hazard. Dr.

Channing was so impressed by the work, that he sought the author out, made his acquaintance, and found that, notwithstanding his "few advantages of early education," he gave better promise of ability to grapple with a profound metaphysical problem, and make more progress in its analysis, than any of the regulation scholars with whom he was acquainted. An authoritative critic speaks as follows of Mr. Hazard's first work, the essay on language:

> The essay was not more worthy of attention from the circumstances under which it was written than from the interest and freshness, if not the absolute originality, of some of its thinking. The tone of the first essay is that of a refined and elevated idealism in its underlying philosophy and in the moral earnestness of its practical spirit. The essay was highly esteemed in those days of transcendental aspiration, and excited a very general curiosity among the eager seekers after new truths and new prophets. Unlike many of the effusions of the taught and untaught seers of those effervescing years, this essay was in every line clear, analytic, and severely reasoned. It was, however, as characteristically idealistic in its philosophical spirit as it was imaginative in its poetical and ethical portraitures. The essay put Dr. Channing upon the quest to discover its author, and this discovery led to a friendly intimacy between the two till the death of the philosophic divine, which was commemorated by an affectionate yet discriminating essay from his philosophic *protégé* and friend.

Yielding to the earnest injunction of Dr. Channing, Mr. Hazard early in life took up the question of free-will, and published the results of his studies in two solid volumes, "Freedom of the Mind in Willing, etc." (1864); and two letters on "Causation," and "Freedom in Willing," addressed to John Stuart Mill (1869). Those who desire to become familiar with Mr. Hazard's reasoning in its full elaboration must consult these works; in the volume before us the results are necessarily much epitomized.

Into the merits of the great question of free-will we can not, of course, here enter. It is alleged that modern science, by its vast extension of the idea of natural law, has strengthened the conceptions of necessity and fatalism at the expense of moral freedom. But determinism never had a more powerful champion than Jonathan Edwards, and he certainly did not draw his inspiration from modern science. Mr. Hazard takes broad issue with Edwards. Professor Huxley, a leading "automatist," and representing the latest science, admits that "volition counts for something"—but the philosophical question is, For how much? Nobody claims that the will is unlimited. The title of Mr. Hazard's book, "Man a Creative First Cause," seems rather startling at first, but it is because of our theological connotations of the term "creative." His obvious implication is of the mind willing and working in its own sphere, where we properly speak of *creative* genius and *originating* capacity. Indeed, Mr. Hazard explicitly says: "Exterior to itself, it (the human mind) may not have the power to execute what it wills; it may be frustrated by other external forces, since in the *external* the ideal incipient creation may not be consummated by finite effort. But, as in our *moral nature* the willing, the persevering effort, is itself the consummation, there can be no such failure; and the mind in it is therefore not only a creative but a supreme creative first cause.

Mr. Hazard's book is tersely and vigorously written, and takes a somewhat wide range both of philosophical and practical suggestion. The author has a sturdy faith in the value of metaphysical studies for practical utility as a mental training, and also in their disciplinary power for the formation of human character. This view is incidentally presented, and we only regret that he has not more fully and formally developed it. Such a discussion would be valuable to education, and we are not without hope that Mr. Hazard may yet find it practicable to give fuller expression to his views and reasonings upon the subject.

INTERNATIONAL SCIENTIFIC SERIES. VOL. XLVI.

The Organs of Speech, and their Application in the Formation of Articulate Sounds. By G. H. von Meyer, Professor in the University of Zürich. New York: D. Appleton & Co. Pp. 349. Price, $1.75.

There has long been wanted a first-class work on this interesting subject, treated with reference to the requirements of ordinary intelligent readers. It has, of course, been familiar in a certain way to the anatomists who have dissected the vocal structures with reference to pathology and surgery, and given the representations of the parts in their text-books. But the combination of physiology with anatomy, and the study of function in connection with structure, and especially the later progress in acoustical science, have given a new interest to the vocal apparatus quite beyond that of the bare anatomist. The subject of the vocal organs, considered in relation to their marvelous capacities, or the most wonderful results obtained from the simplest means, is one of quite extraordinary interest. We hear much of the subtilties, refinements, and complexities of vocal language, with its hundreds of forms among different peoples, its millions of words, its capacity of expressing numberless shades of feeling, and conveying the highest spiritual influence. But, besides the common uses of speech in conversation, reading, and oratory, we are all familiar with vocal music as an art, inexhaustible in its variety of styles, and the ranges of its development. But what is the foundation of all this? Nothing but mechanism, bellows, and mechanical arrangements for acting upon currents of air for the production and control of sound. This side of the subject, being merely mechanical and material, has had but little interest for those who care only about the effects. When people lose their voices, they are reminded that there is a mechanism involved, and consult the doctor to find out what ails their vocal organs; but there has been so little other concern about them, that any thorough-going scientific investigation of their wonderful capacities and working has been long neglected.

Dr. Meyer's work is a contribution to the physiological science of the vocal organs from this point of view. It is an original treatise, with strong philological bearings, and contains various new interpretations, the result of the author's special and extensive researches. The object and plan of the work can not be better presented than in the language of the author in his preface:

The more we become convinced that a true knowledge of the laws which govern the transformation of the elements of speech, in the formation of dialects or derivative languages, can only be obtained from a study of the physiological laws of the formation of articulate sounds, the more necessary does it become for the philologist to be thoroughly acquainted with the structure and functions of the organs of speech. The ordinary anatomical handbooks are little adapted to this purpose, for much is there discussed at length which is of no use to the philologist; while, on the other hand, points which to him are of considerable importance are only briefly alluded to. In physiological hand-books, also, only a short space is in most cases devoted to this subject.

It is, therefore, my object, in the present work, to discuss, with special reference to this requirement of the philologist, the structure and functions of the organs of speech.

In explaining the origin of articulate sounds, I have so far departed from the usual method that I have not attempted to arrange physiologically the entire series of sounds employed in the most differing languages; but rather, starting from the structure of the organs of speech, to give a sketch of all possible articulate sounds. I believe I have thus constructed a system in which all known articulate sounds, and all those with which we may hereafter become acquainted, will find a place. Such a sketch could not, of course, be given without reference to existing languages. The object has not been, however, to enter into the field of discussion upon the various modifications of sounds, but merely to bring forward a sufficient number of examples in confirmation of the laws explained, for which purpose the more nearly related European languages are sufficient.

Ocean Grove Camp-Meeting Association. Fourteenth Annual Report. Ocean Grove, N. J. Published by order of the Association. Pp. 75.

The friends of the Association were disturbed much more than they had reason to be last year by some dozen lines concerning unhealthy conditions that had been noticed at Ocean Grove, which we published in the course of an article of considerable length, dealing with the sanitary condition of seaside resorts generally. Without further noticing the unkind words—the more unkind because they are undeserved—which the president of the Association still applies to us, we call attention to the confessions contained in the present report that there were things at the Grove that needed remedying, and to the gratifying fact that the Association has applied the remedies. Owing to what the report calls continuous and studied misrepresentations, a prejudice existed, "to remove which required our most energetic toil. To meet the expenses of such labor demanded funds largely in advance of current receipts." If only a prejudice, and that false, why so much labor and expense in building sewers and sinking an artesian well to remove what was only ideal and unfounded? A system of sewerage was begun about three years ago. "The plan of running the sewage into tanks, and letting it out periodically into the sea, had many objections, and was only partially successful. Another must be devised. . . . The result is so triumphantly satisfactory that Dr. E. M. Hunt, the Secretary of the New Jersey State Board of Health, after a very careful examination of its work, pronounced it not only satisfactory but the most complete that could be made." It embraces 15,050 feet of twelve-inch mains, and 8,500 feet of connecting lines, or in all 23,550 feet, or four and one half miles of sewer, connecting with all the large and with many of the smaller houses. Of the work of the year, the president is glad to state that "an offensive condition of things which has for several years caused much complaint, in the rear of the tents near the Trenton House, has been effectually removed, and the water-closet arrangements have been so adjusted as to give perfect satisfaction to those immediately concerned, greatly to the relief of the management of the Grove." An artesian well was opened in August, having a depth of 420 feet, and delivering about a barrel of water a minute. There are also at least 800 tube-wells which draw water from a depth of from twenty to thirty feet. Dr. Hunt says, in his report of the State Board of Health, that the sanitary prospects of the Grove have been greatly improved "the last year." The township Board of Health examined the sewer arrangements and report them satisfactory in every respect. Physicians at Ocean Grove and Asbury Park declare that the sanitary conditions of Ocean Grove were never so good; and some of them that the sanitary conditions there are superior to those of any other of the watering places of New Jersey. "The Popular Science Monthly" is as glad as the officers of the Association or its best friends can be that it has been so successful in improving the condition of things, present and prospective, and is able to make so good a showing.

The Evolutionary Significance of Human Character. By Professor E. D. Cope, Philadelphia. Pp. 12.

In this paper Professor Cope essays a sketch of the order of development of the different faculties of the mind, and summarizes his conclusions by saying that the order of the appearance of the intelligence is nearly dependent on the development of the powers of observation. The character of most civilizations tends to diminish the power of perception, while the higher departments of reason and imagination are enlarged. The imagination reached a high development before reason had attained much strength. With the exception of a few families, the intelligence of mankind has, up to within two or three centuries, expressed itself in works of imagination. "With the modern cultivation of the natural and physical sciences, the perceptive faculties will be restored, it is to be hoped, to their true place, and thus many avenues opened up for the higher thought-power of a developed race. Thus it is that in the order of human development there is to be a return to the primitive powers of observation, without loss of the later-acquired and more noble capacities of the intellect."

Horses: Their Feed and their Feet. By C. E. Page, M. D. New York: Fowler & Wells. Pp. 149. 75 cts.

A book of plain, practical maxims on the proper keeping of horses, involving some views that are novel, but the value of which has been tested in the author's experience. A leading object is to recommend a reformed system of feeding, that we might characterize as the "two-meal" system, which is fully expounded and earnestly maintained. Accounts are given of the way Mr. Bonner and other famous fanciers treat their horses. The causes of various diseases are pointed out, and suggestions are given respecting their treatment. The question of shoeing is fully considered, and it is shown how, under many conditions, horses will do better service without shoes; and Colonel C. M. Weld contributes an account of his experience with barefoot horses.

Photo-Micrographs, and how to make them. By George M. Sternberg, M. D., United States Army. Boston: James R. Osgood & Co. Pp. 204, with Twenty Colored Heliotype Plates. $3.

This work, which is really an elegant, although the author modestly styles it a "little" volume, is practical, and is intended for beginners in the art to which it relates. That art, photo-micrography, is the art of taking sun-pictures of microscopic objects more or less magnified, and is to be distinguished from micro-photography, which merely takes microscopic photographs of objects that can be seen by the naked eye. The former art is scientifically instructive, the latter merely produces curiosities. The author's object in preparing the volume has been to give such an account of the technique of the art as will enable persons familiar with the use of the microscope to make photo-micrographs of suitable objects with a minimum expenditure of time and money. The illustrations have been selected with a view of showing the kinds of microscopic objects best suited for photographing, and the results which may be expected by one who is willing to devote a little time to the mastering of technical difficulties. They represent forty-nine different objects.

Sewer-Gas and its Alleged Causation of Typhoid Fever. By George Hamilton, M. D. Pp. 12. The Status of Professional Opinion and Popular Sentiment regarding Sewer-Gas and Contaminated Water as Causes of Typhoid Fever. By George Hamilton, M. D. Philadelphia. Pp. 10. Etiology and Non-Infection of Sewer-Gases. By Washington Ayer, M. D., of San Francisco. Pp. 25.

Dr. Hamilton undertakes to controvert the sewer-gas theory of the origin of typhoid fever, by showing that the disease is not dependent upon the presence or absence of sewers, or upon any conditions of filth in large cities; and that it prevails in the country, where there are no sewers, and everything is favorable to purity of the atmosphere, more extensively and more fatally than anywhere else. Dr. Ayer maintains substantially the same points, but rather on philosophical grounds than by the citation of examples, and disputes the competency of the experiments which have been relied upon to determine that bacteria are the cause of the diseases with which they have been found associated.

The Influence of Athletic Games upon Greek Art. By Charles Waldstein, Esq., University of Cambridge, England. Pp. 24.

This paper is an inquiry into the cause of the persistency of the influence of Greek art upon us. The answer is found in the fact that Greek art is true to nature, yet not so servile as to be sensual and sensational, but is also ideal. "The ideal in art is the highest generalization of form. In Greek art it was the highest generalization of the forms of nature. The works of Greek art are, therefore, not dependent for appreciation upon one individual spectator, or one special mood of the individual, but are valid for all sane men, for all men of a certain physiological constitution of their senses, surrounded by man and nature relatively the same." The inquiry is pursued how Greek art effected this combination of the natural and the ideal. The natural was developed in the portraiture of athletes, the ideal in the effort to represent and characterize the gods.

An Index to Articles relating to History, Biography, Literature, Society, and Travel, contained in Collections of Essays, etc. By W. M. Griswold, Bangor, Me. Q. P. Index. Pp. 56.

This is No. 13 of the "Q. P. Index," a series of works for the projection and execution of which Mr. Griswold, who has made it his special business, deserves the thanks of every student and reader. The character of the present number of the series is fairly well represented by its title. There are hosts of articles of great value on particular subjects inclosed in volumes of essays and miscellaneous writings, which are practically inaccessible because the general title of the volume gives no clew to what is in it. The present index gives the key to the subjects within its scope as represented in 799 volumes by different authors. The publisher hopes in time to improve upon it and enlarge it—that is, to bring other books into view.

A Physician's Sermon to Young Men. By William Pratt. New York: M. L. Holbrook & Co. Pp. 48. 25 cts.

A lecture to young men on the importance of personal purity and of the restraint of all tendencies to vicious indulgence, the destructive physical and moral consequences of which are pointed out in language that does not err by lack of plainness or vigor. As counteractives to vicious propensities, are recommended cold bathing, hard beds, and sleeping alone, abundant work, plain food, careful reading, right choice of companions, and religion.

Hydraulic Tables for the Calculation of the Discharge through Sewer-Pipes and Conduits. By P. J. Flynn, C. E. New York: D. Van Nostrand. Pp. 135. 50 cts.

The usefulness of such tables as are presented in this volume, to all persons engaged in works demanding the calculations, needs no demonstration. The tables are based on Kulter's formula.

The Oyster Epicure. New York: White, Stokes & Allen. Pp. 61. 30 cts.

This is a collation of authorities on the gastronomy and dietetics of the oyster, the reading of which is appetizing, and calculated to make the reader wish he could find some oysters as good in the actuality as he can imagine them to be.

PUBLICATIONS RECEIVED.

Malaria as an Etiological Factor in New York City. By Simon Baruch, M. D. New York: Trow's Printing and Bookbinding Co. Pp. 22.

Continuity and Catastrophes in Geology. By the Duke of Argyll. Edinburgh: David Douglas. Pp. 32. One shilling.

A Plea for the Cure of Rupture. By Joseph H. Warren, M. D. Pp. 117, with a Plate. $1.

Proceedings of the Indiana Pharmaceutical Association, May, 1883. Indianapolis: Joseph R. Perry, Secretary. Pp. 164.

Bulletin of the United States Geological Survey, No. 1. Two Special Papers. By Whitman Cross and S. F. Emmons. Washington: Government Printing-Office. Pp. 42.

Pilot Chart of the North Atlantic, for December, with "Supplement," giving details of storms and nautical information. Washington: U. S. Hydrographic Office. (Supplement) pp. 11.

Reports of Observations and Experiments in the Division of Entomology. Department of Agriculture. Washington: Government Printing-Office. Pp. 75, with Three Plates.

Transactions of the American Dermatological Association, August, 1883. Dr. Arthur Van Harlingen, Secretary. Philadelphia. Pp. 49.

Scientific Papers of the Vassar Brothers Institute, Poughkeepsie, N. Y., 1881-'83. Leroy C. Cooley, Ph. D., Chairman. Pp. 118.

Cuentos de Hoy y Mañana. Cuadros Politicos y Sociales. (Stories of To-day and To-morrow; Political and Social Sketches.) By Rafael de C. Palomino, Jr. No. 1. New York: N. Ponce de Leon. Pp. 53.

Recherches sur le Structure de quelques Diatomées contenues dans le Cementstein du Jutland. (Researches on the Structure of Certain Diatoms contained in the Cement-Stone of Jutland.) By MM. W. Prinz and E. Van Ermengen. Brussels: A. Manceaux. Pp. 74, with Four Plates.

One Thousand and One Riddles. By Nellie Greenway. New York: J. S. Ogilvie & Co. Pp. 124. 15 cents.

Cassell's "Family Magazine." January, 1884. New York: Cassell & Co. (Limited). Pp. 64. 15 cents monthly. $1.50 a year.

Developments in the Kinetic Theory of Solids, Liquids, and Gases. By H. T. Eddy, Ph.D. Cincinnati. Pp. 16.

Local Government and Free Schools in South Carolina. By B. James Ramage, A. B. Baltimore: Johns Hopkins University. New York: G. P. Putnam's Sons. Pp. 40. 40 cents.

Suggestions on Library Architecture, American and Foreign. By J. L. Smithmeyer. Washington: Gibson Brothers. Pp. 31.

Notes on the Literature of Explosives. By Professor Charles E. Munroe, U. S. N. A., Annapolis, Md. Pp. 20.

The Evidence for Evolution in the History of the Extinct Mammalia. By E. D. Cope, Philadelphia. Salem, Mass.: Salem Press. Pp. 19.

The Winter Resorts of Florida, South Georgia, Louisiana, Texas, California, Mexico, and Cuba, and how to reach them. By John Temple Graves. Published by the Passenger Department, Savannah, Florida, and Western Railway Company. Pp. 103.

Injurious and other Insects of the State of New York. First Annual Report. By J. A. Lintner. Albany: Weed, Parsons & Co. Pp. 383.

Geology of the Comstock Lode. By George F. Becker, San Francisco, Cal. Pp. 3.

Proportional Representation: What it is and what it will do. By Simeon Stetson, San Francisco. Pp. 8.

Edison Electric Light Company. Twenty-first Bulletin. Pp. 62.

The "Medico-Legal Journal," December, 1883. New York. Pp. 96. $3 a year.

Geology of the Eureka District, Nevada. Abstract of Report. By Arnold Hague. Washington: Government Printing-Office. Pp. 50.

United States Geological Survey. Second Annual Report, 1880-'81. J. W. Powell. Director. Washington: Government Printing-Office. Pp. 588, with Sixty-two Plates.

United States Geological Survey. Third Annual Report. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 561, with Thirty-two Plates.

On the Contents of a Bone-Cave in the Island of Anguilla, West Indies. Washington: Smithsonian Institution. Pp. 30, with Five Plates.

Archivos do Museu Nacional do Rio de Janeiro. (Archives of the National Museum of Rio de Janeiro.) Vol. III, 1878. Pp. 164, with Twelve Plates. Vol. IV, 1879. Pp. 154, with Seven Plates. Vol. V, 1880. Pp. 470. Rio de Janeiro: De Machado & Co.

Where did Life begin? By G. Hilton Scribner. New York: Charles Scribner's Sons. Pp. 64.

The Güegüence: A Comedy Ballet in the Nahuatl-Spanish Dialect of Nicaragua. Edited by Daniel G. Brinton, M. D., Philadelphia. Pp. 94. $2.50.

Aboriginal American Authors and their Productions. By Daniel G. Brinton, M. D, Philadelphia. Pp. 63. $1.

Lectures on Painting. By Edward Armitage, R. A. New York: G. P. Putnam's Sons. Pp. 337.

Excursions of an Evolutionist. By John Fiske. Boston: Houghton, Mifflin & Co. Pp. 379. $2.

Martin Luther the Reformer. By Julius Koestlin. New York: Cassell & Co. (Limited). Pp. 145. 50 cents.

Health in the Household; or, Hygienic Cookery. By Susannah W. Dodds, M. D. New York: Fowler & Wells. Pp. 602. $2.

Voice, Song, and Speech. By Lennox Browne and Emil Behnke. New York: G. P. Putnam's Sons. Pp. 322.

A Guide to the Microscopical Examination of Drinking-Water. By J. D. MacDonald, F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 83, with Twenty-five Plates. $2.75.

An Examination of the Philosophy of the Unknowable as expounded by Herbert Spencer. By William M. Lacy. Philadelphia: Benjamin F. Lacy. Pp. 235.

Electrical Directory and Advertiser: British, American, and Continental. By J. A. Berly. New York: George Cumming. Pp. 664. $2.50.

Tertiary History of the Grand Cañon District. By Clarence E. Dutton. Washington: Government Printing-Office. Pp. 264, with an Atlas containing Twenty large Plates and Panoramas.

POPULAR MISCELLANY.

The Ice Age.—At a meeting of the Academy of Natural Sciences of Philadelphia, Professor Heilprin advanced the opinion that the enormous sheet of ice which extended over a large portion of North America and Europe during the Glacial period could not have originated from a polar "ice-cap." He deemed it doubtful that there could have accumulated in the Arctic regions sufficient snow and ice to propel a glacier probably several thousand feet thick over hundreds of miles, and up slopes to heights of five or six thousand feet. Precipitation in polar regions takes place mainly in a low atmospheric zone; hence it would be impossible for so great a mass of snow to accumulate at so great an elevation as would be necessary to propel southward a glacier of the extent required by geologists. Professor Lewis called attention to a point observed some time ago by Dr. Hayes, but not yet sufficiently appreciated, namely, that the rate of increase in the thickness of the glacier diminished northward. Recent observations of his own showed the glacier to have been 800 feet thick five miles from its southern limit, and 2,000 feet thick at a point eight miles from its edge, while it was only about 3,100 feet in thickness at a distance of 100 miles, and 5,000 feet at 300 miles from its termination. Rejecting several hypotheses, Professor Lewis suggested that the ice-cap flowed south simply because it flowed toward a source of heat. Such a motion not being caused by gravity, would take place in a nearly flat field of ice, and upon his supposition the ice need not have been more than a few times its present thickness in Greenland. Professor Heilprin replied that no laws of glacial action were known which would account for the indiscriminate progression of an ice-sheet toward a source of heat, and that the molecular expansion theory, as applied to the Alpine glaciers, took no cognizance of the direction of the heat-power, but merely of that of least resistance (the trend of the slope). At a subsequent meeting he supported his views previously communicated by statistics of precipitation at different elevations on the Alps, and presented some curious calculations in regard to the rate of progression of the great ice-sheet. Allowing for it the average rate of the Alpine glaciers, one foot a day, it would have required a period of no less than 25,000 years to move from the sixty-fifth parallel of latitude to the line of its terminal moraine. But it may well be questioned if the conditions allowed progression at more than one fifth of this rate. Professor Lewis remarked that arguments, drawn from meteorological conditions as they now exist, will not in all cases apply in considering the Glacial epoch. He further suggested a probable analogy between the Antarctic ice-cap, some 25,000 miles in diameter, and the polar ice-cap of glacial times, and mentioned Croll's estimate that the former is twelve miles thick at its center. In speaking of a polar ice-cap, he did not mean to imply, however, that the ice was necessarily thickest on the pole, but that in Greenland, Labrador, the Hudson Bay region, or elsewhere, there may have been centers from which glaciers grew finally to coalesce into one mass of ice, the top strata of which flowed southward to the great terminal moraine.

Effect of Watering Plants with Acids.—Mr. L. P. Gratacap, of New York city, has published a report of experiments he has made to determine the effect of watering with solutions of acids upon plants. He experimented upon the silver-leaved geranium with hydrochloric, nitric, carbolic, formic, salicylic, sulphuric, tartaric, and citric acids, and water. The plants watered with the first six acids except salicylic were unfavorably affected from the first day of the experiment. From June 22d to September 6th none of the plants died except the carbolic-acid plant, although the nitric-acid plant succumbed shortly after the experiment terminated. Of the rest the sulphuric-acid plant was most thriving, then the hydrochloric-acid plant, and last, and just alive, the plant treated with formic acid. Analyses of the ashes of the plants showed that the acid waters tended to introduce inorganic ingredients into their tissues. Of hyacinth-bulbs treated in a similar way, only the one treated with tannic acid developed roots. The hydrochloric-acid bulb died, and the sulphuric-acid bulb a month later. After the tannic-acid one, a bulb treated with oxalic acid did best. Tannic acid seemed to increase the intensity of the color of the flower. The plants were dwarfed by the treatment.

Temperature of the Glacial Period.—Mr. G. F. Becker closes a carefully considered review, in the "American Journal of Science," of the phenomena of glaciation with the conclusion that, if the generally received view (the substantiation of which would not be superfluous) that the sun is a gradually cooling body is correct, "it appears nearly certain that the absolute maximum in the development of glaciers is past, and that the glacial period was not one of general cold, but one of higher mean temperature at sea-level than the present." This is advanced without denying that a variety of other causes than those immediately considered by him may have had an influence, and, perhaps, a great influence, upon glaciation. "Indeed, it seems more probable that the formation of glaciers was affected by all contemporaneous changes, such as extraordinary upheavals and subsidences or periodic fluctuations in the eccentricity of the earth's orbit; but, if the reasoning offered is correct, it is not necessary to resort to such events to account for the occurrence of a glacial epoch." He believes that the production of glaciers is chiefly a question of differences between the temperatures at the sea-level and at the level at which the glacier is formed.

Pathology of the Pear.—At a meeting of the New Jersey State Microscopical Society, a paper was read by the secretary, Dr. Samuel Lockwood, on "Fecal Sclerogen," the last word meaning the indurated particles of lignine in the pear. He showed a quantity of material like sand, which had been passed by a person to whom it had caused great distress. In the microscope it looked unlike any mineral sand, and each particle was composed of a cluster of sharp-pointed crystals, like dog-toothed spar. It even resisted the action of nitric acid, but was dissolved readily by ammoniuret of copper. Suspecting its nature, he took the rind and core of a ripe Bartlett, and gave them to his bees, which were suffering from a dearth of flowers. The insects cleaned away the glucose and all the juices, leaving the pear-grit clean; which, by comparison in the microscope, was identical with the fecal grit. The truth was, the person had been feasting inordinately on ripe Bartletts. The doctor remarked that it had never been cleared up why the pear should cause to many such suffering in the alimentary canal, as its juices were really far less acrid than those of the apple. He showed that it was due to the sclerogen, or pear-grit. Each particle literally bristles with sharp angular points, and the cathartic energy is due to the mechanical action irritating the walls of the alimentary canal.

Growth of Boys and Girls.—The investigations of the Anthropometric Committee of the British Association have made more or less clear several interesting facts respecting the rate of growth of the two sexes in the British Isles. The period of most rapid growth is from birth to five years of age, and then both sexes grow alike, the girls being a little shorter and lighter than the boys. From five to ten the boys grow a little faster than the girls, but from ten to fifteen the girls grow the faster, and at between eleven and a half and fourteen and a half years old are actually taller, and from twelve and a half to fifteen and a half are heavier than the boys. The boys, however, take the lead between fifteen and twenty years, and grow at first rapidly, but afterward slower, and complete their growth at about twenty-three years, while girls grow very slowly after fifteen years of age, and attain their full stature at about the twentieth year. The tracings and tables show a slow but steady increase in stature up to the fiftieth year, and a more rapid increase in weight up to the sixtieth year in men, but the statistics of women are too few after the age of twenty-three to determine the stature and weight of their sex at the more advanced periods of life. The curve of the chest-girth in men shows an increase at a rate similar to that of the weight up to the age of fifty years, but it appears to have no definite relation to the curve of stature. The strength of males increases rapidly from twelve to nineteen years, and at a rate similar to that of the weight; more slowly and regularly up to thirty years, after which it declines at an increasing rate to the age of sixty years. The strength of females increases at a more uniform rate from nine to nineteen years, and more slowly to thirty, after which it falls off in a manner similar to that of males. The curves of strength for the two sexes are not parallel: at eleven years females are weaker than males by twenty-two pounds, at twenty years of age by thirty-six pounds. The fact that man continues to grow in stature up to his fiftieth year contradicts the popular notions on the subject, according to which he ceases to grow before he reaches half that age.

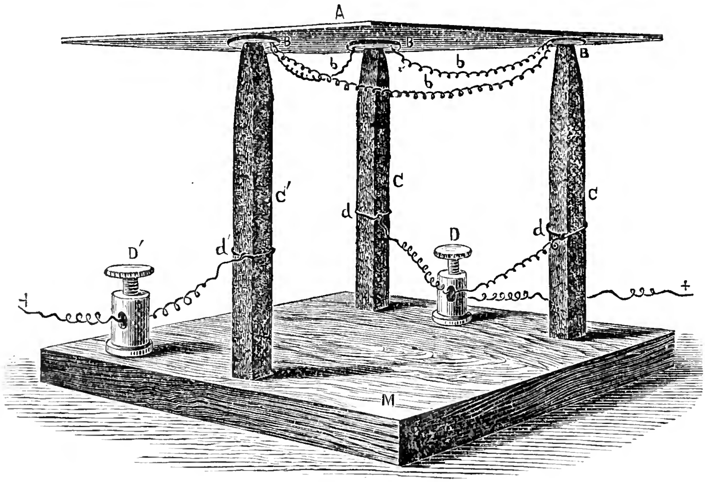
The Extinct Volcanoes of the Pacific Slope.—According to the "Notes" furnished by Messrs. A. Hague and J. P. Iddings, of the United States Geological Survey, to the "American Journal of Science," the series of extinct volcanoes on our Pacific coast extends northward from Lassen's Peak, near the fortieth parallel, at intervals, for nearly five hundred miles, and follows in general the axial lines of the Sierra and Cascade Ranges. The more prominent peaks of the chain are Lassen's Peak and Mount Shasta, in California; Mount Pitt, Three Sisters, Mount Jefferson, and Mount Hood, in Oregon; and Mounts St. Helen's, Adams, Rainier, and Baker, in Washington Territory. Mount Rainier is the grandest one of the number, and forms the most prominent topographical object in Washington Territory. The surface features of the western part of the Territory have been greatly modified by the lava-flows of the volcano, and four of the important rivers of the region rise among its glaciers. Snow and ice cover its top, reaching downward for five or six thousand feet, while with the most marked contrast the broad base of the mountain supports a dark, dense, grand forest vegetation. The summit is formed by three peaks, the chief of which, a circular cone, with a crater about a quarter of a mile in diameter, rises to 14,444 feet above the sea. Mount Hood is situated directly on the crest of the Cascade Range, about twenty-five miles south of the Columbia River, and is 11,225 feet high. Its summit is a single peak—a portion of a rim of an ancient crater. The crater is about half a mile wide from east to west, and its encircling wall, for three fifths of the circumference, rises 450 feet above the snow and ice that fill the basin. Mount Adams and Mount St. Helen's, on the north side of the Columbia River, form, with Mount Hood, a triangle, the area of which has been the center of great volcanic activity. None of the volcanoes along the belt occupy so comparatively isolated a position as Mount Shasta, which stands upon an open plain with the neighboring hills and ridges many thousand feet lower. Its altitude is given as 14,440 feet, and, as the neighboring ridges rarely attain an altitude of over 3,000 feet, the volcano presents an imposing spectacle surpassed by few mountains in the world. As seen from the west, it presents a double cone, the smaller built upon the flanks of the larger one, and about 2,000 feet lower. Around the broad base of the mountain numerous lesser cones have broken out, one of which, Little Shasta, rises to more than 3,000 feet above the neighboring valley. Seventy miles southeast of Mount Shasta, near the boundary between Nevada and California, is Lassen's Peak, which, though it is about 10,500 feet high, is by no means so conspicuous an object as many of the volcanoes, because it is surrounded by other peaks of considerable elevation. It is a broad, irregularly shaped mountain, with four prominent summits, and bears on its slopes abundant evidence of comparatively recent extrusions of lava.

Science and Jack-Puddings.—Mr. R. A. Proctor, in "Knowledge," notices the single abusive utterance that was made against Mr. Herbert Spencer while he was in this country, and which came, not from a corner saloon, but from a pulpit, and remarks of it that it is difficult to say whether the terms used by the preacher "are more strikingly contrasted with the teaching and method of the writer he attacks or with those of the intelligent, well-trained, and well-educated clergymen who have, indeed, dissented from some of the inferences which appear to them to follow from modern scientific theories, but who know well that they would but degrade their cause and themselves (to say nothing of their calling) were they to substitute reviling for rhetoric and railing for reasoning." Then Mr. Proctor quotes such passages from the attack as are fit for publication, and adds: "Nearly three centuries ago there was at least earnestness in the arguments used by priests, and monks, and friars, against the fearful doctrine that the earth goes round the sun. Unwise though their conduct, and unjudging their intolerance, they believed what they taught, and in their day their belief was natural enough. It is encouraging to find that in our day the advance of science is only opposed by the untaught and the foolish; only abused by the ranter and the Jack-Pudding. When we consider how necessary are certain doctrines for the world's welfare—even though hereafter they may have to give place to higher and broader and deeper truths—it is well to see that those who do their best to discredit those doctrines are not now men whose words have any weight, are not even fanatics or bigots, but simply—clowns and charlatans."

The Recent Eclipse of the Sun.—The formal reports of the observations of the solar eclipse of the 6th of May last have not yet been published; but a few preliminary statements respecting them have appeared in the journals. The American, French, and English parties arrived safely and in good time at Caroline Island, and set up their apparatus under generally satisfactory conditions. The day of the eclipse opened rather unfavorably, but the sky cleared before the first contact. The clouds continued, however, to float around, so that the corona was partly hidden during twenty seconds of the first minute of totality, and the phenomenon was wholly obscured after the cessation of totality. As totality, however, lasted for nearly five minutes and a half, good observations of that stage were obtained. The supposed intra-Mercurial planets were sought but not found. Photography does not seem to have given the results that were expected from it; but it is said that proofs were got the combination of which will permit the reconstruction of the entire corona as it was shown at the time. Mr. Hastings, of Baltimore, made some observations on the spectra of the opposite sides of the corona, from which he has drawn the conclusion that the outer portions of it are not real, but are effects of diffraction. This conclusion, "Ciel et Terre," of Brussels, observes, would account for the differences of form which the corona exhibits to different observers, but fails to account for the predominance of coronal light toward the solar equator. M. Janssen observed anew that, besides the spectrum of bright lines, the corona gives a weak continuous spectrum showing some of the principal dark rays of the solar spectrum. This would favor the theory that the light really proceeds from the coronal appendage, and that its exterior is made up of a mass of meteors reflecting the light of the sun—a theory that is already supported by the results of polariscopic analysis. It is also stated that M. Tacchini has observed near the limit of the coronal atmosphere the spectrum of a hydrocarbon similar to that which comets give when they are far from the sun.

Function and Structure.—The French Academy of Medicine recently discussed the question whether an identity of action exists between the living tissues of animals and of men. M. Béchamp denied any similarity, and alleged differences in the properties of the salivas of man and animals, and between the milks of man, the cow, and the goat, in support of his view. The answer to this, as suggested by the "Lancet," is that, in the process of evolution, function precedes structure; hence the legitimate corollary is deduced that the properties of a tissue are more delicate tests of its nature than the structure. It is more than probable, however, that in drawing this conclusion we are swerved by the imperfections of our senses, and that molecular structure goes hand-in-hand with function, and that a change in property is accompanied by a corresponding variation in the arrangement of the constituent atoms of a molecule. Every cell and every molecule has its individual characteristics, and these idiosyncrasies may extend to different individuals of the same species, to different species, and to different genera.

A Home-made Microphone.—Some of the readers of this journal may be pleased to have a description of a little microphone that has given good results, and which can be made, in a few minutes, from material at hand. It is represented in the figure of the natural size. It is made from a visiting-card of the ordinary thickness cut square. A round card might look better, but it will give less satisfaction. On the card should be fastened with sealing-wax three thin, light disks of carbon, B B B′, of the quality used in the electric light. The disks should be placed symmetrically at the angles of an equilateral triangle, and should be put in communication with each other by the copper wires *b b b′*, which are either soldered or stuck tightly into holes made in each disk to receive them. Platinum may be advantageously substituted for copper. The rest of the apparatus consists of a square wooden foot, M, supporting three prismatic rods of carbon, C C C′, arranged so as to correspond exactly with the three disks B B B′. Two of the rods, C C, communicate by the copper or platinum wires *d d* with the common terminal D, while the third rod, C, communicates alone with a second terminal, D′. The upper ends of the charcoal rods should be cut into a bevel-shape—not into a point, for that does not give sufficient contacts. The rods are sealed to the wooden base M. The theory of this microphone is very simple. The current enters, for example, by the terminal D′, follows the rod C′, then the disk B′, whence by the wire *b* it passes by the two disks B to return to the terminal D through the two rods C C. The little instrument may be made very sensitive to the voice and to all sounds, provided the card A is given the proper weight, and is neither too heavy nor too light. The voice, with its timbre, of a person speaking in his usual tone at the other side of the room, can be heard very distinctly in it. The sounds of the piano are particularly well reflected. The apparatus should be placed upon a table two or three metres away from the sound. For a battery to put the microphone in action, I have generally used a small Bunsen element. Two or three Leclanché elements would do as well. I have used a modification of the Leclanché elements, in the shape of a pile made of a plate of zinc and a carbon plate, moistened with a saturated solution of bichromate of potash and hydrochlorate or sulphate of ammonia. It is in fact the bichromate pile without the costly mechanism which is used for relieving the zinc from the action of the acid when the apparatus is at rest. This element does not waste when the current is interrupted, as in the Leclanché pile. A difficulty which arises in the use of the pile, from the penetration of the carbons by the ammoniacal solutions till they attack the wires, has been obviated by M. Préaubert's device of exposing the carbons to a bath of



boiling paraffine, which destroys their capillarity, while it does not affect their conducting power. The superficial paraffine may be scraped off after the bath. Piles may be obtained by this means that will endure indefinitely, and have, apparently, an electromotive force superior to that of a Leclanché pile of the same dimensions.—M. A. Bleunard (*translated for the Popular Science Monthly from La Nature*).

Lightning without Audible Thunder.—A correspondent of "Nature" reports a violent rain and lightning storm which took place near the crest of the Apennines, and during which no sound of thunder was heard. The writer also describes two other such storms that he witnessed on the edge of the Montenegrin highlands. "On these nights," he states, "the lightning was so incessant and vivid that we were able to walk about, choosing our way among the stones and shrubs as readily as by daylight, the intervals between the flashes being, I should judge, never more than a minute, while much of the time they seemed absolutely continuous, the landscape being visible in all details under a diffused violet light. Looking overhead, the movements of the lightning were easily discernible, the locality of the discharges varying from one part of the vault to another in a manner which it was impossible to confound with the reflection of lightning from a distance. Like the storm of last night, those were followed by copious rain, but not a single peal of thunder was heard during the whole night."

Combustion - Products from Different Lights.—The following figures show the amount per hour of combustion-products from several varieties of artificial light. Unless the electric light has some peculiar injurious influence, it has a great superiority on sanitary grounds:

LIGHT OF 100 CANDLES.	Water-vapor, in kilometres.	Carbonic acid, in cubic metres.	Heat, in calorics.
Electric lamp, arc.........	0	0	57–158
Electric lamp, incandescent	0	0	290–536
Gas, argand-burner	0·86	0·46	4860
Lamp, petroleum, flat flame	0·80	0·95	7200
Lamp, colza-oil............	0·85	1·00	6800
Candle, paraffine..........	0·99	1·22	9200
Candle, tallow.............	1·05	1·45	9700

NOTES.

Mr. Robert E. C. Stearns, in a paper read before the California Academy of Sciences, announces his conclusion, from his studies of the shells of the Colorado Desert and the region farther east (particularly from studies of *Physa* and *Anodonta*), that every item bearing upon the geographical distribution of the species indicates the mountain-lakes as the sources whence they are derived; points to their descent from northerly regions as well as from higher altitudes; and contributes additional testimony as to the antiquity of these widely spread though inferior forms of life.

General Richard D. Cutts, of the United States Coast Survey, died in Washington, December 13th, in the seventy-seventh year of his age. He had been connected with the Coast Survey during the greater part of his life, and was at the time of his death first assistant superintendent of the service.

In a paper before the American Association on the "Serpentine of Staten Island, N. Y.," Dr. T. Sterry Hunt expressed himself in favor of the opinion of Dr. Britton, of the School of Mines, Columbia College, that the belt containing the mineral is a protruding portion of the Eozoic series. The appearance of isolated hills and regions of serpentine is common in other regions, and is by Dr. Hunt explained by the consideration that this very insoluble magnesian silicate resists the atmospheric agencies which dissolve limestones and convert gneisses to clay—the removal of which rocks leaves exposed the included beds and lenticular masses of serpentine. Similar appearances are seen in many parts of Italy, where ridges and bosses of serpentine are found protruding in the midst of Eocene strata, and have hitherto, by most European geologists, been regarded as eruptive masses of Eocene age. Mather, who described the Staten Island locality more than forty years ago, also looked upon the serpentine as an eruptive rock.

A curious instance of the kindling of a fire by means of the concentration of the sun's rays by a globular water-bottle through which they passed is related by a correspondent of "La Nature." The day was cold, but the sun shone brightly; the bottle, an "onion-shaped" flask, filled with water so as to form a perfect lens, sat upon the table. The starting of the fire, which would have caused great damage if the relater of the incident had not been present to extinguish it, was revealed by the smoke. A deliberate experiment was made on the next day, with complete success, in kindling a fire by this means.

The "Pall Mall Gazette" cites some more cases illustrating the quality of the learning furnished by the English board-schools. The study was geography. The children were able to give an accurate list of the exports of Norway, but could not recall the picture of a fiord. They knew that the latitude of Paris was 49°, but when asked, "What is latitude?" they were either dumb, or gave such answers as—"Latitude means lines running straight up"; "Latitude means zones or climate"; "Latitude is measured by multiplying the length by the breadth." Correct lists of imports were given, but customs duties were defined, by a girl, "Customs are ways, duties are things that we have to do, and we ought to do them"; by a boy, "Customers' duties are to go to the places and buy what they want, not stopping about, but go out when they are done."

According to tables prepared by Dr. Daniel Draper, of the New York Meteorological Observatory, Greenwich Observatory had 1,245 hours of sunshine in 1878, in a possibility of 4,447, while New York had 2,936 hours, in a possibility of 4,449; and in 1879, Greenwich had 977 hours, and New York 3,101 hours.

Professor Sven Nilsson, of the Lund University, Sweden, a distinguished zoölogist, died November 30th, at the age of ninety-seven years.

It is proposed to hold next year, in the building of the International Fisheries Exhibition at South Kensington, an exhibition illustrating the relations of food, dress, the dwelling, the school, and the workshop, with health. The exhibition will be divided into sections of education and health, and further into six principal groups: 1. Food-matters and their preparation; 2. Dress, with specimens of different styles and materials; 3, 4, and 5. What pertains to the healthful construction and fitting of the dwelling, the school, and the workshop; and, 6. All that relates to primary, technical, and art education.

Popular lore teaches several signs by which it pretends to determine from the weather on a particular day what the weather will be for a longer or shorter time in the future. M. A. Lancaster reports, in "Ciel et Terre" of Brussels, concerning a test he has made of one of these signs. It is that of St. Médard's day, or the 8th of June, concerning which a proverb is rife in the Continental countries that, if it rains then, it will rain for forty days afterward. M. Lancaster examined the record for fifty years, from 1833 to 1882, and found from it that, as a rule, it rained about as much and as often during the forty days following the 8th of June when it did not rain on that day as when it did. Taking the averages of all the years, there was a difference of 2·3 days, or less than one seventeenth, and of twelve millimetres (88·1–77·6) of rain in favor of the rainy St. Médard: not enough, certainly, on which to found a rule.

Mr. John Eliot Howard, F. R. S., a well-known chemist and quinologist of London, died in November last, at the age of seventy-six years. His father, Mr. Luke Howard, F. R. S., was in his own day distinguished as a meteorologist.

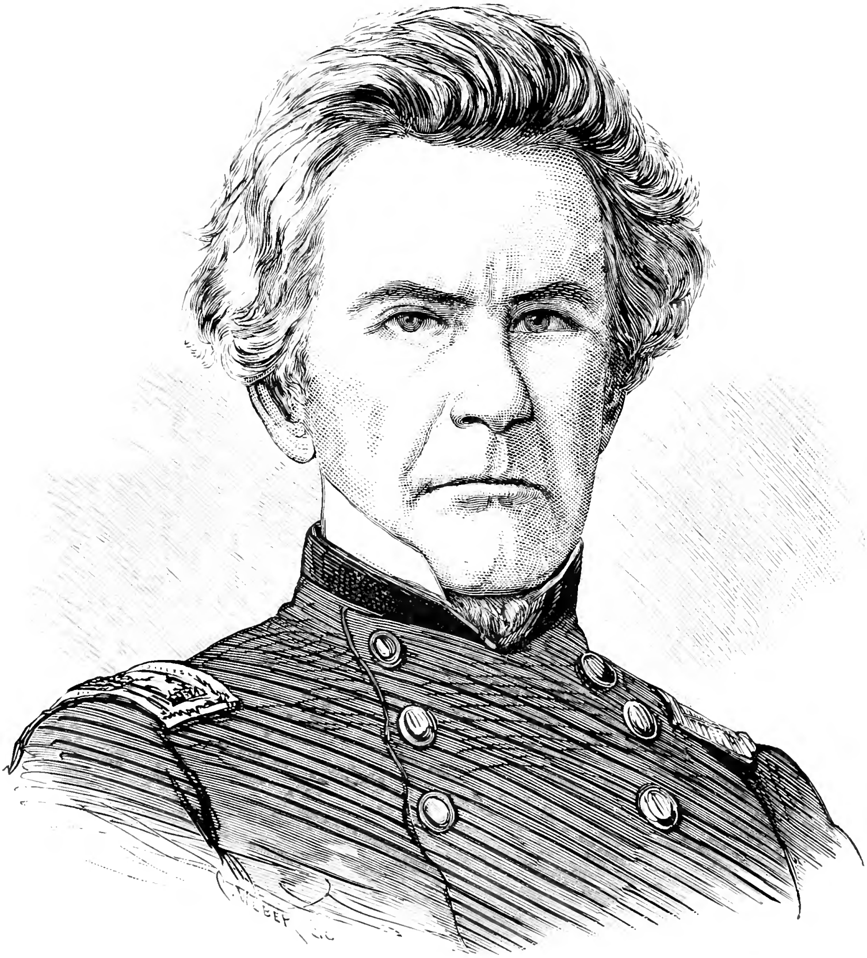
Turgenieff, the great Russian novelist, recently deceased, had the heaviest brain that has yet been weighed—2,012 grammes. The average weight of the human brain is 1,390 grammes. The statistics of brain-weights so far gathered do not show that great intellects are marked by heavy brains. Cuvier's brain, 1,800 grammes, was considerably larger than the average, while Gambetta's was remarkably small. The brains of Raphael, Cardinal Mezzofanti, Charles Dickens, Lord Byron, and Charles Lamb, did not exceed the average, and only Mezzofanti's reached it.

Lieutenant Wissmann, a German explorer, is about to make another journey into Africa, the cost of which is defrayed by private contributions. His object will be to explore the Kaissai from Mukenge to its mouth into the Congo. The success of the expedition is likely to have an important bearing on the extension and development of trade on the Congo, and to contribute much to geographical knowledge; for the contemplated route will intersect the southern and unexplored part of the bend of the great river, probably in the middle.

The remains of Commandant Langle and other companions of the explorer La Pérouse, who were massacred by savages in the last century, have been discovered by the Roman Catholic missionaries on the Island of Tutuila, where the massacre occurred. A memorial chapel is to be built at the spot where they are buried.

The Italian traveler Sacconi, who was exploring the country of the Somaulis under the auspices of the Geographical Society of Milan, was murdered by the natives on the 12th of August. His death puts an end to one of the most important explorations of the day into a country concerning which many questions still remain to be settled.

Among the 20,000 articles of bronze belonging to the lake-dwellers so far found in Switzerland, about 30 per cent are rings, 17 per cent bracelets, 4 per cent knives, 3 per cent needles, 0·4 per cent hammers, and 0·2 per cent fibulæ.



ORMSBY MACKNIGHT MITCHEL.

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FROM MONER TO MAN.

By FRANCES EMILY WHITE, M. D.,

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MAN has long been regarded not only as a compendium of the entire animal kingdom, but as an epitome of the universe—as Nature's short-hand expression of a long-continued history begun with the beginning condensation of the nebulæ, and still going on to the development of higher types of humanity. Nature's language is hieroglyphic, and for the correct interpretation of her occult characters a key is necessary. It is one of the many triumphs of modern science that she has found at least a partial key to this mysterious book, and it is to the unlocking of some of its secrets that your attention is invited on this occasion.

My subject—the development of the human body from a microscopic speck of living matter—is a vast one, and the attempt to condense its consideration into the space of a single hour can result, at best, in a little more than a bare outline; but even such an exposition, however imperfect, may perhaps be deemed justifiable as a means of inciting to further study, and it is in this hope that the task is undertaken.

In the earliest perceptible stage of its existence, the human being consists of a minute apparently homogeneous mass of living matter of the kind known, since the days of Von Mohl and Remak, as *protoplasm*. The word means simply the *first formative material*, or the material in which all plants and animals have their origin. That it is a fact of natural history, and not a mere figment of the scientific imagination, that all plants and animals originate in a common substance, is no longer denied. This great principle was, indeed, recog-

* Address delivered at the opening of the Twenty-ninth Annual Session.

nized by Harvey, and first expressed in his famous aphorism, "*Omne vivum ex ovo*"—an egg, whenever it occurs, consisting essentially of a minute globule of protoplasm.

What is the origin of this universal, white-of-egg-like material? As little is known of the history of the first production of protoplasm as of that of the elements—hydrogen, oxygen, nitrogen, carbon, etc., of which it is composed. So far as yet discovered, all protoplasm, whether vegetable or animal, is derived from pre-existing protoplasm. The spontaneous production of living matter from non-living materials has never been satisfactorily proved. The particular kind of protoplasm which we are about to consider—viz., the human germ—is the combined derivative of certain glands which exist in separate adult human beings who represent the opposite sexual polarities belonging to all except the lowest vegetable and animal types. At the earliest recognizable stage of his existence man may therefore be regarded, physiologically, as a secretion. Zoölogically, to what rank is he, then, entitled? The undeveloped human ovum, immediately after its fertilization, corresponds in structure to the lowest known order of the most simple class of animals, the *Protozoa*, which stand at the very foot of the zoölogical scale. To this most humble of all known living creatures Professor Haeckel has given the name of *Moner*, a word of the same origin as monad, and expressive of ultimate simplicity and primitiveness.

More simple even than the moner, however, is the *bathybius*, found on the deep-sea bottom, and described by Professor Huxley as consisting of an ill-defined mass of a slime-like material possessing all the properties of living protoplasm. Even granting with skeptics on this point that the existence of bathybius is not satisfactorily proved, we may nevertheless assert with confidence that, as the natural predecessor of the moner, it ought to exist, and will some time be discovered, just as certain unobserved heavenly bodies have been partially described and located by astronomers long before the telescope had penetrated the obscurity in which they were hidden.

Through the processes of nutrition, under the combined influences of growth and development, this non-nucleated mass of living protoplasm (the human ovum) acquires a nucleus; in other words, there appears at its center a minute speck of matter slightly more opaque than the surrounding matter. Differentiation has therefore begun; that is, a difference of parts has made its appearance. How does this nucleus (to which, in cell-physiology, so much importance is attached) differ from the surrounding matter which constitutes the bulk of the germ? Chemically, it is more active; it is believed to be the part where nutrition (the assimilation of new material) mainly takes place. Its greater chemical, and, therefore, nutritive activity, is shown by its deeper staining with coloring-matters, such as carmine and hæmatoxylin, and by the fact that, with the access of nutriment, fresh nuclei make their appearance. It undoubtedly contains a larger proportion of the nitrogenous matter which enters into the composition of all protoplasm, and, like the nuclei of other cells, a certain percentage of phosphorus. At this stage of its existence the germ (still microscopic) is represented in the zoölogical scale by the *Amœba,* which it closely resembles in structure, having thus ascended to the second round of the zoölogical ladder.

The amœba has received its full share of attention from biologists. Its physiological endowments are scarcely greater than those of the non-nucleated moner. Both are capable of effecting those exchanges of matter which constitute nutrition ; both are capable of reproduction (a phase of nutrition) ; both have the power of changing their form by thrusting out portions of their mass (the so called "false-feet"), and of thus executing slight creeping movements. These little masses of protoplasm are also capable of responding to contact of other matter, thus exhibiting the rudiments of common sensation. What is the evidence of this capacity ? How does the amœba manifest a sense of touch ? When some substance, perhaps a smaller representative of its own species, floats against the surface of an amœba, the precocious bit of protoplasm responds to the salute by flowing around its victim, which is thereby inclosed within the body of its captor, and gradually appropriated as food. Probably the term "victim" is of doubtful application in this case, since the difference between eating and being eaten must be trifling. However that may be, the one improvises a stomach for the occasion, and digests the other with all the *nonchalance* of a Feejee-Islander. The human germ is, however, preserved from a similar indulgence in incipient cannibalism by its different environment—not the only period of its existence when it escapes evil-doing through lack of opportunity—for it receives its pabulum, ready prepared, from the blood of the mother, which is doubtless one of the conditions of its future higher development.

In this response to contact by movement on the part of the amœba, it exhibits the rudiments of both muscular and nervous action, since, under the influence of an external force or stimulus, a reflex movement is produced.

The next perceptible change in the evolution of the ovum is known as *segmentation.* This consists in an increase of its mass by duplication and reduplication ; the single cell first acquires a second nucleus, and the surrounding protoplasm then separates into two masses, each having its own nucleus ; this process is continued until the enveloping membrane contains a mass of cells, each like the original amœboid cell. From the resemblance of the ovum at this period to a mulberry, this is called the mulberry or *morula* stage of embryonic development. In the zoölogical scale, it corresponds to the *labyrinthula,* a little animal which consists of an aggregation of simple nucleated cells. From this multiplication of nuclei, which are regarded as the active centers of nutrition, there must result an increased power of development and growth.

By the absorption of fluid from the maternal tissues in which it is imbedded and the accumulation of this fluid at the center of the mass, the cells of this mulberry-like body become crowded outward to the periphery, thus forming a lining for the membranous sac—i. e., the outer covering of the ovum—which incloses them, the entire globular mass now being about one twenty-fourth of an inch in diameter, and consisting of a structureless outer membrane lined with a layer of nucleated cells (the *blastoderm*), and filled with clear fluid. These lining cells multiply rapidly; the inner ones become larger, darker, and softer than the outer ones, and thus differentiation has again occurred—the lining having developed into two distinct layers. This is known as the *gastrula* stage of embryonic development. All animals, from sponges to man, pass through this phase, becoming first two and then three layered sacs; but, from this point, the different branches or sub-kingdoms diverge; and the next recognizable phase in the development of the human embryo is confined to vertebrates, with a single exception, the *ascidian*. The larval ascidian swims like a tadpole by means of a caudal appendage in which may be traced a rod-like body thought to be a rudimentary *chorda dorsalis*, since it resembles the embryonic structure which, in the perfect vertebrate, develops into the spinal column with its contained, highly endowed spinal cord. This, however, not only fails to develop but actually disappears in adult life, leaving the ascidian a simple invertebrate animal. But, whether the ascidian be a true connecting link between invertebrates and vertebrates, or, as suggested by Balfour, a reversion from the higher form, it serves equally to indicate a close relationship between these two great subdivisions of the animal kingdom.

Between the two layers of germinal cells which belong to the gastrula stage, a third layer is developed, and from these three layers (the *epiblast*, the *mesoblast*, and the *hypoblast*) all the tissues and organs of the body are derived. The inner layer (hypoblast) gives origin to the epithelial lining of the alimentary canal and to the various glands derived from it. From the outer layer (epiblast) are developed the brain and spinal cord, and the epidermis with its appendages and derivatives, including the organs of the special senses. From the middle layer (mesoblast) the various intermediate structures are produced. The remaining history of development is, therefore, the history of the differentiation of these three layers of the blastoderm (which alike consist of simple nucleated cells) into the various tissues and organs of the body. Accompanying this process there is a corresponding development of functions. As absorption and assimilation, so perfectly performed by these germinal cells, are, however, the fundamental facts in the nutrition of even the highest organisms, so also reaction in response to a stimulus, of which we have found even the moner and the amœba to be capable, is the fundamental fact in the functions of the fully developed muscle, nerve, and brain of the highest organisms.

The embryon, in its condition of a three-layered sac, soon begins to show a slight bilateral symmetry, and a *chorda dorsalis* appears. Its rank, as a vertebrate, is thus established in the dawning of that important structure, a backbone.

Allusion has been made to the ascidian as introducing the vertebrate type. Whatever may be thought of the claims of this animal to so important a place in the genealogical tree, there can be little doubt about the position of the *amphioxus* with its dorsal cord distinct and persistent throughout life. Though classed, on this account, among vertebrates, it is singularly wanting in vertebrate characteristics, having neither heart nor brain in the true sense of these words. It is also destitute of limbs, even of the most rudimentary kind, such as are found in the very lowest fishes. In fact, it is distinctly neither vertebrate nor invertebrate, thus admirably filling the position of a connecting link between these two great subdivisions of the animal kingdom.

At the chordonian stage of its development, the human embryon is equally destitute of a true heart, brain, and limbs, thus corresponding to a sub-type of the vertebrates called by Haeckel, *Acrania*, of which the amphioxus is the best-known representative. There is, nevertheless, in this heartless, brainless, limbless, and almost shapeless mass of but slightly differentiated protoplasm, that wonderful impulse of evolution by which its destiny, as an individual of the highest organic rank, is assured.

Along the line of the *chorda dorsalis*, rudimentary nerve-centers and spinal vertebræ gradually appear, the embryon thus entering on a grade of development comparable to that of the lowest fishes, in which the spinal column is cartilaginous rather than bony.

The budding limbs resemble budding fins ; arches similar to those which, in water-breathing animals, support the gills are seen ; and the rudimentary lungs are mere air-bladders.

Next arises the *amnion* stage, so named from an important though temporary nutritive organ whose development begins at this period ; it is an extension of the yolk-sac, and contains a highly nutritious fluid.

The gill-arches gradually disappear, developing into more advanced structures ; the heart becomes subdivided into four chambers ; the air-bladders give place to true lungs ; and, with the complete formation of a placenta, the mammalian stage of development is fully established. The embryon is henceforth recognizable as belonging to the class mammalia, the highest of the vertebrates.

As the growing organism becomes more and more complex, its progress is more and more gradual. We have seen how the germ passes, almost at a single step, from the gastrula to the rudimentary vertebrate stage; but, after the mammalian stage is reached, it moves with deliberation through various lower embryonic forms of the class mammalia, till the human type is fully developed. At birth even, differentiation is far from being complete; not only do the several human races differ materially in shape and size of skull and in weight of brain, but there are also wide possibilities of difference among individuals of the same race and even between members of the same family. Exceptional characters are not recognized in their cradles; on the contrary, growth and differentiation continue till full maturity is reached, lifting the inventor, the philosopher, and the creative genius as far above the average human being as the average human being is above the chimpanzee.

In order to illustrate the relations to each other of the different grades of animal life, Haeckel employs the figure of a tree, which is intended to exhibit the probable lines of evolution of the entire series of animal forms continued through vast geological periods; and it is a fact of the utmost significance that this tree serves equally well as an illustration of the plan and progress of *human embryonic development*, thus indicating that the life-history of every human embryo is a recapitulation, in brief, of the history of the development of the whole animal kingdom. The base of the trunk of this tree represents the lowest, i. e., the most simple of animal forms—those which the human germ so closely resembles after fertilization, before development has begun.

The roots of this tree have not been represented by Professor Haeckel; but the supposition that, like the roots of other trees, they are concealed in the inorganic crust of the earth, is necessary to the completeness not only of the figure, but of the theory which it is intended to illustrate; I have therefore ventured to make this addition in the copy of Haeckel's figure which is before you.*

Ascending by a single step, the lowest branches represent those organisms in which the first developmental change has occurred, the amœba, it will be remembered, showing its superiority to the moner in the possession of a *nucleus*.

From this point the trunk is carried upward through the various stages, giving off large branches which thereafter pursue separate paths of development in different directions. These groups, in their turn, subdivide; and while at each step the divergence is a gentle one, it nevertheless leads farther and farther away from the common type with which the process of differencing began; like the terminal twigs of any widely-branching tree which, though closely surrounded by other twigs, are far removed from the common trunk, and still more widely separated from those branches which have developed on the opposite side.

This tree is one which bears all manner of fruit; but, as all the

* The lecture was illustrated by drawings.

branches of a tree receive the life-supporting sap from a common trunk, so all living forms have a common origin in protoplasm with which the evolution of their life begins ; the entire growth and development of the body consisting in the growth and differentiation of the protoplasm of which its tissues and organs are composed.

Observe how admirably the figure of a tree exhibits the supposed relationship between the various types of animals both extinct and living ; indicating, not that each type has been derived directly from one immediately preceding it, either in time or in structural rank, but that various types have had a common ancestor from which, by development in different directions, all have more or less diverged ; so that the relationship between man and the existing anthropoid apes, for example, is that of remote cousinship rather than of direct descent. The common stock is represented by the trunk of the tree ; from this trunk, which rises higher and higher with each diverging offshoot, has sprung an immense variety of branches ; and, at the very pinnacle of this magnificent structure, man appears—the crowning efflorescence of organic evolution.

The permanent types which represent these various phases of embryonic development show a progressively increasing differentiation from their environment. The moner and the amœba are almost as structureless as the water in which they are found, consisting of little more than water with a trace of albumen ; in specific gravity, in temperature, in color, etc., the difference between these low organisms and their environment is slight. Compared with the differences—chemical, physical, and structural—between man and the invisible atmosphere in which he is submerged, the contrast in this particular is a striking one. This leads us to other considerations of still greater significance.

The true environment of any organism consists in as much of the external universe as that organism is capable of holding communication with ; so that, as the life becomes higher, the environment also becomes more complex.

At the deep-sea bottom, where life is exhibited in its most simple grades, the temperature is unvarying ; no light penetrates to those depths ; a uniformity of conditions is thus preserved almost unbroken, and the adjustments necessary to the continuance of life under such circumstances are as trifling as the grade of life is simple.

By the greater complexity of the human organism as compared with other animals, man is brought into communication with and under the influence of a vastly increased variety of external conditions, mainly through the organs of the special senses and their intimate relations with a highly developed nervous system.

That without the eye and its connections with the brain we could have no consciousness of light is the merest commonplace of physiology ; yet, could we realize the full meaning of this and other similar facts, we should be near to an understanding of the difference between a high and a low organism; the life is high when there is a high degree of correspondence with a highly complex environment.

Poets have understood this principle better, perhaps, than physiologists.

"Who has no inward beauty none perceives,
Though all around is beautiful"—

says Wordsworth; and Coleridge—

". . . We receive but what we give;
And in our lives alone does Nature live!"

Emerson also embodies this whole philosophy in a single illustration: "The sea drowns both ship and sailor, like a grain of dust, and we call it fate; but let him learn to swim, let him trim his bark, and the water which drowned it will be cloven by it and will carry it like its own foam—a plume and a power."

When we remember that our environment consists, not only of the natural elements of earth and sky, reaching to the most distant star which communicates its vibrations to our atmosphere, but that it also includes other human beings with the influences which such an environment involves, we realize that, while physiology undoubtedly rests on chemistry and physics, it also includes psychology and reaches far toward sociology—sciences which involve the highest problems of our existence; and, though we find it impossible to sink our plummet to the depths of this ocean, or to send an arrow to the stars which gem the arching dome above, we may at least hope to gather a few shells on the shore of the one, and to intercept some gleams of light from those distant suns which fascinate by their very distance, and make glorious the night of our intellectual darkness even.

How, we next inquire, does the human embryo differ, at the progressive stages of its evolution, from the embryos of the various lower types which it successively resembles? Whence the impulse of development by which it rises from these lower levels to the human plane? In reply to these questions we can only refer to the principle of *heredity* which, though it imprints upon the germ no trace discoverable by any known test, unfailingly molds the plastic protoplasm into certain prescribed and prearranged forms, with their accompanying capacities and powers. The inherent forces by which one germ develops into an oak and another into a trailing vine, one into a mollusk and another into a man, are handed down from generation to generation, so that each plant and animal reproduces its own kind and not some other kind. This can not be regarded, however, as an exceptional fact; the production of the germ with all its hidden possibilities, like every other differentiation of matter, depends upon the general principle known as the *persistence of force;* and to deny that the power of development of any grade of life is inheritable is to deny the persistence of force *—a doctrine which lies at the very foundation of the stately edifice of modern science.

What is there in the whole stupendous drama of evolution, as conceived by the most enthusiastic supporters of the hypothesis, more wonderful or more difficult of comprehension and acceptance than these facts of embryonic development at which we have briefly glanced?

By the simultaneous processes of growth and differentiation, by a gradual increase of complexity and heterogeneousness continued through a considerable period of time, a microscopic speck of apparently structureless protoplasm, undistinguishable by any known test from the germ of any other animal, develops into the most highly endowed organism of which we have any knowledge.

And through what agencies are these remarkable results accomplished? Besides the inherited impulse of growth and development already referred to, there is furnished to this germ a due supply of ready-prepared food; a certain uniform temperature is also secured to it until the time of birth. After that period, its environment becomes gradually more complex; but embryonic development does not differ essentially from the continued development of infancy, childhood, and youth, by which the adult state is reached. The minute speck of simple protoplasm which constitutes the human organism at the beginning of its career is as truly an independent individual as it ever becomes. At this, as at every subsequent stage of its existence, its life and growth and progress depend on the activities of its own tissues, brought into play by the influence of external forces. Then, as always, it receives food from its environment; while the appropriation and assimilation of this food, as well as the elimination of the products of disintegration and waste, are accomplished by means of the same processes of absorption, chemical combination and decomposition, which constitute nutrition at all periods of existence. The embryon lives its own life—a work which can not be delegated to another.

Our next inquiry is in regard to the forces manifested by living bodies. What are the relations between the highly developed varieties of protoplasm which constitute their different tissues and organs and the remarkable functions—muscular action, emotion, volition, etc.—peculiar to animal organisms?

This question will be best answered by means of a familiar illustration. By an appropriate combination of valves and pistons, of wheels and levers, and numerous other contrivances put together in strict conformity with the principles of mechanics, in which the most delicate allowances are made for unavoidable friction, and the attraction of gravitation is either annihilated by counterbalancing weights or turned to account as a source of power, a machine is constructed which strikingly illustrates the importance, not only of the particular

* See "Principles of Biology," Herbert Spencer, vol. ii.

character of the different parts of which it is composed, but of the *relations of these parts to each other.* The force operating such a machine may be derived from a simple fall of water, or from the oxidation of burning anthracite; but, although this may be the sole source of the actual energy expended, it is far from being the only factor concerned in the production of the special kind of work accomplished. The results are due to the transformations of this initial force into force of other kinds, the character of the work done depending on the peculiar construction of the machine—in other words, on the relations of its parts. Thus the expansive power of steam may be expended in the idle clapping of the lid of a tea-kettle, or in the driving of the piston in the engine of an ocean-steamer, according to the relations into which the steam is brought. Keeping this illustration in mind, we may perhaps attain to some conception of the meaning of a living organism, and wherein consist the differences in different organisms.

The life-processes are concerned in the building up of the tissues—that is, in the construction and constant repair of the mechanism out of materials supplied by food; coincident with this assimilation of new material, there is a corresponding accumulation of energy or force. The energies *liberated,* on the other hand, in the activities of muscle, nerve, brain, etc., come from the oxidation—the so-called waste—of these tissues; and (as in the machine) the results produced are due to the transformations of this initial force, derived from oxidation of the tissues, into other kinds of force, viz., those manifested by living animal organisms, the character of the work done depending (as in the illustration) on the particular construction of the mechanism concerned. In the operations of living organisms, not less than in those mechanisms whose motive power is derived from steam, not a known law of matter is violated, but all are wrought into a harmony so complete that the entire complex and heterogeneous structure acts as a unit.

Glancing in thought over the vast expanse of matter of which the universe consists, what has been the direction of the progress witnessed through the long ages since the beginning condensation of the nebulous masses in which our solar system is believed to have originated? The immense globes which whirl in repeated circles through the heavenly spaces, though bound together by the strongest and most subtile bonds, roll blindly on, forever unconscious of themselves and of one another. The lily of the field even, clothed in beauty though it be, and surrounded by the greater glories of earth and sky—the warm sunshine and green fields—has no conscious enjoyment of itself or of them; but as elements identical with those which compose these unconscious forms have combined and recombined in compounds of increasing complexity, as molecules have condensed and differentiated in the development of a higher kind of living matter, *consciousness* has dawned, and (mainly through the avenues of the special senses) *mind* has developed. Each generation, heir to the endowments of all preceding ones, has added its increment of gain, and later generations—those which belong to the historic period—have begun their lives with a vast amount of inherited intelligence. There is sound philosophy in the statement once jocosely made, that the natives of a certain part of the country, remarkable for their intellectual activity, are born with a good common-school education. By far the greater part of our education is indeed born with us.

Increased refinements of emotion, clearer subtilties of thought—these are the directions which further development of the race must take; and the individual who experiences a hitherto unrealized emotion, or who grasps a new thought which corresponds with some never before observed fact or relation in the external world, is the seat and center of progress. In such minds, nature is undergoing a still higher evolution, and the colors of humanity are thus successively planted on hitherto unscaled summits.

COLLEGE ATHLETICS.

BY EUGENE L. RICHARDS.

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II.—EVILS AND THEIR REMEDIES.

WITH regard to the evils of the present system of college athletics it must be remembered that the best system will not be free from all evil. No human system can be free from evil. Even the divine government of the world does not exclude the existence of evil. That the present system has evils is no valid argument against it, unless it can be shown either that these outweigh the good, or that some other practical system can be devised which shall have all the good with less of the evil of the present system.

1. One evil alleged against the present system is the excessive amount of time required for exercise under it. It is no doubt true that some students do give too much time to athletics. Some students also give too much time to study; yet that fact is not brought forward as a fatal argument against the college course of study. Of the two excesses—excess of study and excess of exercise—the dangerous pressure at present is toward excess of study. But, in point of fact, this evil of too much time given to athletics has been greatly exaggerated. The winter term is not open to the charge of excessive athletics. The athletes then training do not devote an average of more than an hour a day to exercise. Perhaps a few give an hour and a half. It would be safe to say that, counting all the time consumed, including the time

of exercise, the time used in going to and from the gymnasium, and the time used in dressing and undressing, it would not go beyond two hours per day, and in most cases would be less than that amount. So, to consider the question of excessive time, we must look at the fall and spring terms. In the fall, during days when afternoon recitations are held, the class nines do not spend more than two hours' time altogether, including both practice in the field and the time of going to and from practice. The same may be said of the Foot-ball and Lacrosse Teams. On Wednesday and Saturday afternoons the students give from two to three hours to practice. On these afternoons the match-games occur. They are prohibited on other days, except during examinations, at which time they are allowed on any day, provided no player is thereby prevented from attending his examination. The crews, also, in practice on the water and in going to and from their boats, spend two hours daily. On Wednesdays and Saturdays they use more time, but the practice is so arranged as not to interfere with recitations.

In the summer the same amount of time, daily, is given to practice, except that, when recitations cease and examinations begin, the University and Freshman Nines use more time. Even then that time will not average more than three hours per day. When match-games are played out of town, to the time of the game must be added the time used in travel to and from the scene of the match. In the season of 1882, of the games played during the time when recitations or examinations were being held, only five were played out of town by the Yale University Nine, though the men went out of town once or twice more but were prevented from playing by the rain. Of these five, three were played in New York city, which is only a little over two hours' ride from New Haven. Of the remaining two, neither needed more than thirty-six hours' absence from town.

The University Crew row only one race a year. The Foot-ball Elevens and the Lacrosse Team play a few games out of New Haven, but do not use in this way as much time as the Nine.

2. It is said that the excitement attendant on these sports distracts from study. It is true that the contests do furnish excitement for the students, but it is excitement of a healthy kind. Athletic sports do not divert so many from study as the theatre and billiards. Banish athletics, and you increase the attendance at the theatres and the saloons, where the temptations are greater, and the excitements less healthy than those of the ball-field and boat-race.

3. There is the evil of betting. This is not an evil peculiar to athletics. The men in college, who are in the habit of betting, would continue to bet on something else, if not a game were played nor a race rowed. Gambling would increase if the athletics were prohibited. Games and races in colleges do not create betting. They simply divert it from other channels.

4. Then there are the disorders consequent upon victories. These disorders are sometimes quite serious, but are by no means so serious as they are often represented to be. On the campus such disorders have never been more serious than some disorders taking place after the conferring of degrees. They have always been easily controlled. They have been avoided when the college authorities have given notice that a recurrence of them would imperil the existence of the athletic organizations, or annul the permission to play match-games. These disorders, then, can not be a necessary and inherent evil of athletics.

It may be replied that disorders consequent upon victories are not confined to the college campus. Indeed, to the minds of many candid men, the great disorders which bring dangerous disgrace to the present system of college athletics, and reflect upon college government as well, occur at the intercollegiate contests, when the athletes meet on neutral ground. Such men admit the advantages of the system. They would encourage it in the separate colleges, but would have it go no further. They would abolish intercollegiate contests altogether. But this action would do away with the very element (healthy rivalry between colleges) which is the most effective motive power and stimulus of the whole system. Without this element the system would go to pieces in many colleges. In others it would be miserably contracted and inefficient. For this evil a more general interest in the subject on the part of instructors and parents, and their more general attendance at the games, would easily suggest the remedies of a healthy and manifested public opinion and a judicious personal influence.

5. It is charged against athletics that they benefit the few, and that these few are those least requiring the exercise. One part of the charge can be appreciated—that few are benefited—these few being the members of the Crew, Nine, Eleven, and Lacrosse Teams of the university. These, with substitutes, amount to about fifty men. But it has been already shown that more men are induced to exercise than the actual membership of these organizations; and that the present system affects, in the matter of exercise, at least half of the undergraduate department.

The objection, that the men under training in the university organizations are the men least requiring the training, can be understood to be one of two propositions, viz., either that these men have naturally so much power or skill that they need not develop any more, or that they will cultivate their strength and nerve without being stimulated to do so by the workings of the present system. This would be like arguing that men of great mental gifts either do not need an education, or would get an education without any opportunities being provided for this purpose in a school or college system—a proposition which, however true in exceptional cases, taken as a general statement no argument is required to prove absurd. Men of muscle do need exercise. Indeed, it may be said that they must have exercise. The more systematic such exercise is, the better their brains work, as observing instructors of such men will testify. The reason is plain. They enjoy better health. The men who suffer most from the confinement of student-life are the men of vigorous bodies. Their vital force is like a flame. It must be fed with oxygen. Many of them, without the capacity of self-control, and without the health which they gain by exercise under the present system of athletics, would never be able to graduate. Many others would graduate with impaired bodily powers, and others still as slaves to habits of dissipation.

6. It is said, again, that the system may develop men, but it only makes fine brutes of them, and sets before the college a false standard of excellence, viz., one entirely physical. It can not be said with truth that the standard is false. The standard of good scholarship remains, and many of the athletes take high rank in scholarship. The standard of good conduct remains. The students still respect their fellows who approach these standards, yet they think no worse of a man, but rather better of him, and rightly, too, if he be a thorough man, and have a manly body as well as a good mind and upright character. Other things being equal, the bright mind and good heart in a strong body are better than the same things in a weak body, because they can accomplish more in life.

It is further said that the applause bestowed upon some feat in any of the athletic contests helps to establish some boy in the conceit that he is a great man, because he can do such things, and that, therefore, study is of no further use to him. There may be such youths, but, whatever be their fate at other colleges, they seldom appear at the college with which the writer is connected, and when they do appear do not stay.

7. The evil of a general nature last to be considered is that of expense.

The expenses of the organizations which have special university representatives are only taken into account, since these are the organizations of which the evils have been so loudly proclaimed to the public. In the table given below (for Yale College), the "expenses" and "income" are the totals for both university and class clubs combined. For base-ball, foot-ball, and Lacrosse, the amounts in the column headed "Earned" are made up for the most part of gate-money taken at exhibition-games. For the boat clubs, of the amount put in the same column, $1,045.36 was the net result of a dramatic entertainment given by the students for the benefit of the university club. The balance was obtained from entrance and carriage fees at regattas, renting of lockers, and sale of boat.

CLUBS.	Expenses.	INCOME.			
		Total.	Balance from 1881.	Earned.	Subscribed.
Boat.......	$7,348.86	.$7,426.52	$177.54	$1,322.11	$5,926.87
Base-ball...	6,863.38	7,254.15		5,457.15	1,797.00
Foot-ball...	2,689.80	2,792.36	$1,080.71	1,329.65	382.00
Lacrosse....	574.00	575.00		225.05	349.95
Total.....	$17,476.04	$18,048.03	$1,258.25	$8,333.96	$8,455.82

It will be observed that the total amount subscribed is less than half the expenses. Two hundred and ninety dollars of this sum was given by graduates. Deducting this, and considering that, according to the catalogue of 1881–'82, there were, in the undergraduate academical and scientific departments, seven hundred and eighty-six students, the cost (above earnings) of the present system averages only a little over ten dollars per man. As all departments are benefited by the system, the average ought to be taken for the whole university. There being in the university over one thousand men, the average cost per man would be considerably less than ten dollars. It will be said that part of the earnings come from the students, since they are the chief attendants at the game. This is true. Assuming that half the earnings come from the students (an amount probably in excess of the real amount), the average cost per man for the university will not be far from twelve dollars. Fifteen dollars per man would undoubtedly cover the whole cost of athletics throughout the year, counting not only the athletics represented in the table, but all other kinds as well. Certainly this does not seem an extravagant sum to pay for the benefits derived from the system. The writer believes that the expenses can be very much diminished. The tendency to unnecessary increase of expenses can certainly be diminished by measures hereafter noticed.

By the table, it will be seen that the subscriptions for base-ball and foot-ball were small in amount as compared with their earnings. It is generally believed, among students, that the university organizations of both these sports can be made self-supporting.

The evils already commented on are general. There are other so-called evils which are special—some peculiar to one kind of athletics, but not belonging to the others. One of these, charged against base-ball, is that the game brings the students into contact with "professionals." Whatever may be the extent of the evil in other colleges, at Yale it has not proved to be so great as to call for Faculty interference, or even to excite apprehension. All the evils, real or imaginary, connected with ball-playing, are reduced to a minimum when the students meet "professionals." They meet them simply for practice. Betting is, as a rule, precluded by the fact that the result is generally a foregone conclusion, and men bet on only doubtful issues. Off the field there is no more intercourse between the students and the "professionals" than is necessary to transact the business attending the match. The professional nine are then generally represented by their business manager, and the students by the president or treasurer of their club. In the game one nine is in the field, while the members of the other are at the bases, or waiting for their turn at the bat. The "professionals" are under the strictest discipline, so that their presence does not invite or occasion dissipation in any form. Victories of college nines over "professionals" are not frequent, and are not attended by disorders on the campus.

But to some objectors the evil of "professionalism" in athletics includes more than playing with professional nines. The employment of professional "trainers" in preparing students for contests is, for some, the chief evil. Such trainers are looked upon as bad companions for our young men. It is contended that they undermine the morals of our students by their profanity and generally low talk. They are also supposed to give too high a standard of excellence for our amateur athletes, and thus to draw on too much of their time and strength, in the effort to make them conform to this standard. All these things may happen in some cases, but they do not happen frequently. Admitting, for the sake of argument, what is generally denied by the students, that for the past two years the crew has been coached by the professional oarsman who rigged their boats, his coaching would have brought him into personal contact with not more than a dozen men at the most, and for a time of only three or four weeks in the spring and summer. For a short time in the winter some of the candidates for the university nine have exercises in boxing with a trainer, in order to bring them into "condition" for the spring and summer work. There can hardly be more than fifteen such men.

The only other really professional training done has been done for those who go into track athletics. This training lasts for about six weeks, and is given to some fifteen or twenty men. A "professional" has sometimes accompanied the foot-ball team when they have played their great matches, but his office has not been to train the men, but to apply his skill to limbering stiffened joints and healing bruised muscles.

It is quite natural that students, when taking lessons of any kind, should prefer the best masters. Unfortunately, the best masters are not always the best men. That the pupils are, therefore, always led into bad courses by the example of their instructors does not follow. There is enough good sense in college students generally to dissociate good instruction from faults of character. The trainer seldom influences the student beyond the purpose of his training. The young man does not make a companion of his trainer, nor trust his morals to his direction. An easy cure for possible evils in this direction would be for the faculty of each college, troubled by vicious trainers, to forbid their students employing such men. An investigation, however, into the relations between such trainers and their pupils would show that the pupils despise the lowness of the men quite as much as do the faculty themselves. Another and better remedy would be to select an amateur athlete from the graduates, educated as a physician, and give him a salaried office, with duties as general adviser and guardian of the athletic interests. Such a man, if properly qualified, would help the students to a safer and better physical development than they now get, and would, besides, soon drive away all trainers exercising improper influences among them.

In foot-ball there is no professional element. But it is charged against the game that there is danger in it to life and limb. Undoubtedly it is a rough sport, but year by year it is becoming less dangerous in consequence of the increasing strictness of the rules and the severity of the penalties against foul play. In the match-games these rules are generally so well observed that few accidents occur. In the games between Yale and Princeton, which have always been the most hotly contested, no man has been seriously hurt. It is a game which particularly requires courage, and is therefore a most manly game. It is like a battle with the danger not all left out, but a battle in which courage and self-possession not only secure victory but safety. With all its dangers it is less dangerous to the players than the confinement accompanying excess of study.

One great evil connected with athletics, and not generally receiving public notice or animadversion, is the excess of feeling between students of different colleges, occasioned by the intercollegiate contests. This excess of feeling seems akin to excessive class-feeling already noticed. It is partly due, no doubt, to the youthfulness of the parties. It is seldom entertained by the contestants. It is a strange fact that such feeling does not appear to exist between professional clubs, nor between professional and amateur clubs. In this matter, therefore, it would seem that the students might learn a good lesson from "professionals."

What the condition of the college would be without a system of athletics is a question already partly answered by what has been said in meeting the charges against the system. We can understand, also, the effect of abolishing the present system by calling to mind the disorders reported in colleges in which no such system is allowed to exist. The revolts against authority and the great disorders between classes now occur with the most frequency not at colleges which have the greatest number of students and the most extensive athletic organizations, but at the colleges in which the students either are not able or are not allowed to establish such organizations. The disorders which used to occur in New Haven thirty or even twenty-five years ago ought to convince any candid man that, however great the present evils of college-life are *with* athletics, the past evils *without* athletics were worse. On one occasion in those "good old times," in consequence of a conflict between students and town boys, a cannon was brought before the college buildings to demolish them. The writer remembers another occasion when there was a collision between students and firemen, and one of the firemen was mortally wounded by a pistol-shot. That night the dormitories were bolted and barred and the students acted like a besieged party, and were making preparations for a possible fight the next day. In those same good old times there were more frequent disturbances between classes. There were snow-ball fights, too, on the campus, to the great destruction of window-glass. According to the testimony of men in the college in those days, drunkenness was more common. Certainly within the last twenty years the college sentiment with regard to intoxication has undergone a change for the better. Before that period a student given to this vice did not neces-

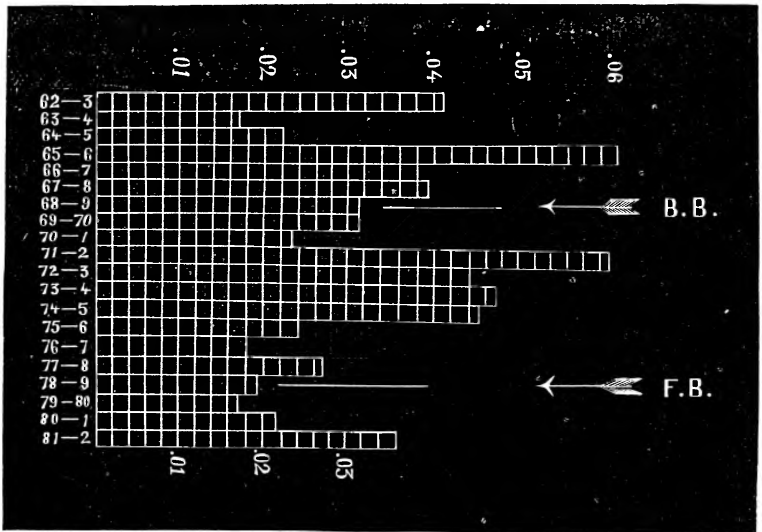

Fig. 1.

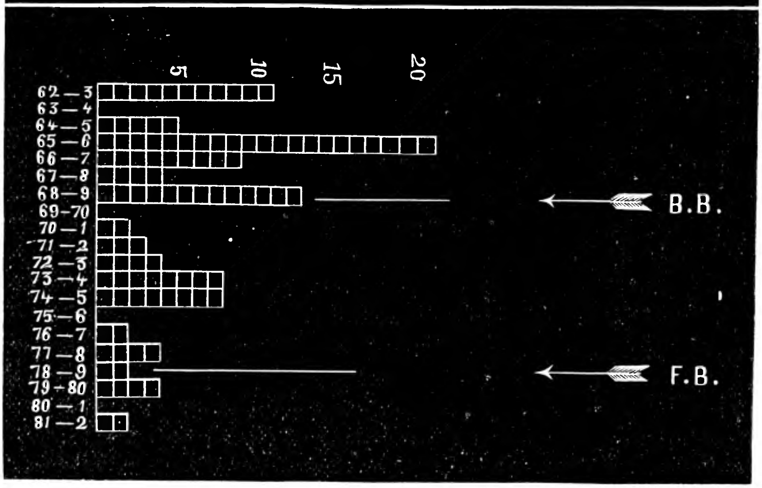

Fig. 2.

sarily lose caste among his fellows as he does at this day. The pressure of college opinion is against dissipation. It is absolutely necessary for the athletes to abstain from it. Being taught the evil effects of excesses upon their strong men, the university is not slow to see that intemperance is a wrong and an evil for all men.

As a contribution to this part of the discussion, the accompanying diagrams are offered, as bearing on the subject of disorders. The first diagram gives, for each year of the twenty college years from 1862–'63 to 1881–'82, the percentage of the number of men expelled and suspended from the Academical department of Yale College to the membership of that department. The numbers were taken from the Faculty records, and include expulsions for all cases of disorder; all dismissals and suspensions for disorders by day or by night; for drunkenness and for marks and irregularity. Each case counts as a unit without regard to the severity of the penalty. Had more weight been allowed to one case than another, it is not likely that the results would have been materially changed, as the severe punishments of expulsion and dismissal are infrequent. No account is taken of dismissals for scholarship, the writer for the present confining his investigations to the effects of athletics on college order. The percentages are arranged in vertical columns, one for each college year, the year being written under the column. Each square represents one fifth of one per cent (0·002). Thus, in 1862–'63, the cases of discipline were four and one tenth per cent of the total membership for that year. In the next year the cases of discipline were one and seven tenths per cent, etc. The average for the twenty years will be found to be about three per cent. For the first decade the average was a little more than three and six tenths per cent, and for the last decade a little less than two and four tenths per cent. Though a race between crews of Harvard and Yale was rowed as early as 1852, yet it was not until the summer of 1864 that the Harvard-Yale boat-race began to be the regular event which it has since continued to be. The first permission to play ball out of town was granted to the Yale Club in June, 1869, and the first permission to the Foot-ball Team was given in November, 1878. These permissions are indicated on the diagrams.

In the second diagram the expulsions, dismissals and suspensions for hazing, rushes, and attempted interference by members of one class with the liberty or property of members of another, are given by *numbers*. Each square represents one case of discipline. These cases, though already counted in forming Diagram No. 1, are represented in No. 2 by themselves, in order to make evident the fact that this particularly troublesome class of disorders is diminishing. The writer has already stated the reasons of his belief that the diminution of them is due in great measure to the influence of athletics.

In the opinion of the writer, the diagrams show that, whatever may be the public impression, the real facts, as evidenced by the Faculty records, are, first, that the college disorders, as a whole, have not increased since the introduction of athletics ; and, second, that one class of disorders has sensibly diminished. Of course, other influences have contributed to bring about these results. Still, even if the claim in behalf of athletics of a special influence for good in this respect be not allowed, it can not be fairly said that the evil effects of the system are such as to overpower all the other good influences.

As to those evils which are capable of remedy, and of which the remedy has not been before expressed or implied, we will take up that of unnecessary expense. It has been before shown that the expense of the system is not enormous, considering the good done. But undoubtedly it is greater than it need be. Moreover, it will naturally tend to increase. Still, it is well to remember that, as the number of athletic organizations increases, the increased subscriptions demanded of the students begin to waken some of the thoughtful among them to wiser discrimination in their giving, and to a sharper watchfulness of the management of the associations to which they do give. Consequently, new care in the spending of money is required of each university organization, and a healthy suspicion on the part of the students is developing itself. In other words, each athletic interest begins to act as a check on the extravagance of the others. Still, money is inevitably wasted, in consequence of the inexperience of the young men. Each officer, as a rule, serves but a year, when he makes room for a new officer, who is as inexperienced as his predecessor. The experience gained each year might be made serviceable by associating with the incoming treasurer a permanent graduate treasurer. The vice-president might be elected to become president as soon as the year's service of the president expired, so that he would serve as vice-president one year and one year as president, his service thus extending over two years. It has also been proposed to consolidate the athletic interests under one salaried superintendent, who should be a graduate. The objection to this plan is that, though it might secure a more consistent and economic management, it would destroy the present healthy rivalry of the athletic interests, and relieve the students themselves of the responsibility of success or failure. Besides the changes suggested, a general auditing committee for all the interests should be formed consisting of graduates and undergraduates. At present, though the accounts of all the interests are published, yet nobody feels it his particular business to object to any one item. If a graduate finds fault, his complaint is not worth much, as only undergraduates are supposed to know the needs of to-day. A committee of both graduates and undergraduates could audit the accounts, and would be able to make suggestions which would be sure of a hearing. By such changes in the system and the economies which ought to result from them, field-sports, such as base-ball, foot-ball, and lacrosse, should be self-supporting. The income derived from gate-money should meet the expenses.

Since some very worthy people who believe in manly sports object to young men playing for money taken at the exhibition-games, it is necessary to say a word of explanation with regard to this feature of all ball-games. If field athletics are to continue, the expense of them must be met in one of two ways, either by gate-money or by subscription. Most young men prefer to give their money at the gate, and thus to pay for what they see. If a club knows that it is to spend only what it earns, it will be stimulated, first, to play as good a game as possible; and, secondly, to spend its earnings with prudence. It seems only just, too, that, if the public desire to see a good game, they should pay for the exhibition. The men work hard in practice, and are entitled to have their expenses paid. More than that they do not ask. They do not play for gain, but for honor. By their rules, they do not allow any man to be a member of their organizations who has earned money as a professional.

The evil of liability to strains and injuries in athletics can not be entirely obviated. It is well to bear in mind, at this point, the fact that even those who are not athletes do not, therefore, enjoy immunity from accidents. Yet, so far, according to the recollection of the writer, no regular member of a Yale Crew, Team, or Nine, has been permanently injured by participating in a race or match. Still, it is possible that a slight injury, to a person having organic weakness, might result in a fatal difficulty. Such an issue might be avoided by the requirement that every candidate for trial should be examined by a competent physician, and, in default of procuring a certificate of physical soundness, should be excluded from participation in athletic contests. Besides this, every candidate for a place in a crew should be debarred from entering a race unless he had mastered the art of swimming.

If, moreover, the Faculty of every college having a system of athletics would exert a sympathetic as well as a judicious oversight of the students interested in the system, they would find the young men quite willing to listen to friendly suggestions. If, also, the times of recitation were so arranged that a proper amount of time could be devoted to exercise without interference with study, more brain-work, and of better quality, would be secured than by the policy prevailing in some colleges, according to which, not only no encouragement is given to athletic sports, but, on the contrary, every obstacle is thrown in their way.

The college which neglects or ignores physical culture may send out scholars, but it will not educate forceful men. It will not be the living power which it might be. Truth is not to prevail by the dry light of intellect alone, but through the agency of good, wise, and strong men.

GREEN SUNS AND RED SUNSETS.

By W. H. LARRABEE.

THE whole world enjoyed, during the closing months of 1883 and through January, 1884, the spectacle of a succession of sunsets and sunrises marked by a brilliant, gorgeous red coloration. The phenomenon, if it had been only for a day or two, might not have excited any particular remark, for in the United States the sight of a brilliantly-colored sunset is not at all unusual; but when it was found to be continuous for months, and to extend to every part of the earth, the impression became nearly universal that something uncommon was going on in our atmosphere or in space. The phenomenon apparently reached its culmination about the 27th of November, when the western sky was illuminated for more than an hour after sunset by a lurid glow, as of some great conflagration; and in many places the public thought it actually was the mark of a fire, while in some towns fire-alarms were sounded. The phenomenon first began to excite attention in the Eastern States at about the time of its brightest manifestation, in the last days of November. It was, however, remarked on the Pacific coast about a week earlier; in Europe early in the month; and at points in the Indian and Pacific Oceans as early as September. Among the earliest published mentions of it were those from the islands of Rodrigues, Mauritius, and Seychelles, August 28th, Brazil, August 30th, New Ireland, September 1st, the Gold Coast, Africa, September 1st and 2d, and one that was made in connection with the observation of a "blue sun" at Trinidad, September 2d, when, after dark, says the report, "we thought there was a fire in the town, from the bright redness of the heavens." At Ongole, India, after the sun had set, green, "light yellow and orange appeared in the west, a very deep red remaining for more than an hour after sunset"; whereas under ordinary conditions all traces of color leave the sky in that latitude within half an hour after the sun disappears. Captain Rolland, of the French *Messageries* steamer Saghelien, passing from near King George's Sound, Australia, to the Island of Réunion, observed, from the 25th of September to the 12th of October, a red light around the sun, which became more pronounced at sunset, and persisted for a length of time after that hour in proportion as the ship was in a higher latitude. "The colored part of the sky, which was at times extremely lively, had, about a half-hour before sunset, a very considerable surface, extending to a distance of forty-five degrees from the sun." The same coloring was seen in the morning. A correspondent writing from Wailuku, Sandwich Islands, to the "Hawaiian Gazette" of October 3d, speaks of the "most extraordinary" sunsets they had been having for some time past, "fiery red, spreading a lurid glare over all the heavens, and producing a most weird effect." The Attorney-General of West Australia wrote to Dr. J. W. Judd, October 27th, describing the same glow; and a letter from Umballah, India, October 30th, says: "There has been for some time a remarkable appearance in the sky every night. The sun goes down as usual and it gets nearly dark, and then a bright red and yellow and green and purple blaze comes in the sky and makes it lighter again. It is most uncanny, and makes one feel as if something out of the common was going to happen." The writer of this article has noticed from his own windows the interval of darkness between the setting of the sun and the appearance of the glow remarked in the letter.

The earliest observations of the glow in Europe appear to have been made about the 9th of November, after which time references to it and descriptions of it abound in the scientific and other journals. These descriptions agree with each other as to all essential features, and might be as well applied to the phenomenon as seen anywhere in the United States. The sky is generally spoken of as cloudless where the glow has appeared, although a few observers speak of light cirrus clouds floating in the air or passing over the sun or near it; and one observer at Ootacamund, India, mentions a green cloud that passed over the sun's disk, followed by a red one.

The red light is regarded by those who have paid most attention to the subject as associated with the blue or green sun which was observed in many parts of the East Indies early in September. It was noticed at Manila, in the Philippine Islands, on the 9th, when, during a "light dry mist," "the sun appeared colored green and diffusing over all the bodies it illuminated a strange and curious greenish hue, to the great terror of the islanders"; at Colombo, Ceylon, on the same day, when the sun, about forty minutes before setting, emerged from behind a cloud of a bright-green color. The whole disk was distinctly seen, and the light was so subdued that one could look steadily at it. The moon was also, to some extent, affected in the same way. A correspondent of the "Ceylon Observer," writing on September 12th from Puleadierakam, states that no light came from the sun, although it was visible, until nearly seven o'clock in the morning, and adds: "For the last four days, the sun rises in splendid green when visible—that is, about 10° from the horizon. As he advances he assumes a beautiful blue, resembling bnrning sulphur. When about 45° high, it is not possible to look at the sun with the naked eye; but, even when at the very zenith, the light is blue, varying from a pale blue early to a bright blue later on, almost similar to moonlight even at midday. Then, as he declines, the sun assumes the same changes, but *vice versa*. The heat is greatly modified, and there is nothing like the usual hot days of September. The moon, now visible in the afternoon, looks also tinged with blue after sunset, and as she declines, assumes a most fiery color at 30° from the zenith."

At Madras, India, Professor C. Michie Smith, of the Christian College, remarked the "perfectly rayless" and bright silvery-white color of the sun on the 9th of September. The same was noticed on the next day, but was succeeded, after the reappearance of the sun from behind a cloud, by a bright pea-green color. This peculiar color was again observed the next morning, and in the evening it "was a magnificent spectacle, and attracted the notice of every one. The silvery sheen was visible early in the afternoon, and the brightness of the sun rapidly faded, till by about five o'clock one could look at it directly without any difficulty. At this time there was a distinct tinge of green in the light when received on a sheet of white paper, while shadows were very prettily tinted with the complementary pink. As the sun sank toward the horizon the green became more and more strongly marked, and by 5.30 it appeared as a bright-green disk, with a sharp outline. In fact the definition was so good that a large spot (about 1′ long) was a conspicuous object to the naked eye." The green suns were also seen for several days about the 22d. The spectrum, which Dr. Smith carefully examined, "showed clearly that aqueous vapor played a large part in the phenomena, for all the atmospheric lines usually ascribed to that substance were very strongly developed. But in addition to this there was a very marked general absorption in the red." Abnormal electrical conditions of the atmosphere were noticed at this place in connection with the phenomenon. Of an earlier date than any of these observations is a notice of a "green sun," remarked at Panama on the 2d and 3d of September, the same day on which a blue sun and lurid sky were observed at Trinidad.

The appearance of the green color in the sun and in parts of the sky outside of the sphere of the red glow was also remarked in numerous observations made in Europe. In one of the earliest notices of the spectacle published in England, the writer says that at sunset "a very peculiar greenish and white opalescent haze appeared about the point of the sun's departure, and shone as if with a light of its own, near the horizon. The upper part of this pearly mist soon assumed a pink color, while the lower part was white, green, and greenish-yellow." Another observer, at Worcester, describes the blue of the sky as having been changed to green and the green as being speedily replaced by the ruddy tint; and again, in the morning, "the color of the sun changed to an exquisite emerald hue, staining the landscape, and investing houses, buildings, glazed windows, and greenhouses with a remarkably weird aspect." At sunset of the same day, "the crescent of the moon, being just above the fringe of red light, assumed a lively green hue, and continued to exhibit the novelty of an emerald crescent" for a quarter of an hour. At other places, we read of the contrast of the glow with "the pale greenish hue of the clear sky around"; of a crimson arch stretching from southeast to northeast, "with a very clear greenish-blue sky beneath it in the east," and between the arch and the western horizon "a sky of a bright silver-white color, which was so brilliant that it gave us quite a second daylight"; at another, of the sky nearer the zenith appearing "of a sea-green tint." The sea-green tint in the east was observed at Rome; and at Berlin, according to Herr Robert von Helmholtz, there was "a greenish sunset at 3.50, an unusually bright-red sky with flashes of light starting from southwest. An interesting physiological phenomenon which recalls 'Contrast-Farben' was there beautifully illustrated by some clouds, no longer reached by direct sunlight; they looked intensely green on the red sky." The whole phenomenon was exhibited, according to Mr. J. Addington Symonds, with remarkable intensity at Davos-Platz in the High Alps; and on one occasion "the whole north-eastern region of the heavens was at the same time of the most vivid golden-green — the peculiar green of chrysoprase and some highly-tinted beryls. Each tone of light, rose and green, was reflected on the long, broad basin of valley snow, the blending of both colors being of a strange, bewildering brilliancy." The sun, at this place, appeared through the day "surrounded by a luminous, slightly opalescent haze —not at all resembling halo or iridescence of vapor."

The red glow and the green sun are most likely due to a common cause. The same medium which will give by transmitted light a green color to objects viewed through it, will, by the universal law of the absorption and reflection of light, reflect the red rays. The close connection of the two phenomena may be regarded as real.

The spectacle must be due to some peculiar condition of our atmosphere, for, if it was produced by any cause outside of the atmosphere, it would have been visible in some form through the night, whereas its duration corresponded tolerably closely with that of ordinary twilight; the cause must have been co-extensive with the atmosphere, for the glow lasted as long as the twilight, if not longer. The manifestation was not auroral or electrical, for no auroras have been seen which could reasonably be associated with it, and no electrical disturbances have been mentioned in connection with it, except at Madras. Professor Michie Smith, of Madras, and Professor C. Piazzi Smyth, believe that it is the result of peculiar conditions of vapor in the air; but, while this might easily account for colors lasting a few days, it is difficult to suppose a peculiar accumulation and distribution of ordinary vapors enduring for so long a period. Nevertheless, Mr. Lockyer has seen the sun green through the steam of a steamboat; it has been seen green through the mist of the Simplon; and Mr. Henry Bedford, describing the summer sunset and sunrise just within the Arctic Circle in July, 1878, in an English magazine of that year, said: "The color brightens, and some small streaks of clouds grow brighter and brighter, until the sun—the GREEN sun—appears. A distant low range of rocks comes between us and its point of rising, and, as we glide on, an opening between them shows us the sun, a bright emerald, as pure and brilliant as ever gem that glistened; again we lose it, and again an opening shows it to us in its own golden light; and then once more it is the bright green; and now it rises higher, clears the ridge, and is once more the golden orb." The Rev. G. H. Hopkins, of Cornwall, England, has observed that in a clear sky, as the disk of the sun sinks down beneath the horizontal line of the ocean, the parting ray is of a deep emerald green. The effect is not produced if there are clouds around the sun. Dr. F. A. Forel, of Morges, Switzerland, mentions as a fact confirmatory of the opinion that meteorological factors alone can not furnish a sufficient explanation of the phenomenon, that in Switzerland the glow, after having decreased subsequently to the 3d of December, attained a second maximum on the 24th and 25th of the month, when the atmospheric conditions were quite different from those which prevailed in the country at the time of the first maximum.

The hypothesis that the spectacle was caused by the presence in the atmosphere of a cloud of "cosmic dust," which the earth has encountered in its travels, has been advanced by several observers, and is supported by Mr. Proctor. Mr. Nordenskiöld and other men eminent in science have taught us to believe that a meteoric dust falling upon the earth from space plays a much more important part in terrestrial economy than we have been accustomed to suppose; and they have collected, in uninhabited countries and far away from any volcano, quantities of dust—little rounded particles of metallic compounds—unlike anything the earth is known to produce, and strikingly like what meteors of that size would be. Investigating whether an unusual quantity of such dust is now falling upon us, Mr. W. Mattieu Williams has found it in carefully selected snow from his garden. M. Émile Yung, of Geneva, has also found an extraordinary quantity of a similar dust in fresh snow that fell in the latter part of November and early in December on the steeple of the cathedral of Saint-Pierre, at "les Treize-Arbres," Mont Salève.

Numerous suggestions have been made that the phenomena are the result of the diffusion through the whole atmosphere of the entire earth of ashes and cinders from the eruption of the volcano of Krakatoa, in the Straits of Sunda, which took place on the 26th of August last. This theory has the support of Professor Lockyer and other eminent men of science, and there is much to be said in favor of it. The principal objections to it are summarized in a remark by Mr. Proctor, "that we should have to explain two incongruous circumstances: first, how the exceedingly fine matter ejected from Krakatoa could have so quickly reached the enormous height at which the matter producing the after-glow certainly was; and, secondly, how, having been able to traverse still air so readily one way, that matter failed to return as readily earthward under the attraction of gravity." It will not do to limit our ideas of the effect that may have followed the eruption of

Krakatoa by our knowledge of what has followed any other volcanic eruption ; for the outburst at Krakatoa far exceeded in violence any event of the kind that is remembered in the history of man. Mr. W. J. Stillman, formerly United States consul in Crete, who has witnessed the explosions of two eruptions of the submarine volcano of Santorin, and has seen masses of rock weighing many tons thrown from a half a mile to a mile, and escaping gases expanding, after two seconds, into huge masses of cloud, at an elevation of from six to ten thousand feet, and then drifting away with the wind and dropping volcanic dust in its course, believes that on the enormously greater scale of the Krakatoa explosions the dust could have been thrown to the top of the atmosphere, there to drift over the whole earth ; and he suggests that at such a height the distribution might be effected in twenty-four hours by a single revolution of the earth. Mr. Proctor's second difficulty is met by Messrs. Preece and William Crookes, who suggest that very finely divided particles of dust having an electrical charge of the same sign as that of the earth, may be kept suspended in the upper air for an indefinite period, by electrical repulsion ; and Dr. Crookes adduces experiments showing how similar things have been done with electrified gold-leaf. Professor S. P. Langley contributes some interesting testimony on this point, which is based upon his observations on Mount Whitney, in 1881. On this mountain, from a height of twelve thousand feet, "we looked down," he says, "on what seemed a kind of level dust-ocean, invisible from below, but whose depth was six or seven thousand feet. . . . The color of the light reflected to us from this dust-ocean was clearly red, and it stretched as far as the eye could reach in every direction, although there was no special wind or local cause for it. It was evidently like the dust seen in mid-ocean from the Peak of Teneriffe—something present all the time, and a permanent ingredient in the earth's atmosphere. At our own great elevation the sky was of a remarkably deep violet, and it seemed at first as if no dust was present in this upper air, but in getting, just at noon, in the edge of the shadow of a range of cliffs which rose twelve hundred feet above us, the sky immediately took on a whitish hue. On scrutinizing this through the telescope, it was found to be due to myriads of the minutest dust-particles. . . . It is especially worth notice that, as far as such observations go, we have no doubt that the finer dust from the earth's surface is carried up to a surprising altitude. I speak here, not of the grosser dust-particles, but of those which are so fine as to be individually invisible, except under favorable circumstances, and which are so minute that they might be almost an unlimited time in settling to the ground, even if the atmosphere were to become perfectly quiet." Professor Langley thinks that the explosion of Krakatoa may have added millions of tons to the dust-envelope of the globe, and that the new contribution is not likely at once to fall to the surface again.

In illustration of this theory, we have the testimony of Captain Sir C. Fleming Stenhouse, who named the island, that after "Graham's Island" appeared in the Mediterranean in 1831, similar red sunsets to those the world has just been admiring were seen at Malta. A more striking record of a similar phenomenon is given in White's "Natural History of Selborne," Bohn's edition, page 300, where we read: "The summer of the year 1783 was an amazing and portentous one, and full of horrible phenomena; for besides the alarming meteors and tremendous thunder-storms that affrighted and distressed the different counties of this kingdom, the peculiar haze, or smoky fog, that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appearance, unlike anything known within the memory of man. By my journal I find that I had noticed this strange occurrence from June 23d to July 20th, inclusive, during which period the wind varied to every quarter, without making any alteration in the air. The sun, at noon, looked as black as a clouded moon, and shed a rust-colored ferruginous light on the ground and floors of rooms, but was particularly lurid and blood-colored at rising and setting. . . . The country people began to look with a superstitious awe at the red, lowering aspect of the sun; and, indeed, there was reason for the most enlightened person to be apprehensive, for all the while Calabria, and part of the Isle of Sicily, were torn and convulsed with earthquakes; and, about that juncture, a volcano sprang out of the sea on the coast of Norway." Cowper mentions the same phenomena in his "Task"; and Mrs. Somerville, in her "Physical Geography," traces their origin to the eruption of the volcano Skaptar, in Iceland, "which broke out May 8th, and continued to August, sending forth clouds of mingled dust and vapor, which spread over the whole of Northern Europe." It is stated in the "Annals of Philosophy," vol. ii, that the sun appeared of a blue color in England, in April, 1821; and it appears from other sources that a violent volcanic eruption had taken place in the Island of Bourbon in February of that year, and a destructive outbreak in Gunung Api in June of the previous year.

A curious counterpart to White's relation is given by Professor James Main Dixon of what he witnessed in Japan at the time of the eruption of Krakatoa. "During the two or three days at the end of August," he says, "we enjoyed fine, dry weather, but the sun was copper-colored and had no brightness. It was capital weather for traveling, but rather inexplicable. When we got to Nikko, the people came to us to inquire if some catastrophe were impending, for the appearance of the sun foreboded evil. We laughed at their fears, and assured them all was right. However, it seems that if the appearance of the sun foreboded no evil, it was a wonderful sign of the greatest earthquake and volcanic catastrophe on record. The fearful explosion of Krakatoa, in the Straits of Sunda, took place on August 26th; and there seems little reason to doubt that the monsoon had carried the volcanic dust along with it, the dust obscuring the sun. The distance is nearly three thousand miles."

Dr. Budde, of Constantinople, was assured, when traveling in Southern Algeria in 1880, that the sun has a decidedly blue color when seen through the fine dust of a Sahara wind. Mr. Edward Whymper, remarking upon a metallic-green coloration of the moon, observed on some evenings in December, says that the peculiar hue recalled to him a similar appearance which he had witnessed in South America when the atmosphere was charged with volcanic dust; and he has described the colorings seen by his party under a cloud of ashes from Cotopaxi in language which would almost precisely apply to the diversified appearances that are the immediate subject of our discussion. Extremely brilliant colorations of the sky have been mentioned by several travelers as common spectacles in a particular tropical belt. Colonel Stuart Wortley, who spent the year 1862 in Southern Italy, in the study, by the aid of photography, of the formation of clouds, was struck with the unusual colors of the sunsets during and after the eruptions of Vesuvius with which that year was distinguished. Four years ago, while sailing in the Pacific, he was much impressed with the fact that "very frequently the whole vault of heaven was overspread with magnificent and glorious coloring, and that in the higher regions of the air colors were found that were never seen in the horizon or below a certain height." Inasmuch as this exceptional magnificence and peculiarity of coloring only occurs in certain latitudes and in well-defined belts, he suggests that, seen in the new light that is now cast on the subject, "the constant stream of volcanic matter thrown out by the great volcanoes in the mountain-ranges of South America, and possibly from elsewhere, form an almost permanent stratum of floating matter, carried in certain directions and kept in certain positions by alternating currents in the higher regions of the air, and that to this stratum of volcanic matter much of the exceptional coloring, found to be associated with sunrises and sunsets in portions of the Southern Pacific Ocean, is due." As an interesting coincidence in connection with this view may be noticed the extraordinary fact, to which Mr. Lockyer has called attention, that "before even the lower currents had time to carry the volcanic products to a region so near as India, an upper current from the east had taken them in a straight line *via* the Seychelles, Cape Coast Castle, Trinidad, and Panama, to Honolulu, in fact very nearly back again to the Straits of Sunda."

Very strong evidence in favor of the theory of the agency of volcanic dust has been derived from the examination of the sediment in freshly fallen snow at Madrid, Spain, on the 7th of December, and of the mineral matter deposited by a rain that fell at Wageningen, Holland, on the 13th of December. The sediment at Madrid, besides the ordinary atmospheric dust of the city, contained particles of what appeared to be volcanic hypersthene, pyroxene, magnetic iron, and volcanic glass. At Wageningen, every drop of the rain that fell upon the windows left, when it dried up, a slight sediment of grayish-colored matter which was compared with original volcanic ash from Krakatoa that had been sent to the Agricultural Laboratory for analysis. Both the sediment and the volcanic ash were found to contain in common—1. Small, transparent, glassy particles; 2. Brownish, half-transparent, somewhat filamentous little staves; and, 3. Jet-black, sharp-edged, small grains resembling augite. These observations, say Messrs. Beyerinck and Van Dam, who made the analyses, "fortify us in our supposition that the ashes of Krakatoa have come down in Holland." On the 17th of November a fall of layers of gray and black dust took place at Storlvdal, Norway, and a fall of discolored rain near Worcester, England. Grayish sediments were found deposited on windows at Gainsborough and York, England, after a heavy rain on the 12th of December.

Mr. E. Douglas Archibald has suggested in "Nature" that, whether the cause of the phenomena be meteoric dust or volcanic ashes, the reflection arises from a definite stratum, and not merely from an atmosphere filled throughout with such dust. Professor Roujon, of Clermont, France, has also observed that two of the twilights, one following the other one day apart, "were so different in intensity as to provoke the supposition that the substance which produced them, at a great height, was not uniformly diffused, but moved in vast masses." This would serve to account for the variations that all must have observed in the brilliancy of the glow.

Mr. Edmund Clark has offered a suggestion upon which the theory that invokes the agency of aqueous vapor and the one which refers the manifestations to volcanic or meteoric dust may be combined, viz., that the dust may act as a nucleus for the condensation of any vapor that may exist at such a high level. The height of the mass of the matter producing the glow has been fixed by Miss Ley, of England, at thirteen miles.

THE ANCESTRY OF BIRDS.

By Professor GRANT ALLEN.

SEATED on the dry hill-side here, by the belted blue Mediterranean, I have picked up from the ground a bit of blanched and moldering bone, well cleaned to my hand by the unconscious friendliness of the busy ants; and looking closely at it I recognize it at once, with a sympathetic sigh, for the solid welded tail-piece of some departed British tourist swallow. He came here like ourselves, no doubt, to escape the terrors of an English winter: but among these pine-clad

Provençal summits some nameless calamity overtook him, from greedy kestrel or from native sportsman, and left him here, a sheer hulk, for the future contemplation of a wandering and lazy field-naturalist. Fit text, truly, for a sermon on the ancestry of birds; for this solid tail-bone of his tells more strangely than any other part of his whole anatomy the curious story of his evolution from some primitive lizard-like progenitor. Close by here, among the dry rosemary and large-leaved cistus by my side, a few weathered tips of naked basking limestone are peeping thirstily through the arid soil; and on one of these gray lichen-covered masses a motionless gray lizard sits sunning his limbs, in hue and spots just like the lichen itself, so that none but a sharp eye could detect his presence, or distinguish his little curling body from the jutting angles of the rock, to which it adapts itself with such marvelous accuracy. Only the restless sidelong glance from the quick upturned eye suffices to tell one that this is a living animal and not a piece of the lifeless stone on which it "rests like a shadow." A very snake the lizard looks in outline, with only a pair of sprawling fore-legs and a pair of sprawling hind-legs to distinguish him outwardly from his serpentine kin. Yet from some such lizard as this, my swallow and all other birds are ultimately descended; and from such a little creeping four-legged reptile science has to undertake the evolutionary pedigree of the powerful eagle or the broad-winged albatross.

Reptiles are at present a small and dying race. They have seen their best days. But in the great secondary age, as Tennyson graphically puts it, "A monstrous eft was of old the lord and master of earth." At the beginning of that time the mammals had not been developed at all; and even at its close they were but a feeble folk, represented only by weak creatures like the smaller pouched animals of Australia and Tasmania. Accordingly, during the secondary period, the reptiles had things everywhere pretty much their own way, ruling over the earth as absolutely as man and the mammals do now. Like all dominant types for the time being, they split up into many and various forms. In the sea, they became huge paddling enaliosaurians; on the dry land, they became great erect dinosaurians; in the air, they became terrible flying pterodactyls. For a vast epoch they inherited the earth; and then at last they began to fail, in competition with their own more developed descendants, the birds and mammals. One by one they died out before the face of the younger fauna, until at last only a few crocodiles and alligators, a few great snakes, and a few big turtles, remain among the wee skulking lizards and geckos to remind us of the enormous reptilian types that crowded the surface of the liassic oceans.

Long before the actual arrival of true birds upon the scene, however, sundry branches of the reptilian class had been gradually approximating to and foreshadowing the future flying things. Indeed, one may say that at an early period the central reptilian stock, consisting of the long, lithe, four-legged forms like the lizards, still closely allied in shape to their primitive newt-like and eel-like ancestors, began to divide laterally into sundry important branches. Some of them lost their limbs and became serpents; others acquired bony body-coverings and became turtles; but the vast majority went off in one of two directions, either as fish-like sea-saurians, or as bird-like land-saurians. It is with this last division alone that we shall have largely to deal in tracing out the pedigree of our existing birds. Their fossil remains supply us with many connecting links which help us to bridge over the distance between the modern representatives of the two classes. It is true, none of these links can be said to occupy an exactly intermediate place between reptiles and birds; none of them can be regarded as forming an actual part of the ancestry of our own swallows and pigeons: they are rather closely related collateral members of the family than real factors in the central line of descent. But they at least serve to show that, at and before the period when true birds first appeared upon earth, many members of one great reptilian group had made immense advances in several distinct directions toward the perfected avian type.

Clearly, the first step toward the development of a bird must consist in acquiring a more or less upright habit: for the legs must be well differentiated into a large hind pair and a free fore pair, before the last can be further specialized into feathered wings; and the body must have acquired a forward poise before flying becomes a possible mode of locomotion. Such an upright habit is first foreshadowed in the larger-limbed and longer-legged lizards like the dinosaurians, which walked to some extent erect, and more particularly in some highly specialized reptiles like the iguanodon, which had large hind-legs and small fore-legs, and could walk or hop on the hind-legs alone, much after the fashion of a kangaroo, or still more of a jerboa or a chinchilla. Now, it is noticeable that the tendency to acquire the most rudimentary form of flying is common among animals of this semi-erect habit, especially when they frequent forests and jump about much from tree to tree. For example, among our modern mammals, the squirrels are a race much given to sitting on their hind-legs and using their paws as hands; while they are also much accustomed to jumping lightly from bough to bough: and some among them, the flying squirrels, have developed a sort of parachute consisting of an extensible skin between the fore and hind legs, which they use to break their fall in descending to the ground. Again, among the lower monkey-like animals, the so-called flying lemur or galeopithecus has hit upon an exactly similar plan; while, in the bats, a membrane which may be fairly called a wing has been evolved to a very high degree of perfection. Everywhere, the habit of living among trees or jumping from rocks tends to produce either parachute or wing-like organs;

and in our own time the tendency is very fully displayed among a large number of forestine mammals.

During the secondary ages, however, it was the reptiles which took to thus developing a rudimentary flying-mechanism. Even at the present day there are some modern lizards, the "flying-dragons" of popular natural history, which possess a parachute arrangement of the front ribs, and are so enabled to jump lightly from branch to branch, somewhat in the same manner as the flying-squirrels. But this is an independent and comparatively late development of a flying apparatus among the reptiles, quite distinct in character from those which were in vogue among the real and much more terrible flying-dragons of the liassic and oölitic age. Far the most remarkable of these predecessors of the true birds were the pterodactyls whose bones we still find in our English cliffs at Lyme Regis and Whitby; creatures with a large reptilian head, fierce jaws set with sharp-pointed teeth, and fore-arms prolonged into a great projecting finger so as to support a membranous wing or fold of skin, somewhat analogous to that of the bats. The pterodactyls do not stand anywhere in the regular line of descent toward the true birds; but they are interesting as showing that a general tendency then existed among the higher reptiles toward the development of a flying organ. In these frightful dragons, the organ of flight is formed by an immense prolongation of the last finger on each fore-leg, to a length about as great as that of the rest of the leg all put together. Between this long bony finger and the hind-leg there stretched, in all probability, a featherless wing like a bat's, by means of which the pterodactyl darted through the air and pounced down upon its cowering victims. As in birds, the bones were made very light, and filled with air instead of marrow; and all the other indications of the skeleton show that the creatures were specially designed for the function of flight. Imagine a cross between a vulture and a crocodile, and you have something like a vague mental picture of a pterodactyl.

But at the very time when the terrestrial reptilian type was branching out in one direction toward the ancestors of the pterodactyls, it was branching out in another direction toward the ancestors of the true birds. In the curious lithographic slate of Solenhofen we have preserved for us a great number of fossil forms with an extraordinary degree of perfection; and among these are several which help us on greatly from the reptilian to the avian structure. The lithographic slate is a member of the upper oölitic formation, and it is worked, as its name implies, for the purpose of producing stones for the process of lithography. But the same properties which make the slate in its present condition take so readily the impress of a letter or a sketch made it in its earlier condition take the impress of the various organisms imbedded as they fell in its soft mud. Even the forms and petals of early flowers washed down by floods into the half-formed mud-bank have been thus preserved for us with wonderful minuteness. Most interesting of all for our present purpose, however, are the bones of contemporary reptiles and birds which this Nature-printing rock incloses for the behoof of modern naturalists. One such reptile, known as compsognathus, may be regarded as filling among its own class the place filled among existing mammals by the kangaroo. It was a rather swan-like, erect saurian, standing gracefully on its hind-paws, with its fore-legs free, and probably dragging its round tail behind it on the ground as a support to steady its gait. The neck was long and arched, and the head small and bird-like in shape ; but the jaws are armed with sharp and powerful teeth, as in the pterodactyls. Altogether, compsognathus must have looked in outward appearance not at all unlike such birds as the auks and penguins, though its real structural affinities lie rather with the emus and cassowaries. The apteryx or kiwi of New Zealand, which is a bird that does not fly, because it has no wings worth mentioning to fly with, approaches even nearer in the combination of both points to this very bird-like oölitic reptile.

Even compsognathus himself, however, though very closely allied to the true birds, can not be held to stand as an actual point in the progressive pedigree, because in the very same Solenhofen slates we find a real feathered bird in person. Accordingly, as the two were thus contemporaries, the one could not possibly be the direct ancestor of the other. Nevertheless, it is certainly from some form very closely resembling compsognathus that the true birds are descended. We have only to suppose such a reptile to acquire forestine habits, and to begin jumping freely from tree to tree, in order to set up the series of changes by which a true bird might be produced. But the first historical bird of which we know anything, the archæopteryx of the Solenhofen slate, still remains in many points essentially a reptile. It is only bird-like in two main particulars ; its possession of rudimentary wings and its possession of feathers. From the popular point of view, these two particulars are decisive in favor of its being considered a bird ; but its anatomical structure is sufficient to make it at least half a reptile ; and eminent authorities have differed (with their usual acrimony) as to whether it ought properly to be called a bird-like saurian or a lizard-like bird. There is nothing like a mere question of words such as this to set scientific men or theologians roundly by the ears for half a century together.

Archæopteryx, then, is just compsognathus provided with rude wings and feathers, but in most other respects a good lizard. Unlike all modern birds, it has a long tail composed of twenty separate vertebræ ; and opposite each vertebra stand two stout quill-feathers, so that instead of forming a fan, as in our own pigeons and turkeys, they form a long pinnate series like the leaflets of yonder palm-branch. These feathers, like all others, show traces of their origin from the scales of lizards. Moreover, in the jaw are planted some small conical teeth, the like of which of course exist in no living bird. The skeleton is for the most part reptilian; and, though the legs are bird-like, they are not much more so than those of compsognathus, an unmixed reptile. Even the wings are more like the fore-legs, and could only be used for flight by the aid of a side membrane. Accordingly, we may say that we have lithographed for us in archæopteryx a specimen of the intermediate state, when reptiles were just in the very act of passing into birds. The scales and protuberances on the body had already developed into feathers; the fore-legs had already developed into rude and imperfect wings, and the feet had become decidedly bird-like; but as yet there was only a very small breast-bone, the tail remained in internal structure like that of a lizard, the jaws still contained pointed teeth, and the wing ended in a three-toed hand, while flight was probably as rudimentary as in the flying-lemur and the flying-squirrel. Nowhere in the organic series has geology supplied us with a better missing link than this uncouth and half-formed creature, Nature's first tentative rough draft of the beautiful and exquisitely adapted modern birds.

Such an animal, once introduced, was sure to undergo further modification, to fit it more perfectly for its new sphere of action. In the first place, the tail was sure to grow shorter and shorter, by stress of natural selection, because a more fan-like organ would act better as a rudder to steer the flight than the long lizard-like tail of archæopteryx. In the second place, the general bony structure was sure to grow better adapted for flight, by the development of some such feature as the keeled breast-bone, and the general modification of the other parts (especially the wing) into better correspondence with their new function. At the same time, it must not be supposed that all intermediate birds would lose their reptilian features equally and symmetrically. Some for a time might retain one lizard-like peculiarity, say the teeth, and some might retain another, say sundry anatomical points in the structure of the skeleton. It was long indeed before the whole tribe of birds acquired the entire set of traits which we now regard as characteristic of their class. During the intervening period they kept varying in all directions, tentatively, if one may say so, and thus the early forms of birds differ far more among themselves than do any modern members of the feathered kingdom. In other words, when the full bird type was finally evolved, it proved so much better adapted to its airy mode of life than any other and earlier creature that it lived down not only the rude reptilian pterodactyls but also the simpler primeval forms of birds themselves: exactly as civilized European man is now living down not only the elephants and buffaloes but the red Indian and the Australian black fellow as well.

Some of the varying primeval forms have been preserved for us as fossils in the chalk deposits of the Western States, which are of course later in date than the oölitic slates of Solenhofen, where we find the compsognathus and his cousin the archæopteryx. One of these first sketches, the ichthyornis, has a row of teeth in each jaw, and displays another strikingly early reptilian or fish-like peculiarity in the joints of its backbone, which are cup-shaped or hollow on either side, exactly like those of a cod. This strange bird must have resembled an emu in many respects, and it might easily have devoured the large ganoid fish of this period with its formidable jaws. Still more reptilian in some particulars is the hesperornis, also found in the Western American chalk. Hesperornis was a huge swimming ostrich, and it had pointed teeth like a crocodile's, set in a groove running down the jawbone. They were supported on stout fangs, in the same way as the teeth of its reptilian allies, the mosasaurians. Like the ostrich, hesperornis had a broad breast-bone, but this breast-bone was destitute of a keel, as is still the case in all the ostrich family. The wings were also very imperfect, like those of the cassowaries. In its tail, hesperornis resembled its predecessor, archæopteryx, so far as regards the lizard-like separateness of the vertebræ, except at the extreme end, where they were slightly massed together into the first resemblance of a plowshare-bone, such as the one I hold in my hand. Thus these two intermediate birds of the chalk period, though slightly more bird-like than their cousins of the oölitic age, still retained, each in its own way, many unmistakable relics of their descent from reptilian or almost amphibian ancestors. As usual, the further back we go, the more do we find all the lines converging toward a common center.

The primitive teeth died slowly and gradually out as time went on. In the still later eocene deposits of the London clay in the Isle of Sheppey, we find the remains of a true bird, known as odontopteryx, in which the teeth have entirely coalesced with the beak, and have assumed the form of bony projections. Strict biologists will tell us that these projections are not teeth at all, because true teeth are not bony in structure, and are developed from the skin of the gums. But such hair-splitting distinctions are of little value from the evolutionary point of view; the really important fact to observe is this, that while hesperornis has teeth in a groove, reptile-fashion, ichthyornis has teeth in distinct sockets, mammal-fashion, and odontopteryx has them reduced to bony projections from the bill, in a fashion all its own, thus leading the way to modern birds, in which the teeth are wholly wanting and the bill alone remains. Indeed, among our existing kinds there are some which still keep up some dim memory of the odontopteryx stage; for the merganser, a swimming fish-eating bird, has bony ridges on its bill, which help it to grasp its prey; and the South American leaf-cutter has a double set of bony bosses on its beak and palate.

The most apparently distinctive feature of birds lies in the fact that they fly. It is this that gives them their feathers, their wings, and their peculiar bony structure. And yet, truism as such a statement sounds, there are a great many birds that do not fly: and it is among these terrestrial or swimming kinds that we must look for the nearest modern approaches to the primitive bird type. From the very beginning, birds had to endure the fierce competition of the mammals, which had been developed at a slightly earlier period; and they have for the most part taken almost entirely to the air, where alone they possess a distinct superiority over their mammalian compeers. There are certain spots, however, where mammals have been unable to penetrate, as in oceanic islands; and there are certain other spots which were insulated for a long period from the great continents, so that they possessed none of the higher classes of mammals, as in the case of Australia, South America, New Zealand, and South Africa. In these districts, terrestrial birds had a chance which they had not in the great circumpolar land tract, now divided into two portions, North America on the west, and Asia and Europe on the east. It is in Australia and the southern extremities of America and Africa, therefore, that we must look for the most antiquated forms of birds still surviving in the world at the present day.

The decadent and now almost extinct order of struthious birds, to which ostriches and cassowaries belong, supplies us with the best examples of such antique forms. These birds are all distinguished from every other known species, except the transitional Solenhofen creature and a few other old types, by the fact that they have no keel to the flat breast-bone—a peculiarity which at once marks them out as not adapted for flight. Every one whose anatomical studies have been carried on as far as the carving of a chicken or a pheasant for dinner knows that the two halves of the breast are divided by a sharp keel or edge protruding from the breast-bone; but in the ostrich and their allies such a keel is wanting, and the breast-bone is rounded and blunt. At one time these flat-chested birds were widely distributed over the whole world; for they are found in fossil forms from China to Peru; but, as the mammalian race increased and multiplied and replenished the earth, only the best adapted keeled birds were able to hold their own against these four-legged competitors in the great continents. Thus the gigantic ostriches of the Isle of Sheppey and the great divers of the Western States died slowly out, leaving all their modern kindred to inhabit the less progressive southern hemisphere alone. Even there, the monstrous æpyornis, a huge, stalking, wingless bird, disappeared from Madagascar in the tertiary age, while the great moa of New Zealand, after living down to almost historical times, fell a victim at last to that very aggressive and hungry mammal, the Maori himself. This almost reduces the existing struthious types to three small and scattered colonies, in Australasia, South Africa, and South America respectively, though there are still probably a few ostriches left in some remote parts of the Asiatic Continent.

The Australian ostrich kind are in many respects the most archaic and peculiar of all. Strangest among them is the kiwi or apteryx of New Zealand, that almost wholly wingless bird who may be seen any morning at the Zoo, gravely stalking up and down, like an important political prisoner, within the small inclosure to which tyrannical circumstances have temporarily confined him. The kiwi has feathers which closely resemble hair in texture, and his wings are so very rudimentary that they can only be properly observed at a *post-mortem* examination. His bones have no air-canals, and some of his internal anatomy is very abnormal. The cassowaries of the Papuan district are somewhat more bird-like in type, but they also preserve many antique features, especially in the relative smallness of the head and brain compared with the general size of the whole body. The Australian emus approach more closely to the true ostriches, and their feathers are far more feathery than those of the cassowary. In both these classes, however, the small and functionless wings are destitute of plumes, which are only represented by a few stiff, horny shafts. The true ostriches, including both the familiar African species and the South American rheas, have real wings with real feathers in them, though they can only use them to aid them in running, and not for the purpose of flight. They are therefore the most bird-like of their order, with small wings and very feathery plumes. We may fairly regard all these keelless and often almost wingless birds—the kiwis, cassowaries, emus, and ostriches—as the last survivors of a very ancient group, immediately descended from ancestors not unlike the toothed hesperornis, and never forced by circumstances to develop into the full avian type represented by the swallows, hawks, and herons. All of them are strictly terrestrial in their habits; none of them can fly in even the slightest degree; and the feathers of the most developed among them invariably lack the tiny barbules or small hooks which bind together the cross-barbs in the feathers of the flying bird, so as to form a compact and resisting blade. It is this looseness of the cross-barbs which gives ostrich-plumes their light and fluffy appearance; while, pushed to an extreme in the cassowary and the kiwi, it makes the plumage of those ugly birds approximate in character to the hair of mammals. Though from the human and decorative point of view we may admire the fluffiness of ostrich-plumes, it is obvious that, looked upon as a question of relative development, such loose, floating barbs are far less advanced in type than the firm and tightly interlocked quill-feathers of a goose or a raven, with which alone sustained flight is possible.

Except in such isolated countries where higher mammals do not, or did not till lately, exist, the power of flight, once acquired, was sure to be developed in a high degree. For the possession of feathers gives birds an advantage in this respect which enables even the little sparrows to hold their own in the midst of our crowded cities. Hence all other modern birds, except these lingering, ostrich-like creatures, have keeled breast-bones, which imply their descent from forms adapted to true flight. They are linked to the ostriches, however, and therefore to the still earlier toothed ancestral types, by the South American tinamous, which are intermediate in various anatomical points (too intricate for a lazy man to go into here and now), between the two classes. Put briefly, one may say that these partridge-like Paraguayan birds are ostriches in the bones of their head, but game-birds in those of the breast and body. This line of descent seems to lead us up directly toward the cocks and hens, the pheasants, and the other scrapers. There are more marks of a primitive organization, however, among the penguins, which are almost wingless swimming birds, belonging nearly to the same class as the ducks and geese ; and we have reason otherwise to consider the penguins a very early form, since fowls resembling them in many particulars have been unearthed in the upper greensand. Here the wings are reduced to small rudiments, covered with bristly, scale-like feathers, and so rigid that they can be only moved in the mass like fins by a single joint at the base. They are used, in fact, exactly in the same way as the flappers in seals, to assist the bird in diving. The habitual erect attitude of the penguins strongly recalls that of their reptilian ally, compsognathus. From such an incomplete form as this, the gap is not great to the equally erect auks, the guillemots, the grebes, and other web-footed divers, which have short, pointed wings with true quills, but without any extended power of flight. Some species, indeed, can not fly at all, though the puffins and many other kinds can steer their way through the air with comparative ease. Thence to the cormorants, gulls, and ducks the transitions are slight and easy. We are thus led insensibly from almost wingless erect birds, like the penguins, through winged, but mainly swimming forms like the auks and divers, to creatures with such marvelous powers of flight as the frigate-birds, the petrels, and the albatrosses, which pass almost their whole life upon the wing. It must be remembered, however, that in this line of descent the comparatively wingless forms must be regarded as somewhat degenerate representatives of flying ancestors ; for the presence of a keeled breastbone almost conclusively proves hereditary connection with fully-winged progenitors.

By far the greater number of modern birds belong to the still more strictly aërial orders of the perchers, the peckers, and the birds of prey. In almost all these cases, the power of flight is highly developed, and the bird type reaches its highest ideal point of typical excellence. Among the perchers, this perfection of form is best seen in the swallows, whose ceaseless and graceful curved evolutions everybody has seen with his own eyes ; while among tropical varieties of the same type the birds-of-paradise, the sun-birds, and the orioles are the most conspicuous. Among the peckers, our own swifts closely simulate the swallow type, while their American relatives, the humming birds, in spite of their small size, possess a power of rapid flitting and of lightly poising themselves in front of flowers which makes them in some ways the very fullest existing embodiment of the avian ideal. To the same order belong also those most intelligent of all birds, the parrots, whose large heads and crafty eyes mark them at once as the opposite pole from the small-browed, dull-eyed, stupid cassowaries. With them must be ranked the toucans, the barbets, the king-fishers, the trogons, and whole hosts of other beautiful southern creatures, among which the feathers have been variously modified into the most exquisite ornamental devices. As for the birds of prey, the eagles, vultures, falcons, hawks, owls, and ospreys must suffice by way of example.

Even among these central groups of birds, which have varied most and developed farthest from the primitive reptilian character, there are many kinds which retain here and there some small and isolated peculiarities of the ancestral forms. For example, among the duck-like birds, as we have already seen, a single group, that of the mergansers, still keeps up some faint memory of the original sharp teeth in the shape of a few horny projections along the edge of the beak. The tooth-billed pigeon of Samoa, a close relation of that early and extinct form the dodo, has also some rudiments of horny teeth ; and the South-American leaf-cutters, a primitive set of songless perchers, possess somewhat similar relics of the lost fangs. So, too, our earliest known bird, the archæopteryx, had three free claws on its fore-limb or undeveloped wing ; and traces of such claws turn up in sundry unconnected birds even now, no doubt by reversion to the almost forgotten ancestral type. In all modern birds, one of the three fingers which make up the pinion still remains free ; and in some species this finger supports an evident claw, sometimes used as a spur for the purpose of fighting. In many thrushes a rudiment of this claw may be perceived in the shape of a small tubercle or knob at the end of the wing, thus pointing back directly to some remote four-footed and claw-bearing reptilian ancestor. Several plovers have spurs, and so has the spur-winged goose ; while the horned screamer has two on each wing, which he uses with great effect in battling with his rivals. The Australian brush-turkeys have also the rudiment or last relic of a primitive pinion-claw.

There is another way in which modern birds still partially recall the peculiarities of their reptilian ancestors, and that is in the course of their individual development within the egg. No adult existing bird has all the bones of the tail distinct and separate, like those of the archæopteryx ; the last joints are all firmly welded together into a solid expanded piece, known from its queer shape as a plowshare-bone, such as the one which I am holding in my hand as the text for this discourse. The use of the plowshare-bone is to support the fan-like quill-feathers of the tail, and also to shelter the oil-glands with whose contents the birds preen and dress their shining plumage, to secure them against the evil effects of damp or rain. But, while the young chick is in the egg, all its tail-bones still remain separate, as in the ancestral, lizard-like bird and the still earlier ancestral lizard ; it is only as the development of the embryo progresses that they become firmly united, as in modern forms. In other words, every young bird begins forming its tail as if it meant to be an archæopteryx, and only afterward so far changes its mind as to become a crow or a sparrow. Similarly, no adult existing bird has true teeth ; but the young of certain parrots show in the egg a set of peculiar little swellings inside the jaw, known as dental papillæ, and commonly found as the first stage of teeth in other animals. Moreover, these swellings are actually covered by a thin coat of dentine, the material of which true teeth are made. So here again the young parrot begins its develment as though it meant to start a set of conical fangs in its jaw, like those of the archæopteryx, but afterward changes its mind and contents itself with a bill instead. Such symptoms as these point back surely though remotely to a far-distant reptilian ancestry.

It is worth while noting, too, that the links which bind the birds to the reptiles bind them also in part to the lower mammals. For the lowest existing mammal is that curious Australian creature known to the rough-and-ready classification of the colonists as the water-mole, and rejoicing in the various scientific *aliases* of the ornithorhynchus and the duck-billed platypus. Unsophisticated English people know the animal best, however, as "the beast with a bill." Now, there are many close resemblances between this strange Australian burrower, on the one hand, and such antiquated forms of birds as the New Zealand kiwi, on the other. In many particulars, too, the water-mole recalls the structure of reptiles, and especially of the ichthyosaurus. In short, it is at once the most bird-like and the most reptile-like of mammals. Hence we may fairly conclude that birds and mammals are both descended by divergent lines from a single common reptilian ancestry. For, on the one hand, the kiwi, an early type of nocturnal bird, preserved for us in isolated New Zealand, has some marked reptilian and mammalian affinities, not only in the external character of its hair-like feathers, but also in the more important structural points of its diaphragm, its movable vertebræ, and its keelless breast-bone, which are questions rather for the professed anatomist than for mere idle loungers basking lazily in the sun on a Provençal hill-side. And, on the other hand, the ornithorhynchus, an early type of burrowing aquatic mammal, preserved for us in isolated Australia, has marked reptilian affinities in its bony structure, and in the teeth implanted on its tongue ; while it has also marked resemblances to the ducks and other swimming birds in the external features of its horny bill and webbed feet, besides being still more closely related to them in many of its less obvious anatomical peculiarities.

Birds, then, may be roughly described as reptiles with feathers. Professor Huxley was the first to see the real closeness of the connection between the two groups, and to unite them under a common name as Sauropsida. Strictly speaking, the only constant difference between them, the only one distinctive character of birds as a class, is the possession of feathers; and, if, like uncompromising Karl Vogt, we insist upon calling archæopteryx a reptile, because of its anatomical peculiarities, even this solitary distinction must vanish utterly, leaving us no point of difference at all between the two classes. It must be remembered, of course, that all the other characters which we always have in our mind as part of the abstract idea of a bird are either not constant or not peculiar to birds alone. For instance, we usually think of a bird as a flying animal; but then, on the one hand, many birds, such as the ostriches, kiwis, penguins, and dodos, do not or did not fly at all; and, on the other hand, many other creatures, such as the bats, flying-squirrels, flying-lemurs, pterodactyls, dragon-lizards, and butterflies, do or did once fly just as much as the birds. So with their other peculiarities: their habit of laying eggs descends to them from fish and reptiles; their nest-building propensities, which are wanting in some birds, are found in the Australian water-mole, in field-mice, and even in stickleback; and their horny bill, which is almost confined to them, nevertheless occurs again in the ornithorhynchus and in many turtles. In short, every other apparently distinctive point about birds except the possession of feathers either breaks down on examination or else descends to them directly from early unbird-like ancestors. And the first feathered creature of which we know anything, archæopteryx, was at least as much of a reptile as of a bird.—*Longman's Magazine.*

MEXICO AND ITS ANTIQUITIES.*

THE Mexican Republic extends from the fifteenth to the thirtieth degree of north latitude, and embraces an area of about 750,000 square miles. It is traversed by the continuation of the Cordillera of South America, here called the Sierra Madre, which trends northwesterly from the Isthmus of Tehuantepec, and varies in height from a moderate elevation in the southern States of Chiapas and Oaxaca to a mean height in the nineteenth degree of latitude of 9,000 feet, with the peaks of Orizaba and Popocatepetl—"the culminating point of North America"—rising to the elevations of 17,200 and 17,720 feet respectively. On the parallel of 21°, the Cordillera becomes very wide and divides itself into three ranges: one running eastwardly to Saltillo

* Appletons' Guide to Mexico. By Alfred R. Conkling, LL.B., Ph. B. With Railway Map and Illustrations. New York: D. Appleton & Co. Pp. 378.

and Monterey; one traversing the States of Jalisco and Sinaloa, and subsiding in Northern Sonora; and a central ridge extending through the States of Durango and Chihuahua, and forming the water-shed of the northern table-land. This range decreases in elevation going northward. Four peaks—Popocatepetl, Iztaccihuatl, Orizaba, and the Nevada de Toluca—rise above 15,000 feet, and three others—the Cofre de Perote, Ajusco, and the volcano of Colima—above 11,000 feet.

FIG. 1.—INDIAN HUT IN THE TIERRA CALIENTE.

The country is divided into three zones: the *tierra caliente*, or hot land, bordering the coast of either sea for from forty to seventy miles inland; the *tierra templada*, or temperate land; and the *tierra fria*, or cold land. About one half the surface of the country lies in the latter zone, while the remainder of the republic is almost equally divided between the temperate and hot regions. The country consists for the most part of a plateau, having an average height of about 6,000 feet above the level of the sea, which extends from the frontier of the United States to the Isthmus of Tehuantepec, and is about 350 miles wide in the latitude of the capital. But few of the rivers are navigable, and the longest of them, the Rio de Santiago, is only 542 miles long. The numerous lakes on the plateau are mostly shallow lagoons, the mere remains of large basins of water that formerly existed, and without outlet, and therefore filled with salt water. After the lagoon of Terminos, on the coast of the Gulf of Campeachy, which is really an arm of the sea, the largest lakes are the Lake of Chapala, in the State of Jalisco, and Lakes Patzcuaro and Cuitzco. The country enjoys a variety of climates, of which those of the temperate and cold regions are tolerably uniform. The rainy season generally occurs in the summer, but at other times the air of the plateau is inconveniently dry.

A large part of the country is overlaid by the igneous rocks, of which trachyte, feldspar, porphyry, and amygdaloid basalt, are of most frequent occurrence. In the Sierra Madre the metamorphic rocks are common. Limestone is extensively quarried at Orizaba, and constitutes the greater part of the eastern branch of the Cordillera between San Luis Potosi and Monterey. The Cordillera, from Chihuahua on the north to Oaxaca on the south, contains very extensive deposits of gold, silver, iron, copper, and lead; and zinc, mercury, tin, platinum, and coal occur in a few places. The argentiferous veins constitute the principal part of the mineral wealth of the country. The silver occurs generally in the form of sulphides, in gangues of quartz, frequently in the metamorphic clay-slate, but sometimes in porphyry, as at Real del Monte, or in talcose slate, as in some mines at Guanajuato. Among the most remarkable mineral veins of the continent, after the Comstock lode, are the *Veta Madre* of Guanajuato and the *Veta Grande* of Zacatecas, which have been worked for about three hundred years.

The next most important deposits are the immense beds of iron, chiefly in the form of the magnetite and hematite ores. The well-known *Cerro del Mercado*, in the State of Durango, has been estimated to contain sixty million cubic yards of iron-ore, which have a weight of five billion quintals, and give, according to an analysis by Mr. M. H. Borje, of Philadelphia, sixty-six per cent of pure metal. Lead-ores are abundant; copper is mined at various places; oxide of tin is found in veins and alluvial beds at Durango. Mercury occurs as cinnabar in several States; and zinc-ores, with platinum, antimony, cobalt, and nickel, in not large quantities, are found in Chihuahua. The principal coal-beds are in the States of Oaxaca, Vera Cruz, Mexico, Puebla, Nuevo Leon, Tamaulipas, and Sonora. The anthracite-bed recently discovered at Barranca, on the Yaqui River in Sonora, is probably the largest and richest deposit of coal in the republic. Lignite, or brown coal, occurs in many places, but is not used to any great extent. The demand for coal is, so far, much greater than the supply accessible to the railroads. Mining is still conducted by working on the old Mexican plan, and this system has been found, under existing circumstances, to be more economical and profitable than a system in which modern and improved methods are applied.

Some of the oldest mines in Mexico, many of which were worked before the Spanish conquest, are at Pachuca, in the State of Hidalgo. There are about one hundred and fifty of them, seventy-five of which are in the Real del Monte, affording an ore composed mainly of blackish silver sulphides. The ore is worked here, as at Guanajuato, by the *patio* process, which is illustrated in the accompanying view. It is first crushed by a revolving stone wheel, iron-tired, in a pit, at the center of which is a sieve through which the finer pieces are shoveled into a vault below. These pieces are then carried to the *arrastras*, flat stones of hard rock kept revolving in a large tub half-filled with water, where they are in twenty-four hours ground to a fine powder.

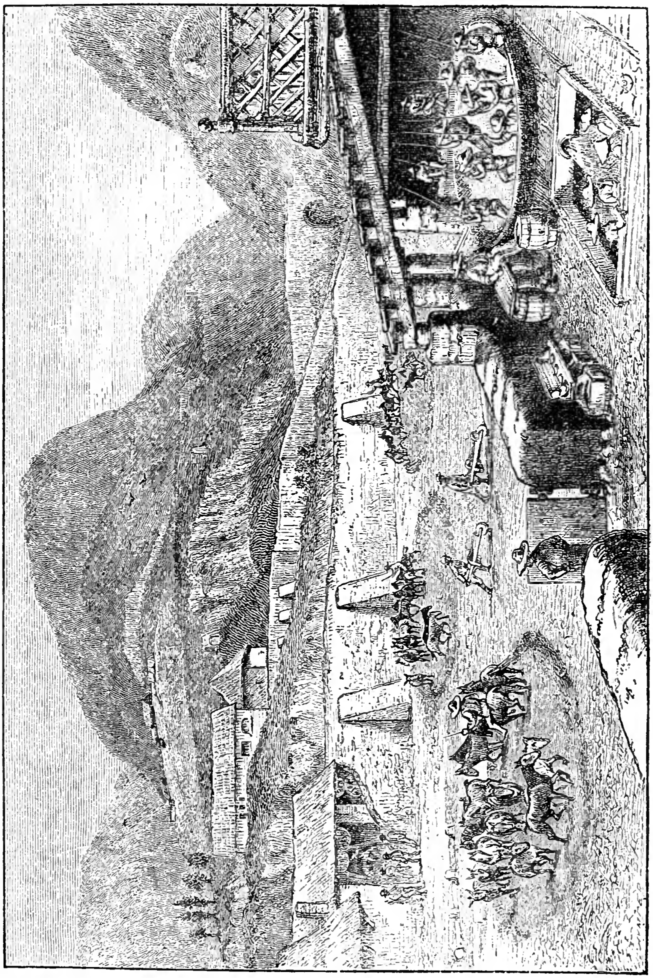

Fig. 2.—Silver Mill at Pachuca.

The pulverized ore, called *lama*, is next carried to the *patio*, a court-yard paved with large flat stones, where it is allowed to accumulate to a depth of about two feet. The muddy mass is then mixed with *magistral*, or blue vitriol, salt, and quicksilver, and the whole, now called *torta*, is thoroughly stirred together by the trampling of mules. This process is kept up for seven hours daily, for from two to four weeks, according to the quality of the ore. The *torta* is then carried to the *lavaderos*, or large cisterns, where it is washed and stirred by means of revolving sticks. The silvery mass being heavy, settles at the bottom, and in two or three days the muddy water is drawn off. The amalgam, or *pella*, which has been formed, is now taken from the *lavaderos* to a sort of oven or depression in the ground, covered with a huge metallic hood termed a *capellina*. A fire is built around the *capellina*, and the mercury is separated by distillation in about four days. The block of silver which remains is transported to the nearest mint, and worked into coin or sold.

The volcanoes form one of the most interesting features of the country. Only four of them are active, but no eruption has taken place from either of these during the present century. Earthquakes are, however, common, and *solfataras*, *fumaroles*, and adjoining warm springs, indicate that these volcanoes are still in a semi-active state. According to Humboldt, they lie on the same great vent of the earth's crust, and approximately on the nineteenth parallel of latitude. Orizaba, which may be reached from Esperanza on the railway from Vera Cruz to Mexico, has been quiet since 1566, but was reported to be smoking in April, 1883. There is no hazardous climbing on the mount-

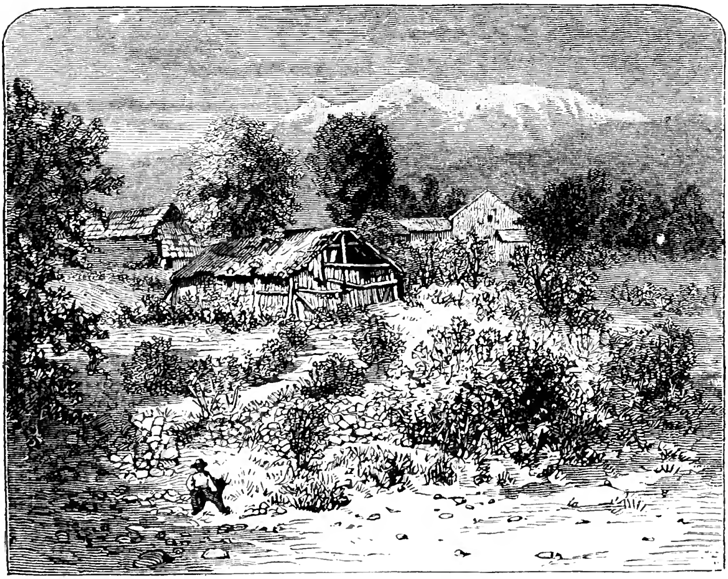

Fig. 3.—Popocatepetl.

ain, but the ascent is exceedingly laborious on account of the steepness of the snow-clad cone. About five hours are required to reach the summit, but very few persons have thus far accomplished the task. The excursion to Popocatepetl starts from Amecameca, on the Morelos Railway, the road leading at first through fine wheat-fields watered by the melting snows of the great volcano. The path soon rises and enters a magnificent forest, which is succeeded by a growth of thick grass, after which the crest-line of the ridge is crossed, and the ranch of Tlamacas, the starting-point for the summit, is reached. The lower part of the peak of the volcano has a slope of about 20°, and the angle increases in ascending till it reaches about 45° just below the summit. The crater is not visible until the traveler arrives at the edge. It is roughly estimated to be about five hundred yards in diameter and one hundred and fifty yards deep, and contains several *fumaroles*, with a small pond at its bottom. The temperature of the air on the summit at about ten o'clock in the morning was 32°. The view from the peak commands an area of about one hundred thousand square miles, and reaches to the Gulf of Mexico, one hundred and fifty miles distant. The descent may be made, if the snow is soft enough, by coasting on a sled. The volcano of Jorullo, in Michoacan, is famous for having been the result of a sudden eruption from a previously peaceful plain, on the night of the 28th—29th of September, 1759, the phenomena of which are fully related in a graphic description in Humboldt's "Cosmos." It is reached by a fifty-five-mile horseback-ride from Patzcuaro-station on the railroad from Mexico to Manzanillo. Horses may be ridden to within half a mile of the crater. The volcano is pear-shaped, with the outlet of the crater on the north side. The cone is covered with loose black ashes, in which a few bushes grow, and slopes at about 45° on the north and west sides. The crater is about a mile in circumference. The traveler may descend in it to the bottom, about five hundred feet below the summit. The walls slant rapidly, and are covered with an enormous mass of talus. Grass, a few ferns, and some native trees grow on its borders, and deer are abundant on the mountain. Shocks of earthquakes are often felt in the environs of Jorullo, one of which, in March, 1883, left cracks in the ground at a point ten miles off. Although no eruption has taken place for more than a hundred years, the volcano is still in a semi-active state, as is shown by the heat of the crater-walls, the emission of aqueous gas and vapor, and the frequency of earthquakes. A very extensive view is commanded from the summit.

Great interest is given to Mexico by its ancient ruins, relics of unknown people, whose character, origin, and history are destined long to be fruitful themes of study. They consist of *teocallis*, or pyramids, in different parts of the country, and the remains of elaborate buildings and of cities, chiefly situated in the States of Yucatan, Chiapas, and Oaxaca. The most prominently known ruins of cities are those of Uxmal, in Northern Yucatan, which are considered to be the oldest; those of Palenque, in Chiapas, next in age; and those of Mitla, in Oaxaca, third in age. The buildings were usually constructed of hewed stone, and have excited general admiration on account of the skill in architecture and the elaborate workmanship displayed in them. Near some of them are the remains of finely constructed artificial lakes, with bottoms of cemented stones; and the traces of a very ancient paved road have been found in Yucatan. Charnay found the country in Yucatan covered with ruins from north to south; and Stephens, about 1840, visited forty-four ruined cities or places, in which remains of buildings were still found, most of which were unknown to white men, even to those inhabiting the country. The remains of Mayapan, the ancient capital of the Mayas, are scattered over a broad plain, and are characterized by a mound sixty feet high with a base a hundred feet square, the summit of which, a stone platform fifteen feet square, was reached by four stairways twenty-five feet wide. Another building is of stone, and circular, and stands on a sloping foundation thirty-five feet high. Near it are two rows of capitals, without columns.

The ruins of Uxmal are pronounced by Stephens, who explored them thoroughly, worthy to stand side by side with those of Egyptian and Roman art. The most important building, the Casa del Gobernador, is three hundred and twenty feet long, and was built of hewed stone laid in mortar or cement, and bore a cornice which was decorated all around with "one solid mass of rich, complicated, and elaborately sculptured ornaments." It stands on a foundation of three terraces, altogether forty-two feet high, the lowest of which was five hundred and seventy-five feet long. The remains of Chichen-Itza are similar to those of Uxmal. In one building the walls of the rooms are covered with picture-writing; and figures of serpents are a frequent ornament. At Ake, thirty-six columns, in three parallel rows, are all that remain of a once magnificent structure.

At Palenque, Captain del Rio found, in 1787, ruins extending seven or eight leagues one way and half a league the other, and visited and described fourteen edifices admirably built of hewed stone. The largest known building is two hundred and twenty-eight feet long, one hundred and eighty wide, and twenty-five feet high, built entirely of hewed stone, laid with admirable precision in excellent mortar, and it stood on a much larger terraced pyramidal foundation. A corridor nine feet high, and roofed by a pointed arch, went round the building on the outside; and this was separated from another within of equal width. Other buildings are nearly as remarkable. Tablets, with elegantly carved inscriptions, are plentiful; and of the sculptured human figures Stephens says that "in justness of proportion and symmetry they must have approached the Greek models."

The four palaces, as Dupaix calls them, at Mitla, are said by him to have been "erected with lavish magnificence. . . . They combine the solidity of the works of Egypt with the elegance of those of Greece. But what is most remarkable, interesting, and striking in these monuments," he adds, "and which alone would be sufficient to give them the first rank among all known orders of architecture, is the execution of their mosaic *rilievos*, very different from plain mosaic, and consequently requiring more ingenious combination and greater art and labor. They are inlaid on the surface of the wall, and their duration is owing to the method of fixing the prepared stones into the stone surface, which makes their union with it perfect." M. Charnay says that the beauty of these buildings can be matched only by that of the monuments of Greece and Rome in their best days.

The Pyramid of Cholula was one of the great edifices of the world. It was 1,423 feet wide at the base, 177 feet high, and covered a superficial area of forty-five acres. Civilized man is gradually destroying it, and a cut has been made in one side of it for a railroad-track. Near it are other smaller pyramids.

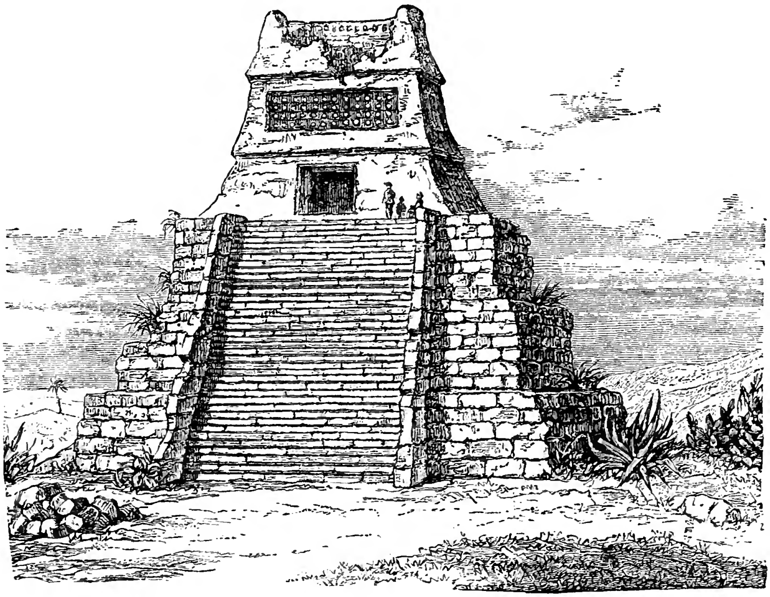

Fig. 4.—Aztec Temple at Cholula.

The *teocallis* of San Juan Teotihuacan are next in age to those of Cholula. The two largest are dedicated to the Sun and the Moon. The former is 180 feet high, and 682 feet long at the base. Its summit—now marked by a platform about 75 feet square and a modern cylindrical monument of stone—is said to have been crowned with a temple, in which was a gigantic statue of the Sun, made of an entire block of stone, and wearing a breastplate of gold and silver. The two principal pyramids are surrounded by several smaller ones, few of which exceed twenty-five feet in height. According to tradition, they were dedicated to the Stars, and served as sepulchres for the illustrious men of the nation.

Toltec ruins are found at Tula, about fifty miles north of the capital.

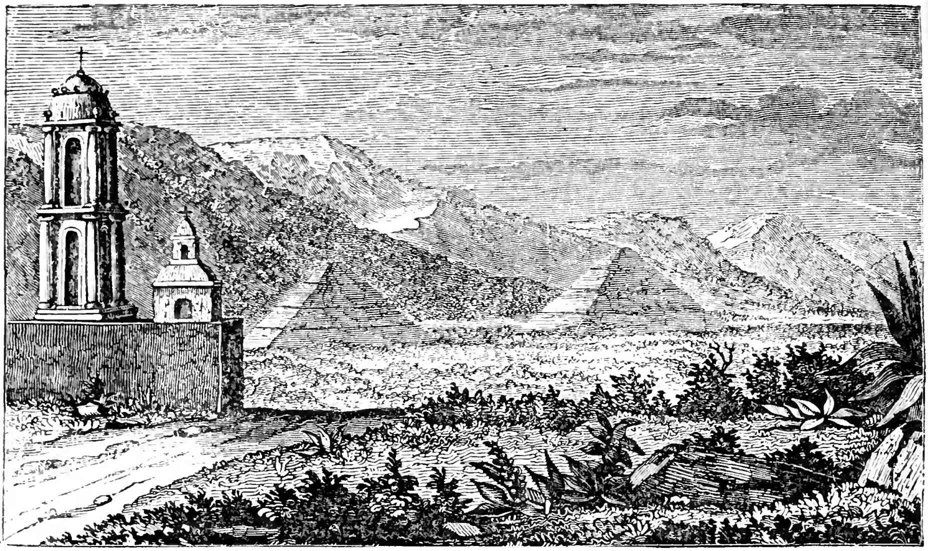

Fig. 5.—Pyramids of San Juan Teotihuacan.

At Papantla, in the State of Vera Cruz, is a pyramid remarkable for its symmetry, built of immense stones of porphyry, regularly cut and finely polished, many of which are covered with hieroglyphics, with carvings of serpents and crocodiles.

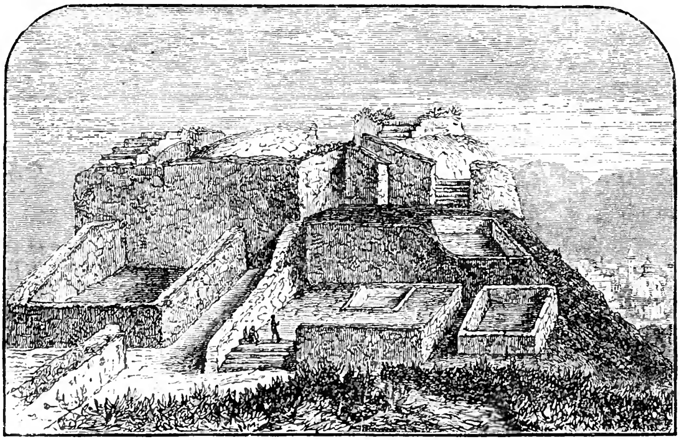

Fig. 6.—Toltec Palace at Tula.

The Museum of the city of Mexico contains a sacrificial stone, and a number of the idols of Aztec worship. We give cuts of two of these idols—Quetzalcoatl, the chief god of the people, and a feathered serpent.

The Marquis de Nadaillac, who has lately reviewed the whole subject of "Prehistoric Art in America," has given a graphical description of the Mexican ruins as a whole. "The massive constructions in Mexico and Peru," he says, "the immense spread of the bases and the inclination of the walls, give a pyramidal tendency and an appearance of stability and durability that force us to think of Egypt. Palenque, with its palaces, and Tiaguanuco, or Huanucho-Viejo, in Peru, with their monumental portals and their not numerous openings in the form of the *tau*, for the admittance of light, their walls covered with bright-red paint, and their figures always in profile, would not be out of place on the banks of the Nile. The bas-reliefs of Chichen-Itza resemble those of Babylon and Nineveh in richness of ornamentation. The meanderings of the friezes of Mitla, of the Casa del Gobernador, and the Casa de Monjas, at Uxmal, are of a kind with those of Greek art. The porch of Kabah, an aqueduct on the Rodadero, at Cuzco, might have stood on the Roman Campagna. The figures with which the temple of Xochicalco (Mexico) was adorned were represented sitting with crossed legs in the traditional attitude

FIG. 7.—QUETZALCOATL.

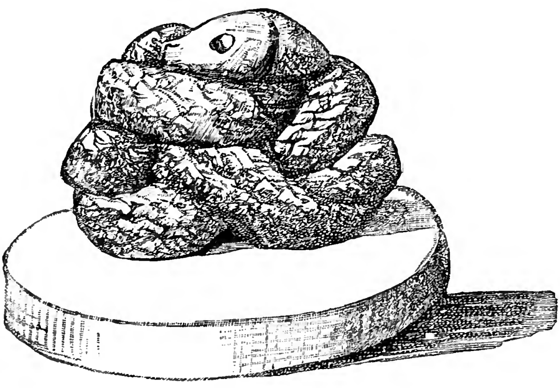

FIG. 8.—FEATHERED SERPENT.

of Buddha; and recently a Protestant missionary remarked upon the resemblances between the edifices at Chichen-Itza and the *topes* or *dagobas* he had seen at Anaradjapora, the ancient capital of Ceylon. The pyramids are certainly the most salient feature in this ancient architecture. The walls that still stand are composed of immense blocks of granite or porphyry of cyclopean construction, or of mason-work of stone or brick covered with cement. All travelers have remarked the solidity and elegance of the building. The façades were regularly shaped, the joints well pointed, and the edges clean-cut. Generally, they were adorned with a projecting cornice loaded with rich ornaments in stucco. The possibly excessive monotony of the architecture was relieved by square towers several stories high. Such towers may be seen at Copan, Palenque, and Tikal; the Casa de la Culebra at Uxmal was crowned with thirteen turrets. The architects were also careful in placing statues, pilasters, caryatides, and bas-reliefs on the façades; and important mural paintings have been described at Chichen-Itza. They represent processions of men and animals, combats, struggles between man and the tiger or the serpent, trees, and houses. One painting, the only one relating to navigation, represents a boat somewhat like a Chinese junk.

"The sculptures that adorned these buildings," the marquis continues, "present so many differences in style and execution that we can hardly believe them the work of the same race, or that they represent the same civilization. In some cases they depict strange idols in incorrect forms, men wearing tigers' heads, an alligator holding in his jaws a figure with a human head and an animal's extremities, or a gigantic frog with his paws terminating in a cat's claws. Besides such monsters, we recollect at Copan a statue wearing the highest expression of Maya art, in which we know not whether to be most astonished at the oddity of the conception, the richness of the ornamentation, or the fineness of the execution. At Palenque we may see a statue with a placid expression that would not be out of place in the palace of a Pharaoh; and the sepulchral stone of Chac-Mol, recently found at Chichen, the bas-reliefs of Santa Lucia, and other works, are not discordant with modern art. These striking contrasts, while they bring no explanation, add, in the endless problems they raise, a new attraction to American archæology."

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

CATARRH.—PLEURISY.—CROUP.

THE progress of the *healing art*, as distinguished from certain sterile branches of medical science, can be best measured by the progress of our insight into the causes of special maladies. For the accidental discovery of a "specific" means generally nothing but the discovery of a method for suppressing special symptoms of a disease. Quinine subdues chills, but does not prevent a relapse of febrile affections ; brandy neither cures nor subdues dyspepsia, but merely interrupts it with a transient alcohol-fever. But, as soon as we ascertained that scrofula, or the "king's-evil," was not caused by a mysterious dispensation of Providence, but by bad food and foul air, the cure of the disease became easy enough ; the king's-evil disappeared without the aid of the king.

That "colds," or catarrhal affections, are so very common—so much, indeed, as to be considerably more frequent than all other diseases taken together—is mainly due to the fact that the cause of no other disorder of the human organism is so generally misunderstood. Few persons have recognized the origin of yellow fever ; about the primary cause of asthma we are yet all in the dark ; but in regard to "colds" alone the prevailing misconception of the truth has reached the degree of mistaking the cause for a cure, and the most effective cure for the cause of the disease. If we inquire after that cause, ninety-nine patients out of a hundred, and at least nine out of ten physicians, would answer, "Cold weather," "Raw March winds," or "Cold draughts," in other words, out-door air of a low temperature. If we inquire after the best cure, the answer would be, "Warmth and protection against cold draughts"—i. e., warm, stagnant, in-door air. Now, I maintain that it can be proved, with as absolute certainty as any physiological fact admits of being proved, that warm, vitiated in-door air is the cause, and cold out-door air the best cure, of catarrhs. Many people "catch cold" every month in the year and often two or three times a month. Very few get off with less than three colds a year ; so that an annual average of five catarrhs would probably be an underestimate. For the United States alone that would give us a yearly aggregate of two hundred and fifty-five million "colds." That such facilities for investigation have failed to correct the errors of our exegetical theory is surely a striking proof how exclusively our dealings with disease have been limited to the endeavor of suppressing the symptoms instead of ascertaining and removing the cause. For, as a test of our unbiased faculty of observation, the degree of that failure would lead to rather unpronounceable conclusions. What should we think of the scientific acumen of a traveler who, after a careful examination of the available evidence, should persist in maintaining that mosquitoes are engendered by frost and exterminated by sunshine? Yet, if his attention had been chiefly devoted to the comparative study of mosquito-ointments and mosquito-bars, he might, for the rest, have been misled by such circumstances as the fact that mosquitoes abound near the ice-bound shores of Hudson Bay, and are rarely seen on the sunny prairies of Southern Texas. In all the civilized countries of the colder latitudes, catarrhs are frequent in winter and early spring, and less frequent in midsummer : hence the inference that catarrhs are caused by cold weather, and can be cured by warm air. Yet of the two fallacies the mosquito theory would, on the whole, be the less preposterous mistake; for it is true that long droughts, by parching out the swamps, may sometimes reduce the mosquito-plague, but no kind of warm weather will mitigate a catarrh, while the patient persists in doing what thousands never cease to do the year round, namely, to expose their lungs, night after night, to the vitiated, sickening atmosphere of an unventilated bedroom. "Colds" are, indeed, less frequent in midwinter than at the beginning of spring. Frost is such a powerful disinfectant that in very cold nights the lung-poisoning atmosphere of few houses can resist its purifying influence; in spite of padded doors, in spite of "weather-strips" and double windows, it reduces the in-door temperature enough to paralyze the floating disease-germs. The penetrative force of a polar night-frost exercises that function with such resistless vigor that it defies the preventive measures of human skill; and all Arctic travelers agree that among the natives of Iceland, Greenland, and Labrador pulmonary diseases are actually unknown. Protracted cold weather thus prevents epidemic catarrhs, but during the first thaw * Nature succumbs to art: smoldering stove-fires add their fumes to the effluvia of the dormitory, tight-fitting doors and windows exclude the means of salvation: superstition triumphs; the lung-poison operates, and the next morning a snuffling, coughing, and red-nosed family discuss the cause of their affliction. "Taken cold"—that much they premise without debate. But where and when? Last evening, probably, when the warm south wind tempted them to open the window for a moment. Or "when those visitors kept chatting on the porch, and a drop of water from the thawing roof fell on my neck." Or else the boys caught it by playing in the garden and not changing their stockings when they came home. Resolved, that a person can not be too careful, as long as there is any snow on the ground. But even that explanation fails in spring; and, when the incubatory influence of the first moist heat is brought to bear on the lethargized catarrh-germs of a large city, a whole district-school is often turned into a snuffling-congress. The latter part of March is the season of epidemic colds.

The summer season, however, brings relief. In the sweltering summer nights of our large sea-board towns the outcry of instinct generally prevails against all arguments of superstition; parents know

* The correlation of damp weather and catarrhs can be explained by the fact that moisture lessens the modicum of fresh air which would otherwise penetrate a building in spite of closed windows. "All materials," says a correspondent of the "Revue des Deux Mondes," "become impermeable to the air when they are wet. It has been found less easy to drive moisture through bricks and mortar than to make air pass through them; only a few drops of the liquid can be made to appear on the opposite surface. Water is therefore not easy to dislodge from the pores it has occupied, and is removed at most very slowly by evaporation. But, when water stops the pores, it prevents the air from circulating through them—a mischievous effect upon the permeability of building materials."—(*Vide* "Popular Science Monthly" for December, 1883, p. 170.)

that their boys would desert and sleep in a ditch rather than endure the horrors of an air-tight sweat-box ; so the windows are partially opened. The long, warm days also offer increased opportunities for out-door rambles. In midsummer, therefore, Nature rallies once more. But not always. There are people whose prejudices can not be shaken by experience, and in their households a perennial system of air-poisoning overcomes the redeeming tendencies of out-door life, as the subtile mixtures of La Brinvilliers overcame the iron constitution of her last husband. Their children snuffle the year round ; no cough-medicine avails, no flannels and wrappers, even in the dog-days ; and the evil is ascribed to "dampness," when the cold-air theory becomes at last too evidently preposterous.

To an unprejudiced observer, though, that theory is equally untenable in the coldest month of the year. No man can freeze himself into a catarrh. In cold weather the hospitals of our Northern cities sometimes receive patients with both feet and both hands frozen, with frost-bitten ears and frost-sore eyes, but without a trace of a catarrhal affection. Duck-hunters may wade all day in a frozen swamp without affecting the functions of their respiratory organs. Ice-cutters not rarely come in for an involuntary plunge-bath, and are obliged to let their clothes dry on their backs : it may result in a bowel-complaint, but no catarrh. Prolonged exposure to a cold storm may in rare cases induce a true pleural fever, a very troublesome affection, but as different from a "cold" as a headache is from a toothache—the upper air-passages remain unaffected. Sudden transition from heat to cold does not change the result. In winter the "pullers" of a rolling-mill have often to pass ten times an hour from the immediate neighborhood of a furnace to the chill draught of the open air ; their skin becomes as rough as an armadillo's, their hair becomes grizzly or lead-colored ; but no catarrh. On my last visit to Mexico, I ascended the peak of Orizaba from the south side, and reached the crater bathed in perspiration ; and, following the guide across to the northwest slope, we were for ten minutes exposed to an ice-storm that swept the summit in blasts of fitful fury. Two of my companions, a boy of sixteen and an old army-surgeon, were not used to mountain-climbing, and could hardly walk when we got back to our camp in the foot-hills, but our lungs were none the worse for the adventure. Dr. Franklin, who, like Bacon and Goethe, had the gift of anticipative intuitions, seems to have suspected the mistake of the cold-air fallacy. "I shall not attempt to explain," says he, "why damp clothes occasion colds, rather than wet ones, because I doubt the fact ; I believe that neither the one nor the other contributes to this effect, and that the causes of colds are totally independent of wet and even of cold" ("Miscellaneous Works," p. 216).

"I have, upon the approach of *colder* weather, removed my under-garments," says Dr. Page, "and have then attended to my out-door affairs, minus the overcoat habitually worn; I have slept in winter in a current blowing directly about my head and shoulders; upon going to bed, I have sat in a strong current, *entirely nude*, for a quarter of an hour, on a very cold, damp night, in the fall of the year. These and similar experiments I have made repeatedly, and have never been able to catch cold. I became cold, sometimes quite cold, and became warm again, that is all" ("Natural Cure," p. 40).

There are many ways, less often sought than found, for "becoming quite cold, and warm again," but an experimenter, trying to contract a catarrh in that way, would soon give it up as a futile enterprise; after two or three attempts he would find the attainment of his purpose more hopeless than before; he would find that, instead of impairing, he had improved the functional vigor of his breathing-apparatus. Cold is a tonic that invigorates the respiratory organs when all other stimulants fail, and, combined with arm-exercise and certain dietetic alteratives, fresh, cold air is the best remedy for all the disorders of the lungs and upper air-passages. As soon as oppression of the chest, obstruction of the nasal ducts, and unusual lassitude indicate that a "cold has been taken"—in other words, that an air-poison has fastened upon the bronchi—its influence should at once be counteracted by the purest and coldest air available, and the patient should not stop to weigh the costs of a day's furlough against the danger of a chronic catarrh. In case imperative duties should interfere, the enemy must be met after dark, by devoting the first half of the night to an out-door campaign, and the second half to an encampment before a wide-open window. If the fight is to be short and decisive, the resources of the adversary must be diminished by a strict fast. Denutrition, or the temporary abstinence from food, is the most effective, and at the same time the safest, method for eliminating the morbid elements of the system; and there is little doubt that the proximate cause of a catarrh consists in the action of some microscopic parasite that develops its germs while the resistive power of the respiratory organs is diminished by the influence of impure air. Cold air arrests that development by direct paralysis. Toward the end of the year a damp, sultry day—the catarrh-weather *par excellence*—is sometimes followed by a sudden frost, and at such times I have often found that a six hours' inhalation of pure, cold night-air will free the obstructed air-passages so effectually that on the following morning hardly a slight huskiness of the voice suggests the narrowness of the escape from a two weeks' respiratory misery. But, aided by exercise, out-door air of any temperature will accomplish the same effect. In two days a resolute pedestrian can *walk away* from a summer catarrh of that malignant type that is apt to defy half-open windows. But the specific of the movement-cure is *arm-exercise*—dumb-bell swinging, grapple-swing practice, and wood-chopping. On a cold morning (for, after all, there are ten winter catarrhs to one in summer), a wood-shed *matinée* seems to reach the seat of the disease by an air-line. As the chest begins to heave under the stimulus of the exercise, respiration becomes freer as it becomes deeper and fuller, expectoration ceases to be painful, and the mucus is at last discharged *en masse*, as if the system had only waited for that amount of encouragement to rid itself of the incubus. A catarrh can thus be broken up in a single day. For the next half-week the diet should be frugal and cooling. Fruit, light bread, and a little cold, sweet milk, is the best catarrh-diet. A fast-day, though, is still better. Fasting effects in a perfectly safe way what the old-school practitioners tried to accomplish by bleeding; it reduces the semi-febrile condition which accompanies every severe cold. There is no doubt that by exercise alone a catarrh can gradually be "worked off." But in-doors it is apt to be steep up-hill work, while cold air—even before the season of actual frosts—acts upon pulmonary disorders as it does upon malarial fevers: it reduces them to a less malignant type.

A combination of the three specifics—exercise, abstinence, and fresh air—will cure the most obstinate cold; only, the first signs of improvement should not encourage the convalescent to brave the atmosphere of a lung-poison den. So-called chronic catarrhs are, properly speaking, a succession of bronchial fevers. The popular idea that an average "cold" lasts about nine days, has some foundation in truth. Like other fevers, catarrhs have a self-limited period of development, but the recovery from the first attack constitutes no guarantee against an immediate relapse; on the contrary, the first seizure appears to prepare the way for its successors. A long sojourn in an absolutely pure atmosphere, as in a summer camp on the mountains, seems for a while to make the lungs catarrh-proof, by increasing the vigor of their resisting ability, and the returned tourist may find to his surprise that the air of his family den can now be breathed without the wonted consequences. But the addition of a stove or a double window at last turns the scales against Nature, and the first malignant cold reproduces the sensitiveness of the respiratory organs.

After recovery from a chronic catarrh the danger of contagion should therefore be carefully avoided. In many of our Northern cities ill-ventilated reading-rooms are veritable hot-beds of lung-poison, as crowded court-rooms in the villages, and taverns and quilting-assemblies in the backwoods. Meeting-houses, with their large windows and small, rarely-used stoves, are less dangerous; but stuffy school-rooms are as prolific of colds as swamps of mosquitoes, and often counteract all sanitary precautions of the domestic arrangements. Stuffed railway-cars, too, could claim a premium as galloping-consumption factories; and after dark the retreat to an over-heated "Pullman sleeper" would hardly increase the chances of longevity; the best plan for long-distance travelers would, on the whole, be to secure a rear seat, where open windows are less apt to awaken the groans of air-fearing fellow-passengers, and risk cinders and smoke rather than the miasma of the galloping man-pen.

It would be a mistake to suppose that "colds" can be propagated only by direct transmission or the breathing of recently vitiated air. Catarrh-germs, floating in the atmosphere of an ill-ventilated bedroom, may preserve their vitality for weeks after the house has been abandoned; and the next renter of such a place should not move in till wide-open windows and doors and a thorough draught of several days has removed every trace of a "musty" smell.

If a bronchial catarrh is accompanied by a persistent *cough*, it indicates that the affection is deep-seated, and that it has probably spread to the upper lobes of the lungs. Arm-exercise and a mild, saccharine diet generally suffice to loosen the phlegm and thereby remove the proximate cause of the evil. But, if those remedies fail, there is a presumption that the chronic character of the affection is due to a permanent external cause of irritation, which can be removed only by a change of air. In such cases cough-sirups merely palliate the evil. Medicines, counter-irritants, and fasting are in vain, if the lungs of the patient are constantly impregnated with new morbific germs; even exercise can do little more than alleviate the distress of the symptoms; a radical cure is impossible as long as every night undoes the work of the preceding day. In a home of prejudices the patient should at once change his bedroom and take care to profit by the change.

A neglected catarrh may result in an attack of *pleurisy*. Each lung is inclosed in a sack-like serous membrane, which connects with a similar membrane lining the inner surface of the chest. This double integument, known as the *pleura*, or the visceral and parietal layer of the pleural membrane, communicates both with the lungs and with the upper air-passages, and is more or less affected by every morbid condition of the respiratory organs. *Pleurisy*, or the congestion of the pleural membrane, is generally an inflammatory complication of a chronic catarrh. The original affection may have apparently subsided. Counter-irritants, alcoholic tonics, etc., have subdued the cough; with the exception of an occasional uneasiness about the chest, the condition of the patient seems greatly improved; only an abnormally rapid pulse justifies a suspicion that the smothered fire has not been wholly extinguished. A change of residence or plenty of out-door exercise may perhaps ratify the sham-cure. A normal pulse would give assurance that the masked fever has really subsided. But under less favorable circumstances an oppressive heat and a strange feeling of uneasiness will some day announce the approaching crisis of the latent disorder. Chills follow at shorter and shorter intervals, and at last a pricking pang in the region of the upper ribs reveals the seat of the affection. Breathing soon becomes so painful that the patient finds no rest in a horizontal position, but has to sit up in his bed, and may feel sorely tempted to relieve his distress by invoking the aid of the drug-gods. For believers in the remedial resources of Nature, pleurisy is, indeed, a crucial test of faith, and Dr. Isaac Jennings's observations on his experience during an acute attack of the disease deserve to be framed in every hygienic sanitarium.

"For twelve hours," says he, "breathing was at best laborious and painful, confining me to nearly an erect position in bed; but the distress occasioned by efforts at coughing was indescribable. The confidence of my wife in the 'let-alone' treatment, which had been strengthening for years, and had carried her unflinchingly through a number of serious indispositions, on this occasion faltered; and she begged me to let her send for a physician to bleed me or do something to give at least temporary relief; 'for,' said she, 'you *can not* live so.' In my own mind there was not the least vestige of misgiving respecting the course pursued.

"In view of the constitutional defect in the pulmonary department of my system, and the nature and severity of the symptoms, it appeared to me very doubtful whether the powers of life would hold out and be able to accomplish what they had undertaken and put me again upon my feet. But I felt perfectly satisfied that whatever could be done to good purpose would be done, by 'due course of law.' My mind, therefore, was perfectly at ease in trusting Nature's work in Nature's hands. There was no danger in the symptoms, let them run as high as they would. They constituted no part of the real difficulty, but grew out of it. The general movement which made them necessary was aiming directly at the removal of that difficulty. Instead, therefore, of being troubled with the idea that I could not live with such symptoms, my conviction was very strong that I could live better with them than without them.

"In the morning, ten or twelve hours from the beginning of the cold chill, there was some mitigation of suffering, which continued till afternoon, when there was a slight exacerbation of symptoms; but the heaviest part of the work was accomplished within the first twenty-four hours. From that time there was a gradual declension of painful symptoms, till the fifth day, when debility and expectoration constituted the bulk of the disease.

"Full bleeding at the commencement of the disease, followed by the other 'break-up' means usually employed in such affections, would have given me immediate relief, and, by continuing to ply active means as the work was urged on (for there would have been no stopping of it, short of stopping the action of the heart), the strongest, most distressing, and critical part of the disease might have been pushed forward to the fifth day; and I might even then possibly have recovered. But, granting that my life would have been spared, I suffered much less on the whole under the 'let alone' treatment than I should have done under a perturbating one, besides having the curative process conducted with more regularity, made shorter, and done up more effectually" ("Medical Reform," p. 312).

After the paroxysm of the disease has subsided, the pectoral fever can be alleviated by the free use of cold water and strict abstinence from solid food. Avoid over-warm bedclothing. By a load of warm covers alone a common catarrh can be aggravated into a hot fever till the blanket-smothered patient is awakened by the throbbing of a galloping pulse. Exercise would promote the discharge of the accumulated serum, but, while the patient is too sore to turn over in his bed, gymnastics are out of the question, and their effect must be accomplished by "passive exercise," manipulation of the thorax, and a swinging motion in a hammock or a rocking easy-chair. With the aid of fresh air and abstinence the remedies of the movement-cure might be entirely dispensed with, if the accumulation of purulent matter were the only risk, but in acute pleurisy there is a greater danger from another cause, namely, that the inflamed surface of the visceral pleura has a tendency to adhere to the lining of the thorax and thus obliterate the pleural cavity. The consequences of that result would be a permanent embarrassment of breathing, or even the total paralysis of the affected lung. Passive exercise and friction (rubbing the less affected parts of the chest with a bathing-brush) will, however, not fail to obviate that danger. As soon as Nature finds relief in a copious expectoration, the crisis of the disease is weathered, and further precautions may be limited to rest and a sparse but emulsive diet—a modicum of sweet cream, with oatmeal-gruel and stewed raisins. That pleurisy was formerly considered a most fatal disease can be more than sufficiently explained by the fatal measures of treatment which were then in vogue. Dr. Buchan's "Family Medical Library," not more than thirty years ago about the most popular pathological compend, contains the following directions: "In the beginning of a pleurisy the only efficient course is to make the patient stand up on the floor, while blood is drawn from a large orifice *until he faints or is about falling*. . . . If, after the first bleeding, the pain, with the other violent symptoms, should still continue, it will be necessary to take eight or nine ounces more. If the symptoms do not then abate, and the blood shows a strong buffy-coat, *a third or even a fourth bleeding may be requisite*. . . . Topical bleeding has also a good effect in this disease. It may be performed by applying a number of leeches to the parts affected, or by cupping, which is both a more certain and expeditious method than the other. . . . Then, take: Solution of acetated ammonia, three drachms; mint-water, one ounce; tincture of opium, twenty-five drops; sirup of tolu, two drachms; antimonial wine, thirty drops. Nothing is so certain to give speedy and permanent relief as a combination of ipecac, calomel, and opium." And in that form of the disease known as "bilious pleurisy," "emetics and mercurial cathartics are of the utmost importance. . . . Purgatives should be continued through the whole course of the disease ; . . . a blister should be applied *of sufficient size to embrace the whole breast*"*!* ("Family Medical Library," pages 174, 183).

Croup is an obstruction of the upper air-tubes, induced by the lethargic influence of overfeeding and warm, impure air. How an overloaded stomach reacts on the functions of the respiratory organs, many adults have an opportunity to experience in the strangling sensations of a "nightmare," though the respiratory stimulus of the cool night-air generally helps to overcome such affections, especially if the sufferer can ease his lungs by a contraction of his arms or by turning over on his side. But infants are not only more grossly overfed than the most gluttonous adults, while the phlegm-producing quality of their food increases the danger of respiratory obstructions, but that danger is still aggravated by feeding their lungs on the sickening air of an overheated and ill-ventilated bedroom, and still further aggravated by swaddling and bandaging them in a way to prevent every motion that might help to ease their distress. *Spasmodic croup* generally occurs after the establishment of a plethoric diathesis—after persistent overfeeding has turned a baby into a mass of fat and fretful sickliness. Some night, usually after a heavy surfeit, the child is awakened by a feeling of suffocation and gasps for breath till the obstruction is removed by a violent fit of coughing. "Croup-sirup" (treacle and laudanum) subdues the symptoms by lethargizing the irritability—for a little while, for soon a second and more violent fit has to complete the work of the first paroxysm by expelling the accumulated phlegm.

But a far more dangerous form of the disease is developed when the predisposing causes are aggravated by an inflammation of the larynx. Inflammatory croup, or exudative laryngitis,* does not occur unawares, but is preceded by a very peculiar cough, a hoarse, cough-like bark, mingled with strange wheezing and metallic sounds. The windpipe is congested, and in that note of warning appeals for relief from impure air and deliverance from the influence of a crapulent diet. Nine times out of ten the effect of its appeal is a dose of narcotic cough-medicine, more tightly-closed windows and a hotter stove. The process of surfeit in the mean while continues ; the windpipe, already abnormally contracted by its inflamed condition, becomes less and less able to resist the obstructing influence of the accumulated phlegm ; at night, when the exclusion of every breath of fresh air † has

* Called also "true croup," or "pseudo-membranous laryngitis," "plastic laryngitis."

† "I lately attended an infant, whom I found muffled up over head and ears in many folds of flannel, though it was in the middle of June. I begged for a little free air to the poor creature ; but, though this indulgence was granted during my stay, I found it always on my return in the same situation. Death, as might have been expected, soon freed the infant from all its miseries ; but it was not in my power to free the minds of its parents from those prejudices which proved fatal to their child" (Dr. G. G. Norwood, "Management of Children," p. 619).

still further reduced the functional energy of the respiratory organs, a viscid matter rises in bubbles, and one of these bubbles, like a tenacious membrane, closes the tube of the larynx. Suffocation results, and, in the ensuing struggle for life, Nature has a very slim chance to prevail. In our Northern States alone, five or six thousand perish thus every year—killed by domestic contrivances as surely as the prisoners of Surajah Dowlah were killed by the architectural arrangements of the Black Hole. If the physician is only called in the last stage of the *deliquium*, inflammatory croup constitutes one of those exceptional cases where artificial causes of disease have to be met by artificial remedies. The far-gone exhaustion of the patient, a thin, expiring pulse, would indicate that tracheotomy, or the opening of the windpipe, offers the only hope of salvation. A violent, suffocating, and spasmodic cough would indicate that the expulsive efforts of Nature require the aid of a swift emetic—tartar or ipecacuanha.

But, if the symptoms of danger are heeded in time, croup is as curable as a common catarrh. As soon as the characteristic cough betrays the condition of the windpipe, the patient—infant or adult—should be reduced to two meals, the last one not later than four hours before sunset. Flesh-food, greasy made-dishes, narcotic drinks, as well as all kinds of alcoholic stimulants, should be strictly avoided. Before night *the bed should be removed to a cool and carefully ventilated room.* Families who have no alternative should not hesitate to open every window for at least fifteen minutes, and in the mean while compromise with their prejudices by carrying the child to the next neighbors, rather than bring it back before the air of the bedroom has been thoroughly purified. A draught of very cold air might possibly excite a cough that would precipitate the crisis of the disease, though by no means lessen the chances of a lucky issue. But more probably fresh air, whether cold or cool, would so re-enforce the remedial resources of Nature that the inflammation would subside in the course of a few days.

If in spite of such precautions a strangling-fit should occur at night, the child should be immediately *raised to a half-upright position*, by making the weight of the body rest on the knees, with the head slightly inclined (face downward), the elbows back, and the hands resting against the hips—the position which a person would instinctively assume in the endeavor to aid an expulsive effort of the lungs. Between the paroxysms ease the chest by a *quick forward-and-backward movement of the arms*, and by *persistent friction with a wet brush, applied to the neck and the upper ribs.* Under the influence of these stimulants, combined with the invigorating tendency of fresh air, the organism will employ all its resources to the best advantage and soon relieve itself by a sort of retching cough. If the difficulty has not been aggravated by the use of "croup-sirup," the patient will rest at ease for the remaining hours of the night. A week may go by without a recurrence of the suffocating fit ; but only the subsidence of the inflammation — indicated by the diminished hoarseness of the cough—gives a guarantee that the danger is past.

STUDY—PHYSIOLOGICALLY CONSIDERED.

By P. J. HIGGINS, M. D.

THE ultimate element by means of which those processes that constitute the mind are carried on, is the microscopic cell of the gray matter of the brain. These gray nerve-cells, with the delicate tissue in which they are imbedded, form a layer, from one sixth to one twelfth of an inch in thickness, on the surface of the brain. This area would be small, were it not disposed in folds or convolutions which greatly increase its extent. It is upon the number and quality of these nerve-cells, and the systematic exercise of their function, rather than upon mere size or weight of brain, that the mental capacity of the individual depends.

The activity of the nerve-cells of the brain, in other words, depends partly upon their inherent vitality or vigor of constitution, and partly upon the quantity and quality of their blood-supply. They may be stimulated into unwonted activity by an effort of the will or the spur of excited consciousness ; but even in these cases, should the strain last any length of time, the blood-supply is quickly and largely increased.

Skeptics may cavil, but the solid fact remains that strength of intellect, like that of muscle, is frequently inherited. Capacities differ from the beginning. For this reason, children can not be expected to make equal progress under any system of teaching, any more than horses upon a race-course. But, by persistent and judicious training, the strength, speed, and endurance of all may be increased through a steady and gradual development.

In order that the teacher may utilize his efforts to the best advantage, he should understand the laws of the mind's development, and the influences that modify and regulate its activity. Mental philosophy deals with the former—to explain some of the latter is the object of this paper.

The brain-substance may be touched, and even cut, with little or no consciousness of sensation; yet the gray nerve-matter is very delicate in construction, and exquisitely sensitive to changes in its blood-supply. Like other organs, it is exhausted by continued activity, and needs rest in order to recuperate its vitality. All tissues wear more or less by work ; that is, molecules of their cell-substance die and become foreign matter, which must be cast off and replaced by new material.

This new material is absorbed by the cells from the blood, through the thin walls of the minute blood-vessels in their vicinity. Through the walls of the same vessels the cast-off matters pass in the opposite direction into the circulation and are washed away by its current. While the tissue is hard at work, the process of disintegration is at a maximum, and that of repair at the opposite extreme—consequently the waste is produced more rapidly than it can be carried away, and accumulates. As ashes in a stove interfere with combustion, it impedes the current of thought, and lessens its intensity. But, during repose, the opposite conditions obtain—repair is at its maximum, and waste almost or entirely suspended. The blood has been busy all night ridding itself and the tissues of all impurities, and is richly charged with oxygen. The brain, and consequently the mind, is fresh and vigorous after the night's repose; the damages have been all repaired, and the *débris* cleared away. It is a matter even of common observation that at no other time is the mind so sharp, clear, and strong, as in the morning.

Concrete ideas tax the mind but lightly. The more abstract ideas become, the more difficult is their comprehension, and the greater the nervous strain involved in their contemplation. For this reason, the abstruse studies should be taken up during the forenoon session, as the faculties of the mind are then in the most favorable condition to grapple with their difficulties.

Of all school-studies, mathematics requires the strongest grasp of mind, and the closest exercise of the reasoning powers and the judgment. In abstruseness and difficulty of comprehension, geometry, algebra, and arithmetic, rank in the order enumerated. Rhetoric, including grammar and composition, comes next. In every school and college, therefore, these subjects should be taken up during the morning session.

The mind learns by means of impressions made upon the gray nerve-cells, through the senses, of which sight is the most vivid and durable in its effects. Hearing ranks next, but its impressions are less vivid and more fleeting. Further, they are recalled to the memory less readily and distinctly. We all remember what we see longer than what we hear. Hence the most reliance should be placed upon the eye as an avenue of instruction, and the teacher should make use of it whenever practicable. When an impression is made upon a nerve-cell, it is said to retain it "in potency"—that is, it is capable of renewing it by an exercise of the memory. Now, the clearness and permanence of a mental impression depend—(*a*) upon its vividness; (*b*) upon the frequency of its repetition; and (*c*) upon the inherent vigor of the nerve-cell.

To obtain vividness of impression, the teacher's language should be clear and simple; his descriptions of processes and objects sharp and vivid; he must present the same ideas again and again, in order to fix them permanently in the memory. The inherent vigor of the mind can be strengthened by systematic exercise, just as the muscles of a blacksmith's arm become strong and brawny by years of daily toil at the clinking anvil.

Throughout animated nature, a period of repose succeeds one of activity, both recurring in regular alternation. The vegetable world grows and blooms ; then, for a season, all the vital processes stand still. Work brings weariness, which rest must dissipate. So is it with the tissues of the body ; and the younger and more delicately organized they are, the sooner does toil exhaust them. Brain-matter is the most delicate of all our tissues, and nearly one third of the pure blood thrown out by the heart at each contraction goes to supply it. A tissue, when at work, has its blood-supply largely increased. When the mind is actively engaged in study, the circulation in the brain is full and active, the temperature is raised, even the face is flushed; and the more difficult the study, the more these effects are intensified. After a time, the brain becomes so engorged with blood that its activity is depressed and its energies begin to flag. The younger a pupil is, the sooner does his mind grow tired. Between the ages of six and seven, the lessons should not exceed ten minutes' duration, as young children are unable to keep their attention fixed upon one subject for a greater length of time. It may be laid down as a safe rule, that close mental application for an hour and a half will tire out the majority of pupils, and leave them unfit and indisposed to proceed further without a relaxation of at least ten or fifteen minutes.

Here the forenoon recess is indicated—not, as some imagine, simply to kill time, but as a positive physical necessity, not for the pupil alone, but also for the teacher. The worry and mental strain of governing a roomful of nervous, restless children, and teaching at the same time, no one can fully realize without actual experience.

How should recess be spent by the pupil? To reply to this, his physical condition must be considered. As the blood is contained in a series of closed vessels, it is evident that, if the circulation be increased in one portion, it is correspondingly diminished in another. When the brain is engorged, some other portion of the economy must be under-supplied. By a wise provision of Nature, the surplus is drawn from the tissue that is least active—in this case, from the muscular system. The indication is to relieve the congested brain, and this is best met by muscular exercise, as a tissue in action has its blood-supply largely increased. The muscular system is of considerable extent, and the exercise that brings the most muscle into action is the most beneficial.

Therefore, during recess, nothing can take the place of active exercise in the open air.

But if the temperature is very low, recess had better be taken indoors, for the intense cold exhausts the vitality by drawing largely upon the heat-supply. By constringing the cutaneous vessels, it congests the internal organs and weakens the heart, while it requires some time to restore the equilibrium of the circulation. In rainy weather, the result is still more detrimental. In a climate like ours, exposure to rain is at all times fraught with danger to health, and particularly when one sits still in wet or damp garments for any great length of time. No recess out-doors, on a bitterly cold or rainy day, should be the rule, and gymnastic exercises, calisthenics, motion-songs, etc., should take its place. Every grammar-school should have one room fitted up as a gymnasium. There is a certain amount of nerve-energy that is accustomed to find outlet in the muscles, and, if unduly repressed, it will often break through the strictest discipline and cause the teacher much annoyance. It must not be forgotten that muscles were not created to be kept still during waking hours, and, when kept at rest an hour or two, a surplus of energy accumulates, which recess gets rid of legitimately. It also serves another purpose admirably. Of all sedatives of the nervous system, muscular exercise is the most efficient, because physiological. It quickens the circulation, and stimulates the heart and all the vegetative functions.

After exercise, the muscles—of the hand and forearm particularly—are subject to rhythmic, automatic waves of contraction ; that is, there is a tremor beyond the power of the will to control. So that writing and drawing, which require great steadiness of the hand and fingers, should never be taken up after recess, or at the commencement of the afternoon session. Of the elementary studies, mental arithmetic involves the closest application of the highest powers of the mind—drawing at once upon memory, reason, and judgment—and this may be taken up advantageously from half-past eleven to twelve. Breakfast digestion is then nearly if not quite completed, and intense application is least detrimental to the vegetative system.

The morning meal is usually light in material and amount ; dinner, partaken of soon after noon (except in the largest cities), is the principal meal. It is "solid," in a physiological not less than in a popular sense, for it is most generous in amount, and usually rich in nitrogenized matters—flesh-meat, puddings, eggs, etc. After its ingestion, the digestive organs are taxed to their utmost capacity, and soon become loaded and distended with blood. The digestive system is quite extensive, and is richly supplied with blood-vessels, which are imbedded in rather loose tissue, so that they may dilate, to accommodate the sudden influx from the outlying portions of the body, together with the newly-absorbed products of digestion. The brain is thus deprived of its full supply ; and if, by reason of severe study, it draws upon the circulation, the digestive organs are robbed of their needs, and their efficiency interfered with seriously. Intense application at this time does harm in another way. All the functions of the body are under nervous control. The digestive organs are mainly innervated by the pneumogastrics—two nerves arising from the lower portion of the brain, near the base. Now, the thinking portion of the brain being situated on the convex surface, deep and perplexing thought robs the roots of the pneumogastric nerves of their circulation, and in this way depresses their influence. Lacking the proper nervous stimulus, the digestive juices become scanty in amount ; peristalsis is enfeebled; the liver—that refinery where the crude products of digestion are purified and elaborated—loses tone, and allows the peptones to pass unchanged into the general circulation, giving rise to much discomfort and mental depression. Thus are laid the foundations of dyspepsia, that common complaint of students ; and in the higher institutions of learning, where the course is difficult and protracted, many, after graduation, return home invalids—often only to die.

The products of digestion are taken up by two different sets of vessels. The fatty matters, in the form of an emulsion, go almost directly to the right side of the heart ; while the others, before entering the general circulation, pass through the liver. A portion of the refuse is excreted here ; the rest, remaining in solution in the blood, is carried to other organs to be gradually eliminated. So that, during digestion, the blood is not only charged with impurities from the alimentary canal, but also with newly or imperfectly formed material.

The brain, then, being deprived of its full blood-supply, and the blood itself being impure and impoverished, it may at once be seen that the mind is not very active after dinner, and by no means fitted for severe study. Hence the lighter subjects—reading, geography, history, writing, drawing, music—should occupy the afternoon session, as these subjects involve chiefly the imitative faculty and the memory. Of these, reading and music—the lightest of all—should precede ; dictation and geography may follow. When the programme includes an afternoon recess, history may follow with advantage. The most appropriate time for writing and drawing is from half-past three to four. The muscles of the hand are steady, the pupils are fatigued mentally, and the imitative faculty—the lowest in the scale—is the only one called into play.

Two o'clock may be set down as the most judicious time for the opening of the afternoon session. Half-past one is not quite so good, but will answer very well. To begin at one is a positive detriment. The pupils hurry home, snatch a hasty dinner, and as hurriedly return. Those who dwell at some distance are often late. Some are obliged to attend to household duties, and this also occasions tardiness. Sunlight is cheap and plenty, and the half-hour gained would be more useful if taken at the end of the session. Indeed, two hours' steady work will exhaust the majority of children, and will leave all seriously disinclined to exertion. When school assembles at two, and is dismissed at four, no recess is necessary, if the plan here indicated is followed, for the work is much lighter than during the morning session.

Of late certain spasmodic efforts have been made to abolish recess, and hold but one long session per day—from nine to one or half-past one; but this is a mistaken notion, founded on lack of knowledge of the effects of long-continued study and the physical needs of the young. It is true that in some of the largest cities this plan is followed in the high-schools, but the cause is local, for the pupils come from long distances—in New York city, for instance, as far as five miles. Besides, in many of these schools the pupils do much of their studying at their homes, and the majority are in the neighborhood of twenty years of age, so that they are in a better condition to stand the additional strain without injury.

Anything that distracts the pupil's attention from his studies retards his progress, by making less vivid the impressions received by the nerve-cells; for, by concentrating the mental vision upon one point, to the exclusion of others, we see that point more distinctly. All peripheral irritation, therefore, should be removed as far as possible. The distraction of discomfort, particularly of the cutaneous surface, is a serious drawback; comfortable seats—preferably single—high enough to support the lower limbs, and desks of the proper height to rest the arms, are in this way valuable indirect aids to study. But of all peripheral irritation, that produced by cold is perhaps the most distracting. When the temperature of the room falls below 50° Fahr., the next exercise should be dismissal. Between 50° and 70° the temperature may range; but from 60° to 65° is the safest and most comfortable; safest, because the cutaneous surface does not become overheated and congested—liable to be chilled by the lower temperature of the open air—and most comfortable, because neither heat nor cold is perceptible. It is needless to add that every school-room should have a thermometer, which the teacher should frequently consult, and govern himself according to its indications.

For the reasons noted above, children at home should not be allowed to prepare their lessons immediately after supper, or late into the night; for study congests the brain, and, as sleep is produced by the opposite condition, they lie awake and restless until the amount and pressure of blood within the cranium are greatly diminished.

Strange as the assertion may seem, a pupil's diet has much to do with his progress. A liberal supply of non-stimulating food—in other words, bread, milk, vegetables, fruits, and a farinaceous diet principally—is far superior for the healthy growth of bone and nerve and muscle than a regimen into which nitrogenized materials—flesh-meat, eggs, etc.—enter largely. These latter unduly stimulate the nervous system, cause a premature development of the body, and load the blood with impurities, that tax the liver and the excretory organs sorely. In a warm climate, such as ours, the liver, choked with albuminoids, will fail in its function periodically, through sheer fatigue; the bilious matters then circulate throughout the system and stain the complexion; torpor, *malaise*, and headache, will result. In this condition study is a task instead of a pleasure; the mind is weak, and the memory can not retain imparted knowledge for any great length of time.

In general terms, it may be laid down as a rule, that much effective study must not be expected from a pupil who is overfed, especially if on rich and stimulating food. Let it not be understood that flesh-meat should be excluded from the diet of the young. By no means; it is only its excess that is objected to. An overfed pupil is indolent, intellectually, not because he may be so inclined willfully, but for the reason that his digestive organs rob his brain, and his blood is charged with effete matter; in figurative phrase, the fire is slow because the stove is filled with coal and choked with ashes.

To recapitulate: The more abstruse studies—mathematics, science, rhetoric—should be taken up during the morning session. The proper time for the forenoon recess is at half-past ten. The lighter or concrete subjects—reading, history, geography, writing, drawing, music—should occupy the afternoon session, commencing preferably at two o'clock. When it begins at half-past one, a recess of ten or fifteen minutes is necessary, preferably the quarter-hour preceding three o'clock. No out-door recess when the weather is inclement. For the younger pupils, short lessons frequently repeated, exercising chiefly the imitative faculty and the memory, should be the rule.

FASHION AND DEFORMITY IN THE FEET.

By ADA H. KEPLEY.

"A WELL-FORMED foot," says Chapman in "The American Drawing-Book," "is rarely to be met with in our day, from the lamentable distortion it is doomed to endure by the fashion of our shoes and boots. Instead of being allowed the same freedom as the fingers to exercise the purposes for which Nature intended them, the toes are cramped together, and are of little more value than if they were all in one; their joints enlarged, stiffened, and distorted, forced and packed together, often overlapping one another in sad confusion, and wantonly placed beyond the power of service. As for the little-toe and its neighbor, in a shoe-deformed foot, they are usually thrust out of the way altogether, as if considered supernumerary and useless, while all the work is thrown upon the great-toe, although that too is scarcely allowed working-room in its prison-house of leather. It is, therefore, hopeless to look for a foot that has grown under the restraints of leather, for perfection of form; and hence the feet of children, although less marked in their external anatomical development, present the best models for the study and exercise of the pupil in drawing."

Camper, who wrote, in the seventeenth century, "On the Best Form of Shoe," says that his treatise originated in a jest made with his pupils, who "did not believe I should dare to make public a work on such a subject," which indicates the small estimate that was put upon the foot as an organ of the body. He begins by deploring the perversity which wholly neglects the human feet, while forcing the greatest attention to the feet of "horses, mules, oxen, and other animals of burden," and declares that from the earliest infancy the foot-coverings worn serve but to deform them, and make walking painful, and sometimes impossible; and he lays the blame on the ignorance of shoemakers.

James Dowie, a practical and scientific Scotch shoemaker, in his excellent little book, makes the same statements as the artist; and the great Dutch surgeon, whose treatise he had translated into the English language, also laments that the subject of the feet is so neglected by those who are competent to instruct us about them. Lord Palmerston said to Dowie that "shoemakers should all be treated like pirates, put to death without trial or mercy, as they had inflicted more suffering on mankind than any class he knew."

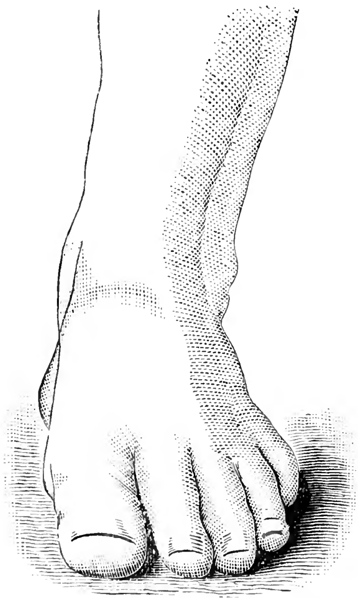

Fig. 1.

One can not treat of the deformities of the feet without considering the nature of their covering, the boots and shoes, for it is these which cramp, distort, and disable them; therefore in this article, after a brief account of the anatomy of the foot, our attention will be confined to its principal distortions and the causes which produce them.

The feet furnish a firm base for the body in standing, and, undeformed, make walking easy and healthful. They sustain alternately the whole of the body's weight, and, though comparatively small, are admirably fitted to carry it without jar or discomfort, if unhampered by their coverings. They are in the highest degree elastic, from the large number of bones, with many articulations, with their attachments, and the plentiful supply of muscles, blood-vessels, and nerves to keep them vigorous and well-nourished. This elasticity enables them to carry the body over smooth and rough surfaces, not only without injury, but to its greater health. In just so far as this elasticity and freedom of natural action are interfered with, is their health, and with it that of the body, lowered.

Anatomists divide the skeleton of the foot into three portions, the tarsus, with seven bones, forming the heel and arch bones; the metatarsus, with five bones just forward of the tarsus; and the toes, which contain fourteen bones, two in the great-toe, three in each of the other toes; beneath the ball of the foot, as it is called, are two small bones, which lie under the articulation of the great-toe and the adjoining metatarsal bones, making twenty-eight bones in each foot (see Figs. 16, 17, 19).

The large articulating surface of the feet, and their numerous blood-vessels, muscles, nerves, etc., render it peculiarly susceptible to injuries. Their distance from the center of circulation, together with the variations of temperature they have to endure, make them extremely liable to contract disease.

It seems as if the general injuries to the body resulting from diseased and crippled feet should be plain enough to attract attention, but such does not appear to be the case. No complete treatise on the feet has been produced. Physicians as a class seem to pay the subject but little attention. In the books in which the diseases and injuries of the feet are considered, the causes of disease, if stated, seem to be mentioned incidentally, and without proper notice of the connection between the diseases and the bad physiological conditions they induce. Physicians will prescribe for diseases caused largely by unsuitable clothing of the feet, without saying anything of the reform in the *chaussure* by means of which the disorder might be greatly mitigated, if not cured. A delicate woman was treated for months for a peculiar disease which made her a complete invalid, by an eminent specialist, who said nothing of the high-heeled, paper-soled, thin boots, the habitual wearing of which greatly aggravated her disorder. A paper showing the deleterious effects of such shoes on the health of women, read at a recent meeting of an association of doctors, seemed, according to the reports, to call out more objectors than it found friends. A competent woman physician excused herself for wearing such shoes because it was so hard to find hygienic shoes in stock, and added that, when physicians prescribed reforms in clothing, they had to be politic, to keep their patients; and when asked if she ever saw a woman who wore tight shoes, replied "No"; nor did she know any who wore tight corsets.

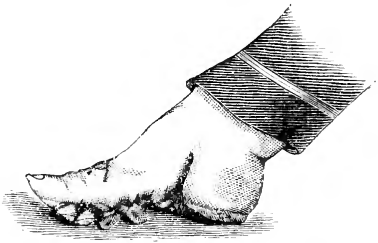

Fig. 2.

Walking is the exercise that, more than any other, brings every portion of the system into healthful activity. Many complaints would disappear under a thorough and careful course of pedestrianism; but who can walk if the feet are sore or diseased? General bad conditions arise from lack of exercise, which invigorates the muscles and oxygenizes the vital fluid. Dyspepsia is the usual attendant on such conditions, and may manifest itself either by general emaciation or by fatty degeneration.

The feet demand a covering which shall conform to their shape, allow them free play, and afford protection from injuries.* Dowie scoffingly remarks, in his treatise, respecting shoes so cut at the toes as to represent the foot like that of a goose, with the great-toe in the middle. We are now in an era of "pencil-toed" shoes, so called, which recall Dowie's comparison. It is difficult to understand how shoemakers can be so careless of the shape of the feet and their needs as to cut shoes that in the toe are the very reverse of what toes demand; but it is more difficult to conceive how any one can endure the suffering they inflict. Dowie insists that tight-toed stockings are injurious to the feet, and recommends that they be woven with a separate covering for each toe, as gloves are made with fingers.

Fig. 1 is a foot copied from the antique, and shows "beauty of form and proportion, ease and elasticity of motion, as well as an admirable expression of adaptation and power for use throughout."

Fig. 2 shows the distorted foot of a Chinese woman, photographed from nature.

Fig. 3 represents the sole of a normal human foot. The dotted line shows how the foot is usually cramped in the shoe-sole. The heel of the foot is narrow, the anterior portion broad, the toes are nearly parallel to a line "C," drawn through the center of the sole from heel to toe. The line A B is drawn through the center of the instep, or great arch of the foot, and bisects the great-toe. It is this arch which mainly supports the weight of the body; the heel forms one of its

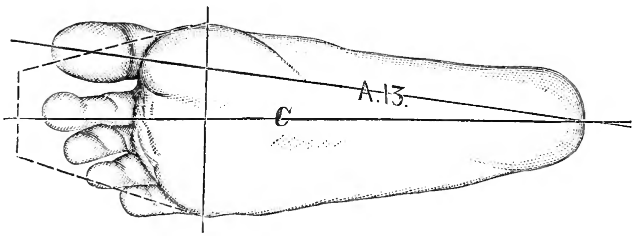

Fig. 3.

piers, the great-toe the other. One may easily see that when the great-toe is drawn from its line with the arch, as indicated by the dotted lines, the stability of the body is by so much destroyed; and when the heel is taken from its level with the bulk of the foot, by a high heel, yet more is the stability of the body destroyed. Erichson says: "Firmness of gait is caused by the foot resting on the heel be-

* The Indian moccasin is probably the easiest and most comfortable foot-covering worn, as it adapts itself perfectly to the shape and motion of the foot.

hind and the ball in front, and principally by the foot resting on the broad line formed by the great-toe and the breadth of the fore part of the foot."

The dotted lines in Fig. 3 show the outlines of a quite liberal sole. It is easy to see how an ordinary foot would be cramped if confined within its limits.

Fig. 4 shows a very common shape of the foot, produced by cramping and crowding the toes. Many persons have only to look at their own feet to see fine specimens of this sort.

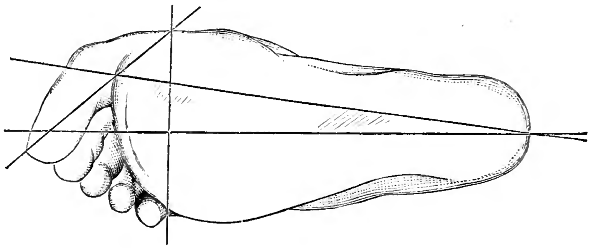

FIG 4.

The diseases most common to the feet are corns, bunyons, calluses, enlarged and stiffened joints, stiff and wasted toes, overlapping and underlapping toes, in-growing nails, caries of the bone, exostosis of the toe-bones, onyxitis of the toes, flat-foot, club-foot, ulcers, malignant and fibrous tumors, dislocations, changes in the shape of the bones from pressure, and elephantiasis. All wounds, injuries, and diseases are extremely liable to take on erysipelatous and scrofulous conditions, which speedily endanger life through their inflammatory, gangrenous, or debilitating nature ; fatty degeneration of the tissues may take place, and weakness of the joints and thickening of the ankles plague their owners.

Corns consist of hardened flesh that becomes thorn-like in its shape and density, and a dismal source of pain. "A corn," says a writer, "is really a wicked demon, incarnated in a piece of callous skin. Its mission is to distress and agonize humanity and increase its wickedness." Gross says, "A bunyon is a corn on a large scale," and he and other writers agree that it is caused by a diversion of the great-toe from its line with the arch of the foot. When the toe is thus diverted, it forms an angle on the foot, which the shoe irritates and makes callous ; inflammation sets in, and suppuration frequently ensues, that, in extreme cases, may make necessary amputation of the foot or feet.

Fig. 5 represents the foot of a young woman who wore high-heeled, narrow-soled shoes, which must also have been too short.

Figures 6 and 7 represent forms of bunyon complicated with under- and over-lapping toes.

Fig. 8 shows a deformity of the foot resulting from inflammation of the metatarsal, phalangeal, or great-toe joint.

Fig. 9 shows an apparatus for the cure of bunyons. Its object is to draw the great-toe back into line with the great arch of the foot.

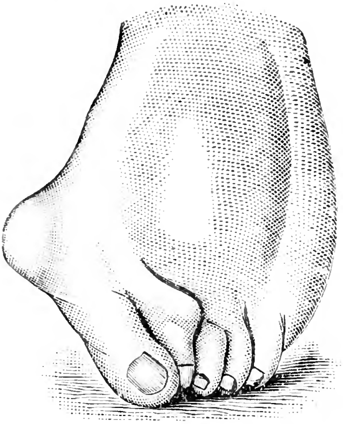

Fig. 5.

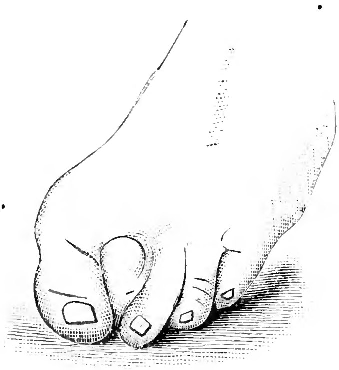

Fig. 6.

Erichson says, bunyon is caused by improperly cut shoes, and adds that to cure it the foot should be put in a shoe cut straight from heel to toe at the inner line of the sole. The toes are naturally quite flexible. Cases are well known of men and women who, being devoid of hands or fingers, have learned to use the feet and toes instead. Miss Biffin, of London, became expert as a portrait-painter; another woman used scissors to cut out all sorts of figures from paper; and men have been fully as capable with their toes. The Chinese and Hindoos are said to be able to pick up the most delicate objects with their toes. Yet in most feet the toes are wholly incapable of independent motion, while in many feet they are entirely stiff, and are distressing objects to look at.

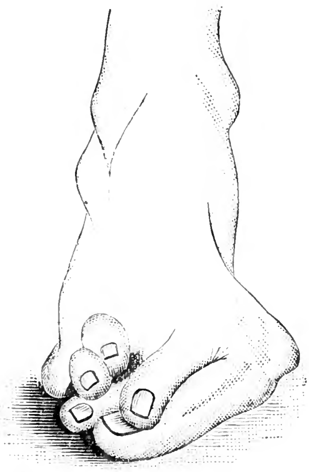

Fig. 7.

In-growing nails are caused by shoes which are too short, and are a source of exquisite torture. This disease may degenerate into a worse condition called onyxitis (see Fig. 10), when it discharges a fetid humor, and may render a resort to the surgeon's knife a necessity. Caries of the bone may follow wounds, bruises, contusions, bunyons, corns, and calluses of the feet; and bunyons, corns, and calluses, as well as wounds, bruises, and contusions, may take on erysipelatous, scrofulous, ulcerous, or tumorous conditions. Exostosis of the bones (Fig. 11) is an abnormal growth which requires the saw, knife, and gouge of the surgeon for its extirpation. The toes are especially liable to this disease.

Fig. 12 is a specimen of splay or flat foot. It is caused by a breaking down of the arch of the foot, whereby locomotion becomes painful and sometimes impossible. Impairment of the general health accompanies it ; in its worst forms a partial displacement of the bones occurs, the toes turn up, and the sole grows convex, while the ankle is very likely to thicken and lose strength by fatty degeneration. It is most common among youth. Some writers attribute it to "vicious eversions of the foot in attempts at polite walking" ; by others it is attributed to overwork. It is most common among the children of the wealthy classes. Old people are subject to it from a breaking down of the tissues with age. For its cure local means must be used, and special attention be given to the general health.

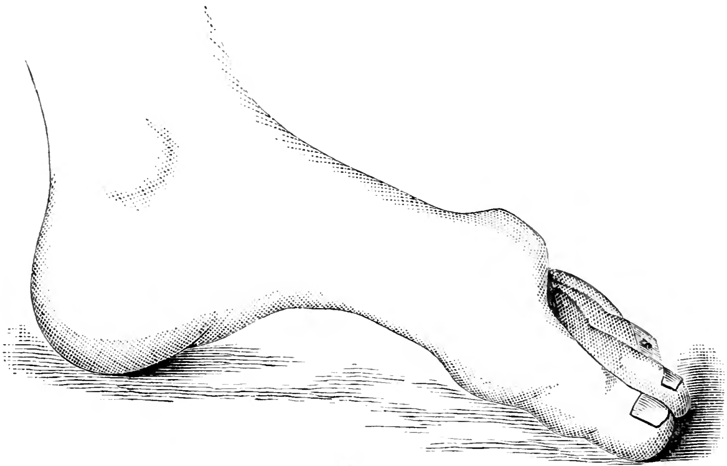

FIG. 8.

A disease called elephantiasis, sometimes necessitating amputation of the whole limb, may result from injuries to the foot. A case of this sort is found in the books, where a dislocation of the foot, caused by drawing off a boot, induced the disease.

It is now time to consider defects in shoes, by which most of these diseases may be provoked or aggravated.

Dowie, who was a practical as well as theoretical shoemaker, and so full of enthusiasm that he studied the foot under skillful anatomists, and sent all his journeymen to a course of lectures on the feet, enumerates as the principal evils, that shoes are worn too short ; that they are cut too narrow at the toes and in the sole; that the soles do not conform to the shape of the inner curve of the foot, nor to the line of the great arch or instep and the great-toe ; that at the waist, or middle, the sole is too stiff and unyielding ; that the toe is vertically too shallow, or "wedge-toed," as he calls it; that the heel is too high; that the sole turns up too much at the toes. He and Camper agree on these points. The evils attending shoes too short will be more readily perceived when it is understood that the foot is lengthened in walking, and more in running and jumping.

The degree of elongation depends upon the shape of the foot. Long, slim, high-arched feet elongate most; short, fleshy feet least. In the first case the elongation varies from one fourth of an inch to one inch. It takes place forward and back, and the shoe should be long enough to allow for it. It is produced by the flattening of the

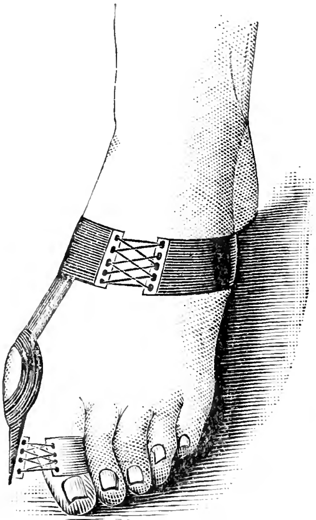

Fig. 9.—Apparatus for the Treatment of Bunyons.

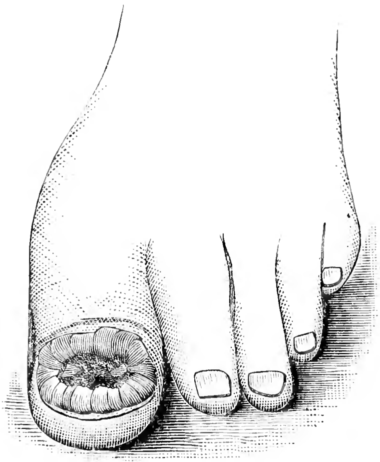

Fig. 10.—Onyxitis of the Great Toe.

arch of the foot, when the weight of the body falls upon it; just as a carriage-spring elongates under pressure. The shoe which is just long enough when the foot is at rest, becomes too short when the elongation takes place, and the toes rise, as shown by the dotted lines in Fig. 13, preventing them from forming the firm pier which the anterior portion of the arch of the foot should have to rest upon, diminishing the elasticity of the organs, impairing their muscular force, and inducing the formation of corns through the rubbing of the toes against the leather. The weight of the body also crowds the toes up, and, turning the great-toe out of place, unfits it for its useful function. In-growing nails are caused by short shoes. An old poet says—

"The shoe too short, the foot will wring";

and an old English couplet sums up the height of aggravating misery in these lines:

"Here's to our friends; as for our foes,
We wish them *short shoes*, and corns on their toes."

Narrow-toed shoes aggravate the abnormal position of the great-toe, and cramp the other toes closely together, stopping all their free and healthful motion.

Narrow soles cramp the whole foot; calluses, corns, stiff and inelastic joints, and wasted muscles follow. The distress endured by a fleshy foot in a narrow shoe must be felt to be appreciated. If shoes are not cut "rights and lefts," they do not conform to the shape of the foot, and keep it in a continuous strain, exercising also a tendency to break down the supporting arch. The foot, thrown out of position, falls too far to one side or the other, and we have "running down at the heels," and vicious inversions of the foot in walking.

Tight shoes impede the circulation, deprive the feet of the warmth they need, and ultimately cause waste of the tissues. A friend of the writer, a strong, vigorous man, in splendid health, nearly lost his life from congestion induced by an hour's wearing of a pair of tight boots. Of shoes too stiff at the waist or middle, Dowie says, "Rigidity of this portion of the foot-covering is particularly destructive of the muscles of the foot and leg, for it interferes almost entirely with the free play of the whole foot." *

"Wedge-toed" shoes call for some preliminary remark. If one examines the ends of the fingers, it will be seen that they have a fleshy protuberance; the toes have this in common with the fingers, and its office in both is to make a soft, cushion-like protection for the bones. A wedge-toed shoe, such as is seen in Fig. 14, forces the toes immovably into a close envelope that crowds this cushion away from the bones, and wastes it to such an extent that the bones, lacking its protection, become diseased often to a degree requiring surgical treatment. The dotted lines in Fig. 14 indicate how the evil might be mitigated by giving a fullness in the upper leather. Take a round and narrow wedge-toed shoe, and let it be short as one may generally see them, worn, and you have an instrument of torture that is little short of the famous iron boot of the past ages.

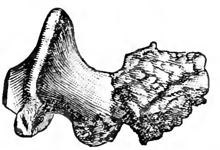

Fig. 11.—Exostosis of the Bone.

"Box-toes" possessed the virtues of giving room for the extension of the foot, and saved their wearers from the torments of "wedge-toes," but they had other defects, and are now almost out of use.

High heels augment all the injuries and miseries we have enumerated. The foot on heels is in the position it occupies in going down-hill, or down the roof of a house, a most insecure and unstable one. The weight of the body is thus thrown forward, the center of gravity

* This is a prolific cause of the homely spindle-shank, which he says marks the English laborer in his wooden solid shoe. Dowie cites the Irish laborer, who goes barefoot, and has a splendid muscle in his calf, as a sample of what free play of the foot will do for the improvement of the leg.

is shifted, and the weight becomes unequally distributed among the different parts of the foot, and the forward portion has to do the bulk of the work. The inevitable detriment such a condition entails upon the health of the foot and of the body does not need to be enlarged upon. Additional inconveniences resulting from it arise from the liability of the body to fall from its unstable poise, and the propensity of the narrowly pointed heels to catch in every little crack or opening, and trip up the wearer. Of these evils the awkward, tottering gait produced by high-heeled shoes is visible evidence.

The center of gravity of the body falls directly on the angle produced by the lines A and B in Fig. 15, which shows the foot at rest in its normal position on a level surface; the line A falls inside the outline of the foot, whereby the harmonious relations of each portion of the foot are indicated. Figs. 13 and 16 represent the foot as in position upon high heels, 13 being rather exaggerated, but 16 little higher than the average heel. A glance will show that just as the heel is elevated, the line A is thrown outside of the outline of the foot, disturbing the relation of its parts, throwing the weight of the body unequally upon it, and thereby seriously interfering with its functions.

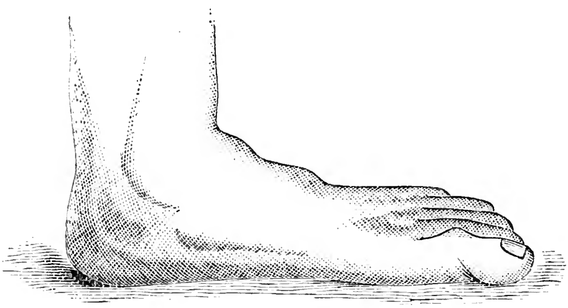

Fig. 12—Splay or Flat Foot.

There are those who believe and assert that an upright carriage of the body is assisted by high heels. A little thought and observation will convince the candid inquirer that this is a mistake. A shoemaker called my attention to the baggy trousers knees observable in connection with the wearing of high-heeled boots, and said, "Elevation of the heel thrusts the knee forward." The human body should stand erect from the heels upward, but the projection of the knee makes necessary a bending forward of the whole frame, to maintain an equilibrium. This is undoubtedly one cause of the ungraceful round shoulders and poked-forward head noticeable with so many women and girls.

The shoes of men, as a rule, are not so badly constructed and worn as the shoes of women and children. A larger proportion of men wear custom-made shoes, in which some effort is made to fit the foot. Business-men generally have eschewed heels, except the lowest "lifts."

Among soldiers and policemen, foot-soreness is a common complaint, and renders the man who has to endure it unfit for service. It is stated that, during the late East Indian wars, the native foot-soldiery, when ordered to "march," took off their regulation shoes and hung them on the ends of their muskets, while they went barefoot. Commanding officers reported great loss of men who could not keep up on account of foot-soreness, and were easily picked off by the enemy. A Highland regiment, when ordered to "charge" the foe, took off their shoes and charged barefoot, as they could do more effective work. The regulation shoes interfered with free muscular action. Dowie characterizes the shoe as a "Juggernaut of cruelty," saying it possesses wedge-toes, a rigid waist, high heels, and convex inner soles, and adds: "If a soldier be weak or lame in the feet, he can never apply with advantage the strength of his arm in charging the enemy, or in sustaining a charge, because the foot is that part of the mechanical system or leverage which rests upon the fulcrum, the ground, and, if you weaken the leverage at this important point, the strength of the whole system is reduced."

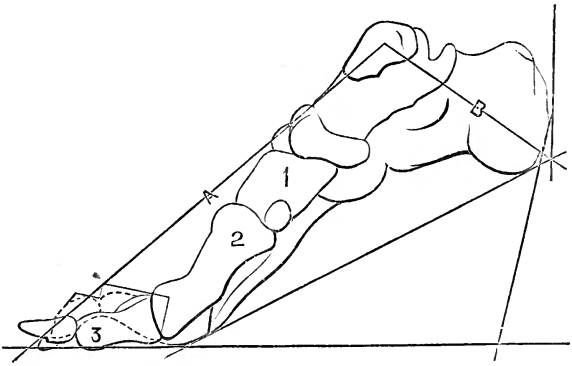

Fig. 13.

The opinions of Mr. Dowie on this subject coincide with those of eminent military men. The defects which he enumerated were common in the shoes of our own soldiery during the late war, and were followed with the same results.

It is very hard to find any woman who will confess that her shoes are too tight, too short, or too high-heeled. Her shoes are usually "miles too big," and hurt by their looseness. If women complain of lame backs or aching feet, they will be sure the shoes have no part in it; because women are really not aware how they have departed from nature in this regard. The perfect female foot is described by a physician as follows: "It should have great breadth and fullness of instep, a well-marked great-toe, a long second toe, a small little-toe." Woman needs a strong and firm footing, particularly because of her function of motherhood, and yet this perfect foot is the exact opposite of the ideal lady's foot of to-day; narrowness, shortness, and littleness are the qualities that go to make it up; and there are women, if we may believe what is said in the newspapers, who to secure a narrow foot are willing to have the little-toe ruined.

Strange as it is, the American women, while cramping the feet, deny it. The Chinese are more logical. They distort and cripple the feminine foot to a much greater degree, and then sing its praises. Its favorite name, the "golden lily," is well known.

Many of the peculiar ailments under which women pass their days in invalidism, unhappy and miserable themselves and making others unhappy, would vanish or be greatly mitigated if they would but apply common sense to the selection of their shoes. It is very hard to persuade them to reform their habits on this point, but I have never known any woman who had learned the new comfort to go back to the old habit.

No exercise is so healthful and delightful as walking, yet few women can endure it. For to walk in their ordinary shoes is one of the most exhausting labors women can attempt. There is no doubt that by a thorough and careful system of pedestrianism many women would become robust, though now half-invalids. I know of one who walked on an average two or three miles a day, and would spend an hour or two cutting brush, saplings, and small trees, lopping off limbs, hauling brush to gullies and into heaps, and climbing fences. Her garments were warm and loose, her shoes "stogies," big, broad, and low-heeled. Health came as a reward. Another case is of a lady who is a commercial traveler in a large Western State. Her health broke with in-door confinement at school-teaching and book-keeping, and she was advised to try the road, which she did, as agent for a sash, door, and blind factory, and afterward for a paint, oil, and glass establishment. She never misses a day nor a train, dresses feet and body for comfort, is hearty and well, and earns a large salary.

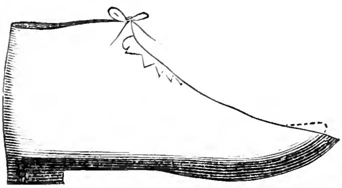

Fig. 14.—A Wedge-toed Shoe.

The feet not only look smaller, but really become so in tight, high-heeled shoes, in consequence of a reduction of the blood-supply. We are told of a Frenchman who invented an apparatus for reducing the size of the nose, and it consisted only of a spring which cut off the supply of blood to the organ. A paper was read at a recent health congress in Switzerland, calling attention to a French style of shoe, which, the author remarked, gave the foot a "hoof-like" appearance. This style is much worn here, and produces a clumping, ungraceful jolt in the gait, tending to induce destructive spinal vibrations.

Probably the worst and most lasting injuries to the foot are produced during childhood, when the bones and cartilages are tender, and the muscles are soft and most sensitive to strains. As a rule, children's shoes are too short and too tight, and no allowance is made in them for the growth which is all the time going on, or trying to go on, in the foot. Evidently an injury cramping the growth at this time can not be remedied; and if the children have any tendency to become bandy-legged or knock-kneed, badly shaped shoes, especially if they have high heels, will aggravate the evil and make it more lasting.

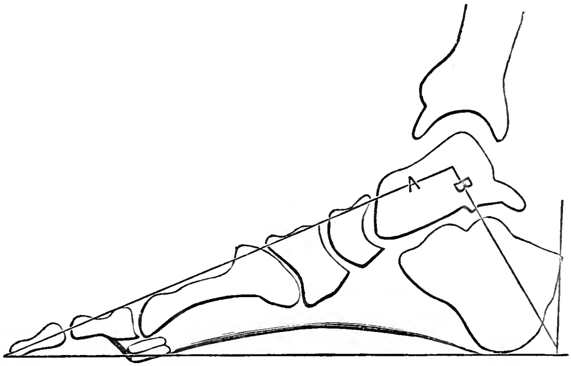

FIG. 15.—PROPER POSITION OF THE FOOT UPON THE GROUND.

André, an old French writer, is quoted by Camper as saying that high-heeled boots produce curvature of the spine in children. The shifting of the body from foot to foot to get ease contributes to this effect in one direction, and the bending forward of the body to preserve equilibrium in another, while the soft condition of the bones and muscles is a helping influence to it.

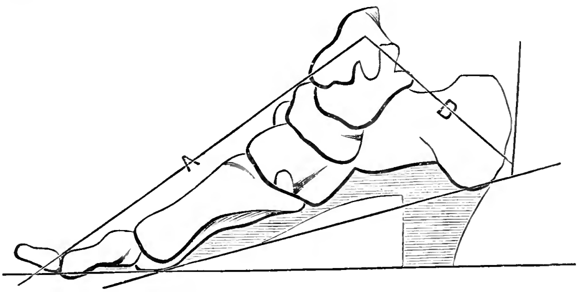

FIG. 16.

It should be remembered, too, that children suffer most from ingrowing nails caused by short shoes. Flat-foot, which is also most common among children and youth, is largely the result of convexity of the inner sole—a too common fault of children's shoes. In such shoes the center of gravity of the body is thrown out of its relations with the corresponding point in the foot, and eversions take place. The continuous strain between the foot and an improperly fitted shoe tends to produce dislocations of the bones and to weakening of the muscles. Doubtless much of the breaking down of girls at school may be traced to some such cause as this. Boys' shoes, on the other hand, generally have low heels and broad soles, and their wearers are relieved from the special suffering which too vain mothers allow to be inflicted on the feet of their daughters.

The evils to which women are subjected from the causes we have delineated do not stop with the sufferers who induce them upon themselves, but are transmitted to their children, an inheritance of acquired weakness and suffering.

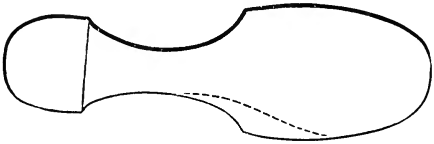

FIG. 17.

Some specimens of the shoemaker's art are shown, to illustrate how far those artists are from adapting their work to what the feet require.

Fig. 17 is the sole of an old lady's shoe, custom-made, for the wearer, suffering from constant aching feet, wanted shoes cut for ease. The heel is correctly cut, but the soles are made convex, or not curved, as the dotted line indicates they should be, to the inner curve of the foot; the toes are narrowed, or rounded, turning the great-toe inward and cramping the rest, and they allow nothing whatever for the elongation of the foot, and would look like stuffed puddings when the feet were in them. They were cut of soft kid, but, except the low heel and the soft material, they had not a single merit. They were cut in exact contrariety to the shape of the feet, and did not bring about the relief that was sought for in them.

Fig. 18 is a sample of an improved cut of shoe for women and misses. These shoes are worn by a small minority at present. They

FIG. 18.

FIG. 19.

do not altogether escape the faults of other shoes; some are wedge-toed; in others the heel is too high; and oftentimes a fault in the sole wrenches or distorts the foot. The best grades of these shoes are too high in price for other than well-to-do people to enjoy them.

Fig. 19 is a specimen of the best sort of shoe made for children, but, worn too short and too tight, it will become a means of harm to the tender foot of the child.

It is hard to understand how men and women can endure to wear the present style of pointed-toed shoes and boots. The "corn-crop" is one that never fails, and the prevalent fashion will certainly assure a yield of unusual abundance. The devotee who wore peas in his shoes for penance could make ample atonement for all his sins by simply dressing his feet according to the mode.

The whole subject is worthy of the profound study of the physician, the shoemaker, and the shoe-wearer, all of whom seem to have wickedly neglected it. If men and women, in this period of the revival of the antique, will study the natural and beautiful feet of that era, when the appreciation of physical beauty was most perfectly developed, we may hope for some not-far-distant time when our demand will be for a normal healthy foot in a natural and comfortable covering, and not for a crippled and distorted, withered, ugly "club," bound in an instrument of torment.

ON RAINBOWS.*

By JOHN TYNDALL, F.R.S.

THE oldest historic reference to the rainbow is known to all: "I do set my bow in the cloud, and it shall be for a token of a covenant between me and the earth. . . . And the bow shall be in the cloud; and I shall look upon it, that I may remember the everlasting covenant between God and every living creature of all flesh that is upon the earth." To the sublime conceptions of the theologian succeeded the desire for exact knowledge characteristic of the man of science. Whatever its ultimate cause might have been, the proximate cause of the rainbow was physical, and the aim of science was to account for the bow on physical principles. Progress toward this consummation was very slow. Slowly the ancients mastered the principles of reflection. Still more slowly were the laws of refraction dug from the quarries in which Nature had imbedded them. I use this language because the laws were incorporate in Nature before they were discovered by man. Until the time of Alhazan, an Arabian mathematician, who lived at the beginning of the twelfth century, the views eutertained regarding refraction were utterly vague and incorrect. After Alhazan came Roger Bacon and Vitellio,† who made and re-

* From author's advance sheets.

† Whewell ("History of the Inductive Sciences," vol. i, p. 345) describes Vitellio as a Pole. His mother was a Pole; but Poggendorff ("Handwörterbuch d. Exacten Wissenschaften") claims Vitellio himself as a German, born in Thüringen. "Vitellio" is described as a corruption of Witelo.

corded many observations and measurements on the subject of refraction. To them succeeded Kepler, who, taking the results tabulated by his predecessors, applied his amazing industry to extract from them their meaning—that is to say, to discover the physical principles which lay at their root. In this attempt he was less successful than in his astronomical labors. In 1604 Kepler published his "Supplement to Vitellio," in which he virtually acknowledged his defeat, by enunciating an approximate rule, instead of an all-satisfying natural law. The discovery of such a law, which constitutes one of the chief corner-stones of optical science, was made by Willebrord Snell, about 1621.*

A ray of light may, for our purposes, be presented to the mind as a luminous straight line. Let such a ray be supposed to fall vertically upon a perfectly calm water-surface. The incidence, as it is called, is then perpendicular, and the ray goes through the water without deviation to the right or left. In other words, the ray in the air and the ray in the water form one continuous straight line. But the least deviation from the perpendicular causes the ray to be broken, or "refracted," at the point of incidence. What, then, is the law of refraction discovered by Snell? It is this, that no matter how the angle of incidence, and with it the angle of refraction, may vary, the relative magnitude of two lines, dependent on these angles, and called their sines, remains, for the same medium, perfectly unchanged. Measure, in other words, for various angles, each of these two lines with a scale, and divide the length of the longer one by that of the shorter; then, however the lines individually vary in length, the quotient yielded by this division remains absolutely the same. It is, in fact, what is called the index of refraction of the medium.

Science is an organic growth, and accurate measurements give coherence to the scientific organism. Were it not for the antecedent discovery of the law of sines, founded as it was on exact measurements, the rainbow could not have been explained. Again and again, moreover, the angular distance of the rainbow from the sun had been determined and found constant. In this divine remembrancer there was no variableness. A line drawn from the sun to the rainbow, and another drawn from the rainbow to the observer's eye, always inclosed an angle of 41°. Whence this steadfastness of position—this inflexible adherence to a particular angle? Newton gave to De Dominis † the credit of the answer; but we really owe it to the genius of Descartes. He followed with his mind's eye the rays of light impinging on a rain-drop. He saw them in part reflected from the outside surface of the drop. He saw them refracted on entering the drop, reflected

* Born at Leyden 1591; died 1626.

† Archbishop of Spalatro, and Primate of Dalmatia. Fled to England about 1616; became a Protestant, and was made Dean of Windsor. Returned to Italy and resumed his Catholicism; but was handed over to the Inquisition, and died in prison (Poggendorff's "Biographical Dictionary").

from its back, and again refracted on their emergence. Descartes was acquainted with the law of Snell, and, taking up his pen, he calculated, by means of that law, the whole course of the rays. He proved that the vast majority of them escaped from the drop as *divergent* rays, and, on this account, soon became so enfeebled as to produce no sensible effect upon the eye of an observer. At one particular angle, however—namely, the angle 41° aforesaid—they emerged in a practically parallel sheaf. In their union was strength, for it was this particular sheaf which carried the light of the "primary" rainbow to the eye.

There is a certain form of emotion called intellectual pleasure, which may be excited by poetry, literature, nature, or art. But I doubt whether among the pleasures of the intellect there is any more pure and concentrated than that experienced by the scientific man when a difficulty which has challenged the human mind for ages melts before his eyes, and recrystallizes as an illustration of natural law. This pleasure was doubtless experienced by Descartes when he succeeded in placing upon its true physical basis the most splendid meteor of our atmosphere. Descartes showed, moreover, that the "secondary bow" was produced when the rays of light underwent two reflections within the drop, and two refractions at the points of incidence and emergence.

It is said that Descartes behaved ungenerously to Snell—that, though acquainted with the unpublished papers of the learned Dutchman, he failed to acknowledge his indebtedness. On this I will not dwell, for I notice on the part of the public a tendency, at all events in some cases, to emphasize such short-comings. The temporary weakness of a great man is often taken as a sample of his whole character. The spot upon the sun usurps the place of his "surpassing glory." This is not unfrequent, but it is nevertheless unfair.

Descartes proved that, according to the principles of refraction, a circular band of light must appear in the heavens exactly where the rainbow is seen. But how are the colors of the bow to be accounted for? Here his penetrative mind came to the very verge of the solution, but the limits of knowledge at the time barred his further progress. He connected the colors of the rainbow with those produced by a prism; but then these latter needed explanation just as much as the colors of the bow itself. The solution, indeed, was not possible until the composite nature of white light had been demonstrated by Newton. Applying the law of Snell to the different colors of the spectrum, Newton proved that the primary bow must consist of a series of concentric circular bands, the largest of which is red, and the smallest violet; while in the secondary bow these colors must be reversed. The main secret of the rainbow, if I may use such language, was thus revealed.

I have said that each color of the rainbow is carried to the eye by a sheaf of approximately parallel rays. But what determines this parallelism? Here our real difficulties begin, but they are to be surmounted by attention. Let us endeavor to follow the course of the solar rays before and after they impinge upon a spherical drop of water. Take first of all the ray that passes through the center of the drop. This particular ray strikes the back of the drop as a perpendicular, its reflected portion returning along its own course. Take another ray close to this central one and parallel to it—for the sun's rays when they reach the earth are parallel. When this second ray enters the drop it is refracted; on reaching the back of the drop it is there reflected, being a second time refracted on its emergence from the drop. Here the incident and the emergent rays inclose a small angle with each other. Take again a third ray a little farther from the central one than the last. The drop will act upon it as it acted upon its neighbor, the incident and emergent rays inclosing in this instance a larger angle than before. As we retreat farther from the central ray the enlargement of this angle continues up to a certain point, where it reaches a maximum, after which further retreat from the central ray diminishes the angle. Now, a maximum resembles the ridge of a hill, or a water-shed, from which the land falls in a slope at each side. In the case before us the divergence of the rays when they quit the rain-drop would be represented by the steepness of the slope. On the top of the water-shed—that is to say, in the neighborhood of our maximum—is a kind of summit level, where the slope for some distance almost disappears. But the disappearance of the slope indicates, in the case of our rain-drop, the absence of divergence. Hence we find that at our maximum, and close to it, there issues from the drop a sheaf of rays which are nearly, if not quite, parallel to each other. These are the so-called "effective rays" of the rainbow.*

Let me here point to a series of measurements which will illustrate the gradual augmentation of the deflection just referred to until it reaches its maximum, and its gradual diminution at the other side of the maximum. The measures correspond to a series of angles of incidence which augment by steps of ten degrees:

i	d	i	d
10°	10°	60°	42° 28′
20°	19° 36′	70°	39° 48′
30°	28° 20′	80°	31° 4′
40°	35° 36′	90°	15
50°	40° 40′		

The figures in the column i express these angles, while under d we have in each case the accompanying deviation, or the angle inclosed

* There is, in fact, a bundle of rays near the maximum, which, when they enter the drop, are converged by refraction almost exactly to the same point at its back. If the convergence were *quite* exact, then the symmetry of the liquid sphere would cause the rays to quit the drop as they entered it—that is to say, perfectly parallel. But inasmuch

by the incident and emergent rays. It will be seen that as the angle *i* increases, the deviation also increases up to 42° 28′, after which, although the angle of incidence goes on augmenting, the deviation becomes less. The maximum 42° 28′ corresponds to an incidence of 60°, but in reality at this point we have already passed, by a small quantity, the exact maximum, which occurs between 58° and 59°. Its amount is 42° 30′. This deviation corresponds to the red band of the rainbow. In a precisely similar manner the other colors rise to their maximum, and fall on passing beyond it; the maximum for the violet band being 40° 30′. The entire width of the primary rainbow is therefore 2°, part of this width being due to the angular magnitude of the sun.

We have thus revealed to us the geometric construction of the rainbow. But though the step here taken by Descartes and Newton was a great one, it left the theory of the bow incomplete. Within the rainbow proper, in certain conditions of the atmosphere, are seen a series of richly-colored zones, which were not explained by either Descartes or Newton. They are said to have been first described by Mariotte,* and they long challenged explanation. At this point our difficulties thicken, but, as before, they are to be overcome by attention. It belongs to the very essence of a maximum, approached continuously on both sides, that on the two sides of it pairs of equal value may be found. The maximum density of water, for example, is 39° Fahr. Its density when 5° colder, and when 5° warmer, than this maximum is the same. So, also, with regard to the slopes of our water-shed. A series of pairs of points of the same elevation can be found upon the two sides of the ridge; and, in the case of the rainbow, on the two sides of the maximum deviation we have a succession of pairs of rays having the same deflection. Such rays travel along the same line, and add their forces together after they quit the drop. But light, thus re-enforced by the coalescence of non-divergent rays, ought to reach the eye. It does so; and were light what it was once supposed to be—a flight of minute particles sent by luminous bodies through space—then these pairs of equally deflected rays would diffuse brightness over a large portion of the area within the primary bow. But inasmuch as light consists of waves and not of particles, the principle of interference comes into play, in virtue of which waves can alternately re-enforce and destroy each other. Were the distance passed over, by the two corresponding rays within the drop, the same, they would emerge exactly as they entered. But in no case are the

as the convergence is not quite exact, the parallelism after emergence is only approximate. The emergent rays cut each other at extremely sharp angles, thus forming a "caustic" which has for its asymptote the ray of maximum deviation In the secondary bow we have to deal with a minimum, instead of a maximum, the crossing of the incident and emergent rays producing the observed reversal of the colors. (See Engel and Shellbach's diagrams of the rainbow.)

* Prior of St. Martin-sous-Beaune, near Dijon, member of the French Academy of Sciences; died in Paris, May, 1684.

distances the same. The consequence is that when the rays emerge from the drop they are in a condition either to support or to destroy each other. By such alternate re-enforcement and destruction, the colored zones are produced within the primary bow. They are called "supernumerary bows," and are seen not only within the primary but sometimes also outside the secondary bow. The condition requisite for their production is, that the drops which constitute the shower shall all be of nearly the same size. When the drops are of different sizes, we have a confused superposition of the different colors, an approximation to white light being the consequence. This second step in the explanation of the rainbow was taken by a man the quality of whose genius resembled that of Descartes or Newton, and who eighty-two years ago was appointed Professor of Natural Philosophy in the Royal Institution of Great Britain. I refer, of course, to the illustrious Thomas Young.*

But our task is not, even now, complete. The finishing touch to the explanation of the rainbow was given by our last, eminent, Astronomer Royal, Sir George Airy. Bringing the knowledge possessed by the founders of the undulatory theory, and that gained by subsequent workers to bear upon the question, Sir George Airy showed that, though Young's general principles were unassailable, his calculations were sometimes wide of the mark. It was proved by Airy that the curve of maximum illumination in the rainbow does not quite coincide with the geometric curve of Descartes and Newton. He also extended our knowledge of the supernumerary bows, and corrected the positions which Young had assigned to them. Finally, Professor Miller, of Cambridge, and Dr. Galle, of Berlin, illustrated by careful measurements with the theodolite the agreement which exists between the theory of Airy and the facts of observation. Thus, from Descartes to Airy, the intellectual force expended in the elucidation of the rainbow, though broken up into distinct personalities, might be regarded as that of an individual artist engaged throughout this time in lovingly contemplating, revising, and perfecting his work.

We have thus cleared the ground for the series of experiments which constitute the subject of this discourse. During our brief residence in the Alps this year, we were favored with some weather of matchless perfection; but we had also our share of foggy and drizzly weather. On the night of the 22d of September, the atmosphere was especially dark and thick. At 9 P. M. I opened a door at the end of a passage and looked out into the gloom. Behind me hung a small lamp, by which the shadow of my body was cast upon the fog. Such a shadow I had often seen, but in the present case it was accompanied by an appearance which I had not previously seen. Swept through the darkness round the shadow, and far beyond, not only its boundary,

* Young's works, edited by Peacock, vol. i, pp. 185, 293, 357.

but also beyond that of the illuminated fog, was a pale, white, luminous circle, complete except at the point where it was cut through by the shadow. As I walked out into the fog, this curious halo went in advance of me. Had not my demerits been so well known to me, I might have accepted the phenomenon as an evidence of canonization. Benvenuto Cellini saw something of the kind surrounding his shadow, and ascribed it forthwith to supernatural favor. I varied the position and intensity of the lamp, and found even a candle sufficient to render the luminous band visible. With two crossed laths I roughly measured the angle subtended by the radius of the circle, and found it to be practically the angle which had riveted the attention of Descartes —namely, 41°. This and other facts led me to suspect that the halo was a circular rainbow. A week subsequently, the air being in a similar misty condition, the luminous circle was well seen from another door, the lamp which produced it standing on a table behind me.

It is not, however, necessary to go to the Alps to witness this singular phenomenon. Amid the heather of Hind Head I have had erected a hut, to which I escape when my brain needs rest or my muscles lack vigor. The hut has two doors, one opening to the north and the other to the south, and in it we have been able to occupy ourselves pleasantly and profitably during the recent misty weather. Removing the shade from a small petroleum-lamp, and placing the lamp behind me, as I stood in either doorway, the luminous circles surrounding my shadow on different nights were very remarkable. Sometimes they were best to the north, and sometimes the reverse, the difference depending for the most part on the direction of the wind. On Christmas-night the atmosphere was particularly good-natured. It was filled with true fog, through which, however, descended palpably an extremely fine rain. Both to the north and to the south of the hut the luminous circles were on this occasion specially bright and well-defined. They were, as I have said, swept through the fog far beyond its illuminated area, and it was the darkness against which they were projected which enabled them to shed so much apparent light. The "effective rays," therefore, which entered the eye in this observation gave direction, but not distance, so that the circles appeared to come from a portion of the atmosphere which had nothing to do with their production. When the lamp was taken out into the fog, the illumination of the medium almost obliterated the halo. Once educated, the eye could trace it, but it was toned down almost to vanishing. There is some advantage, therefore, in possessing a hut, on a moor or on a mountain, having doors which limit the area of fog illuminated.

I have now to refer to another phenomenon which is but rarely seen, and which I had an opportunity of witnessing on Christmas-day. The mist and drizzle in the early morning had been very dense; a walk before breakfast caused my somewhat fluffy pilot dress to be covered with minute water-globules, which, against the dark background underneath, suggested the bloom of a plum. As the day advanced, the southeastern heaven became more luminous, and the pale disk of the sun was at length seen struggling through drifting clouds. At ten o'clock the sun had become fairly victorious, the heather was adorned by pendent drops, while certain branching grasses, laden with liquid pearls, presented, in the sunlight, an appearance of exquisite beauty. Walking across the common to the Portsmouth road, my wife and I, on reaching it, turned our faces sunward. The smoke-like fog had vanished, but its disappearance was accompanied, or perhaps caused, by the coalescence of its minuter particles into little globules, visible where they caught the light at a proper angle, but not otherwise. They followed every eddy of the air, upward, downward, and from side to side. Their extreme mobility was well calculated to suggest a notion prevalent on the Continent, that the particles of a fog, instead of being full droplets, are really little bladders or vesicles. Clouds are supposed to owe their power of floatation to this cause. This vesicular theory never struck root in England ; nor has it, I apprehend, any foundation in fact.

As I stood in the midst of these eddying specks, so visible to the eye, yet so small and light as to be perfectly impalpable to the skin both of hands and face, I remarked, "These particles must surely yield a bow of some kind." Turning my back to the sun, I stooped down so as to keep well within the layer of particles, which I supposed to be a shallow one, and looking toward the "Devil's Punch-Bowl," saw the anticipated phenomenon. A bow without color spanned the Punch-Bowl, and, though white and pale, was well defined and exhibited an aspect of weird grandeur. Once or twice I fancied a faint ruddiness could be discerned on its outer boundary. The stooping was not necessary, and as we walked along the new Portsmouth road, with the Punch-Bowl to our left, the white arch marched along with us. At a certain point we ascended to the old Portsmouth road, whence, with a flat space of very dark heather in the foreground, we watched the bow. The sun had then become strong, and the sky above us blue, nothing which could in any proper sense be called rain existing at the time in the atmosphere. Suddenly my companion exclaimed, "I see the whole circle meeting at my feet!" At the same moment the circle became visible to me also. It was the darkness of our immediate foreground that enabled us to see the pale, luminous band projected against it. We walked round Hind Head Common with the bow almost always in view. Its crown sometimes disappeared, showing that the minute globules which produced it did not extend to any great height in the atmosphere. In such cases, two shining buttresses were left behind, which, had not the bow been previously seen, would have lacked all significance. In some of the combes, or valleys, where the floating particles had collected in greater numbers, the end of the bow plunging into the combe emitted a light of more than the usual brightness.

During our walk the bow was broken and reformed several times, and, had it not been for our previous experience, both in the Alps and at Hind Head, it might well have escaped attention. What this white bow lost in beauty and intensity, as compared with the ordinary colored bow, was more than atoned for by its weirdness and its novelty to both observers.

The white rainbow (*l'arc en ciel blanc*) was first described by the Spaniard, Don Antonio de Ulloa, Lieutenant of the Company of Gentlemen Guards of the Marine. By order of the King of Spain, Don Jorge Juan and Ulloa made an expedition to South America, an account of which is given in two amply-illustrated quarto volumes to be found in the library of the Royal Institution. The bow was observed from the summit of the mountain Pambamarca, in Peru. The angle subtended by its radius was 33° 30′, which is considerably less than the angle subtended by the radius of the ordinary bow. Between the phenomenon observed by us on Christmas-day, and that described by Ulloa, there are some points of difference. In his case fog of sufficient density existed to enable the shadows of him and his six companions to be seen, each, however, only by the person whose body cast the shadow, while around the head of each were observed those zones of color which characterize the "specter of the Brocken." In our case no shadows were to be seen, for there was no fog-screen on which they could be cast. This implies also the absence of the zones of color observed by Ulloa.

The white rainbow has been explained in various ways. A learned Frenchman, M. Bravais, who has written much on the optical phenomena of the atmosphere, and who can claim the additional recommendation of being a distinguished mountaineer, has sought to connect the bow with the vesicular theory to which I have just referred. This theory, however, is more than doubtful, and it is not necessary.* The genius of Thomas Young throws light upon this subject as upon so many others. He showed that the whiteness of the bow was a direct consequence of the smallness of the drops which produce it. In fact, the wafted water-specks seen by us upon Hind Head † were the very kind needed for the production of the phenomenon. But the observations of Ulloa place his white bow distinctly *within* the arc that would be occupied by the ordinary rainbow—that is to say, in the region of supernumeraries ; and by the action of the supernumeraries upon each other Ulloa's bow was accounted for by Thomas Young. The smaller

* The vesicular theory was combated very ably in France by the Abbé Raillard, who has also given an interesting analysis of the rainbow at the end of his translation of my "Notes on Light."

† Had our refuge in the Alps been built on the southern side of the valley of the Rhône, so as to enable us to look with the sun behind us into the valley and across it, we should, I think, have frequently seen the white bow ; whereas on the opposite mountain slope, which faces the sun, we have never seen it.

the drops the broader are the zones of the supernumerary bows, and Young proved by calculation that when the drops have a diameter of $\frac{1}{3000}$ or $\frac{1}{4000}$ of an inch, the bands overlap each other, and produce white light by their mixture. Unlike the geometric bow, the radius of the white bow varies within certain limits, which M. Bravais shows to be 33° 30′ and 41° 46′ respectively. In the latter case the white bow is the ordinary bow deprived of its color by the smallness of the drops. In all the other cases it is produced by the action of the supernumeraries.

The physical investigator desires not only to observe natural phenomena but to recreate them—to bring them, that is, under the dominion of experiment. From observation we learn what Nature is willing to reveal. In experimenting we place her in the witness-box, cross-examine her, and extract from her knowledge in excess of that which would, or could, be spontaneously given. Accordingly, on my return from Switzerland last October, I sought to reproduce in the laboratory the effects observed among the mountains. My first object, therefore, was to obtain artificially a mixture of fog and drizzle like that observed from the door of our cottage. A strong cylindrical copper boiler, sixteen inches high and twelve inches in diameter, was nearly filled with water, and heated by gas-flames until steam of twenty pounds pressure was produced. A valve at the top of the boiler was then opened, when the steam issued violently into the atmosphere, carrying droplets of water mechanically along with it, and condensing above to droplets of a similar kind. A fair imitation of the Alpine atmosphere was thus produced. After a few tentative experiments, the luminous circle was brought into view, and, having once got hold of it, the next step was to enhance its intensity. Oil-lamps, the lime-light, and the naked electric light were tried in succession, the source of rays being placed in one room, the boiler in another, while the observer stood, with his back to the light, between them. It is not, however, necessary to dwell upon these first experiments, surpassed as they were by the arrangements subsequently adopted. My mode of proceeding was this: The electric light being placed in a camera with a condensing lens in front, the position of the lens was so fixed as to produce a beam sufficiently broad to clasp the whole of my head, and leave an aureole of light around it. It being desirable to lessen as much as possible the foreign light entering the eye, the beam was received upon a distant black surface, and it was easy to move the head until its shadow occupied the center of the illuminated area. To secure the best effect it was found necessary to stand close to the boiler, so as to be immersed in the fog and drizzle. The fog, however, was soon discovered to be a mere nuisance. Instead of enhancing, it blurred the effect, and I therefore sought to abolish it. Allowing the steam to issue for a few seconds from the boiler, on closing the valve, the cloud rapidly melted away, leaving behind it a host of minute liquid spherules floating in the beam. A beautiful circular rainbow was instantly swept through the air in front of the observer. The primary bow was duly attended by its secondary, with the colors, as usual, reversed. The opening of the valve for a single second causes the bows to flash forth. Thus, twenty times in succession, puffs can be allowed to issue from the boiler, every puff being followed by this beautiful meteor. The bows produced by single puffs are evanescent, because the little globules rapidly disappear. Greater permanence is secured when the valve is left open for an interval sufficient to discharge a copious amount of drizzle into the air.*

Many other appliances for producing a fine rain have been tried, but a reference to two of them will suffice. The rose of a watering-pot naturally suggests a means of producing a shower; and on the principle of the rose I had some spray-producers constructed. In each case the outer surface was convex, the thin convex metal plate being pierced by orifices too small to be seen by the naked eye. Small as they are, fillets of very sensible magnitude issue from the orifices, but at some distance below the spray-producer the fillets shake themselves asunder and form a fine rain. The small orifices are very liable to get clogged by the fine particles suspended in London water. In experiments with the rose, filtered water was, therefore, resorted to. A large vessel was mounted on the roof of the Royal Institution, from the bottom of which descended vertically a piece of compo-tubing, an inch in diameter and about twenty feet long. By means of proper screw fittings, a single rose, or, when it is desired to increase the magnitude or density of the shower, a group of two, three, or four roses, is attached to the end of the compo-tube. From these, on the turning on of a cock, the rain descends. The circular bows produced by such rain are far richer in color than those produced by the smaller globules of the condensed steam. To see the effect in all its beauty and completeness, it is necessary to stand well within the shower, not outside of it. A water-proof coat and cap are, therefore, needed, to which a pair of goloshes may be added with advantage. A person standing outside the beam may see bits of both primary and secondary in the places fixed by their respective angles; but the colors are washy and unimpressive, while within the shower, with the shadow of the head occupying its proper position on the screen, the brilliancy of the effect is extraordinary. The primary clothes itself in the richest

* It is perhaps worth noting here, that when the camera and lens are used the beam which sends its "effective rays" to the eye may not be more than a foot in width, while the circular bow engendered by these rays may be, to all appearance, fifteen or twenty feet in diameter. In such a beam, indeed, the drops which produce the bow must be very near the eye, for rays from the more distant drops would not reach the required angle. The apparent distance of the circular bow is often great, in comparison with that of the originating drops. Both distance and diameter may be made to undergo variations. In the rainbow we do not see a localized object, but receive a luminous impression, which is often transferred to a portion of the field of view far removed from the bow's origin.

tints, while the secondary, though less vivid, shows its colors in surprising strength and purity.

But the primary bow is accompanied by appearances calculated to attract and rivet attention almost more than the bow itself. I have already mentioned the existence of effective rays over and above those which go to form the geometric law. They fall within the primary, and, to use the words of Thomas Young, "would exhibit a continued diffusion of fainter light, but for the general law of interference which divides the light into concentric rings." One could almost wish for the opportunity of showing Young how literally his words are fulfilled, and how beautifully his theory is illustrated, by these artificial circular rainbows. For here the space within the primaries is swept by concentric supernumerary bands, colored like the rainbow, and growing gradually narrower as they retreat from the primary. These spurious bows as they are sometimes called,* which constitute one of the most splendid illustrations of the principle of interference, are separated from each other by zones of darkness, where the light-waves, on being added together, destroy each other. I have counted as many as eight of these beautiful bands, concentric with the true primary. The supernumeraries are formed next to the most refrangible color of the bow, and therefore occur *within* the primary circle. But, in the secondary bow, the violet, or most refrangible color, is on the *outside;* and, following the violet of the secondary, I have sometimes counted as many as five spurious bows. Some notion may be formed of the intensity of the primary, when the secondary is able to produce effects of this description.

An extremely handy spray-producer is that employed to moisten the air in the Houses of Parliament. A fillet of water, issuing under strong pressure from a small orifice, impinges on a little disk, placed at a distance of about one twentieth of an inch from the orifice. On striking the disk, the water spreads laterally, and breaks up into exceedingly fine spray. Here, also, I have used the spray-producer both singly and in groups, the latter arrangement being resorted to when showers of special density were required. In regard to primaries, secondaries, and supernumeraries, extremely brilliant effects have been obtained with this form of spray-producer. The quantity of water called upon being much less than that required by the rose, the fillet-and-disk instrument produces less flooding of the locality where the experiments are made. In this latter respect, the steam-spray is particularly handy. A puff of two seconds' duration suffices to bring out the bows, the subsequent shower being so light as to render the use of water-proof clothing unnecessary. In other cases, the inconvenience of flooding may be avoided to a great extent by turning on the spray for a short time only, and then cutting off the supply of water. The vision of the bow being, however, proportionate to the

* A term, I confess, not to my liking.

duration of the shower, will, when the shower is brief, be evanescent. Hence, when quiet and continued contemplation of all the phenomena is desired, the observer must make up his mind to brave the rain.*

In one important particular the spray-producer last described commends itself to our attention. With it we can operate on substances more costly than water, and obtain rainbows from liquids of the most various refractive indices. To extend the field of experiment in this direction, the following arrangement has been devised: A strong cylindrical iron bottle, wholly or partly filled with the liquid to be experimented on, is tightly closed by a brass cap. Through the cap passes a metal tube, soldered air-tight where it crosses the cap, and ending near the bottom of the iron bottle. To the free end of this tube is attached the spray-producer. A second tube passes also through the cap, but ends above the surface of the liquid. This second tube, which is long and flexible, is connected with a larger iron bottle, containing compressed air. Hoisting the small bottle to a convenient height, the tap of the larger bottle is carefully opened, the air passes through the flexible tube to the smaller bottle, exerts its pressure upon the surface of the liquid therein contained, drives it up the other tube, and causes it to impinge with any required degree of force against the disk of the spray-producer. From this it falls in a fine rain. A great many liquids have been tested by this arrangement, and very remarkable results have been obtained. I will confine myself here to a reference to two liquids, which commend themselves on account of their cheapness and of the brilliancy of their effects. Spirit of turpentine, forced from the iron bottle, and caused to fall in a fine shower, produces a circular bow of extraordinary intensity and depth of color. With paraffine-oil or petroleum a similar effect is obtained.

Spectrum analysis, as generally understood, occupies itself with atomic, or molecular, action, but physical spectrum analysis may be brought to bear upon our falling showers. I asked myself whether a composite shower—that is to say, one produced by the mingled spray of two or more liquids—could not be analyzed and made to declare its constituents by the production of the circular rainbows proper to the respective liquids. This was found to be the case. In the ordinary rainbow the narrowest color-band is produced by its most refrangible light. In general, the greater the refraction, the smaller will be the bow. Now, as spirit of turpentine and paraffine are both more refractive than water, I thought it probable that in a mixed shower of water and paraffine, or water and turpentine, the smaller and more luminous circle of the latter ought to be seen within the larger circle of the former. The result was exactly in accordance with this anticipation. Beginning with water, and producing its two bows, and then allowing the turpentine to shower down and mingle with the water, within the

* The rays which form the artificial bow emerge, as might be expected, polarized from the drops.

large and beautifully colored water-wheel, the more richly colored circle of the turpentine makes its appearance. Or, beginning with turpentine, and forming its concentrated iris; on turning on the water-spray, though to the eye the shower seems absolutely homogeneous, its true character is instantly declared by the flashing out of the larger concentric aqueous bow. The water primary is accompanied by its secondary close at hand. Associated, moreover, with all the bows, primary and secondary, are the supernumeraries which belong to them; and a more superb experimental illustration of optical principles it would be hardly possible to witness. It is not the less impressive because extracted from the simple combination of a beam of light and a shower of rain.

In the "Philosophical Transactions" for 1835, the late Colonel Sykes gave a vivid description of a circular solar rainbow, observed by him in India, during periods when fogs and mists were prevalent in the chasms of the Ghâts of the Deccan:

It was during such periods that I had several opportunities of witnessing that singular phenomenon, the circular rainbow, which, from its rareness, is spoken of as a possible occurrence only. The stratum of fog from the Konkun on some occasions rose somewhat above the level of the top of a precipice forming the northwest scarp of the hill fort of Hurreechundurghur, from two to three thousand feet perpendicular, without coming over upon the table-land. I was placed at the edge of the precipice just without the limits of the fog, and with a cloudless sun at my back at a very low elevation. Under such a combination of favorable circumstances, the circular rainbow appeared quite perfect, of the most vivid colors, one half above the level on which I stood, the other half below it. Shadows in distinct outline of myself, my horse, and people appeared in the center of the circle as a picture, to which the bow formed a resplendent frame. My attendants were incredulous that the figures they saw under such extraordinary circumstances could be their own shadows, and they tossed their arms and legs about, and put their bodies into various postures, to be assured of the fact by the corresponding movements of the objects within the circle; and it was some little time ere the superstitious feeling with which the spectacle was viewed wore off. From our proximity to the fog, I believe the diameter of the circle at no time exceeded fifty or sixty feet. The brilliant circle was accompanied by the usual outer bow in fainter colors.

Mr. E. Colborne Baber, an accomplished and intrepid traveler, has recently enriched the "Transactions" of the Royal Geographical Society by a paper of rare merit, in which his travels in Western China are described. He made there the ascent of Mount O—an eminence of great celebrity. Its height is about eleven thousand feet above the sea, and it is flanked on one side by a cliff "a good deal more than a mile in height." From the edge of this cliff, which is guarded by posts and chains, you look into an abyss, and if fortune, or rather the mists, favor you, you see there a miracle, which is thus described by Mr. Baber:

Naturally enough it is with some trepidation that pilgrims approach this fear-some brink, but they are drawn to it by the hope of beholding the mysterious apparition known as the "Fo-Kuang," or "Glory of Buddha," which floats in mid-air, half-way down. So many eye-witnesses had told me of this wonder, that I could not doubt; but I gazed long and steadfastly into the gulf without success, and came away disappointed, but not incredulous. It was described to me as a circle of brilliant and many-colored radiance, broken on the outside with quick flashes and surrounding a central disk as bright as the sun, but more beautiful. Devout Buddhists assert that it is an emanation from the aureole of Buddha, and a visible sign of the holiness of Mount O.

Impossible as it may be deemed, the phenomenon does really exist. I suppose no better evidence could be desired for the attestation of a Buddhist miracle than that of a Baptist missionary, unless, indeed, it be, as in this case, that of *two* Baptist missionaries. Two gentlemen of that persuasion have ascended the mountain since my visit, and have seen the Glory of Buddha several times. They relate that it resembles a golden sun-like disk, inclosed in a ring of prismatic colors more closely blended than in the rainbow. . . . The missionaries inform me that it was about three o'clock in the afternoon, near the middle of August, when they saw the meteor, and that it was only visible when the precipice was more or less clothed in mist. It appeared to lie on the surface of the mist, and was always in the direction of a line drawn from the sun through their heads, as is certified by the fact that the shadow of their heads was seen on the meteor. They could get their heads out of the way, so to speak, by stooping down, but are not sure if they could do so by stepping aside. Each spectator, however, could see the shadows of the by-standers as well as his own projected on to the appearance. They did not observe any rays spreading from it. The central disk, they think, is a reflected image of the sun, and the inclosing ring is a rainbow. The ring was in thickness about one fourth of the diameter of the disk, and distant from it by about the same extent; but the recollection of one informant was that the ring touched the disk, without any intervening space. The shadow of a head, when thrown upon it, covered about one eighth of the whole diameter of the meteor. The rainbow ring was not quite complete in its lower part, but they attribute this to the interposition of the edge of the precipice. They see no reason why the appearance should not be visible at night when the moon is brilliant and appositely placed. They profess themselves to have been a good deal surprised, but not startled, by the spectacle. They would consider it remarkable rather than astonishing, and are disposed to call it a very impressive phenomenon.

It is to be regretted that Mr. Baber failed to see the "Glory," and that we in consequence miss his own description of it. There seems a slight inadvertence in the statement that the head could be got out of the way by stooping; for, as long as the "Glory" remained a circle, the shadow of the head must have occupied its center. Stepping aside would simply displace the bow, but not abolish the shadow.

Thus, starting from the first faint circle seen drawn through the thick darkness at Alp Lusgen, we have steadily followed and developed our phenomenon, and ended by rendering the "Glory of Buddha" a captive of the laboratory. The result might be taken as typical of larger things.

SCIENCE *VERSUS* THE CLASSICS.

By C. A. EGGERT,
PROFESSOR IN THE STATE UNIVERSITY OF IOWA.

AT the present stage of the discussion as to the value of the training in the Latin and Greek languages and their literature, the testimony of Professor Preyer, of the University of Jena, is not without importance. Professor Preyer is interested, and he not alone among German professors, in the question of "health and vigor *versus* disease and weakness" of the German youth. In an article "On the Preservation of Health," published in the "Deutsche Rundschau," he made the following pertinent remarks:

"The preservation of health, of the power of sight and muscle, of the readiness of the mind to receive impressions from nature and man, of freshness and youthful elasticity, is undoubtedly of much more consequence for the age of our graduates than a knowledge, no matter how thorough, of history and the dead languages. A first-class German college (gymnasium) requires at present the reading of Sophocles, Homer, Thucydides, Demosthenes, Plutarch, Herodotus, Xenophon, Tacitus, Horace, Cæsar, Cicero, Livy, Virgil, Sallust, Ovid, and I find among its text-books Greek, Latin, and Hebrew grammars, a Latin phrase-book, an ecclesiastical history, and several other books, which, to be understood, require an amount of brain-work out of proportion to the results obtained. I find there the very same Latin and Greek authors which I read myself at school some twenty-four to twenty-eight years ago. The *present stand-point of the humanistic gymnasia is*, in spite of some attempts at adaptation to the new time, *essentially the mediæval one*, which was justifiable several centuries ago, because there was then nothing better than the ancient classics, and particularly no exact natural science, to furnish means of discipline. *At present, however, there are many books which, both as regards form and contents, are better fitted for* the instruction of young people than the authors enumerated. Why are not extracts read from the writings of Galilei, Descartes, Newton, Bacon, Faraday, Luther, Harvey, Frederick the Great, Leibnitz, Kant, Haller? At the age of our graduates it is, besides, of the greatest importance that there be less reading and writing, less taxing of the memory, more exercise of the muscular system. Not learning, but health and character, should be the main objects in education and schooling, and therefore the education of the senses should be emphasized. Only a philologist will deny that grammar, with its many exceptions, is rather a heavy ballast for the memory than a proper means for the training of the logical faculty. The student involuntarily becomes accustomed to admit exceptions also in the case of other rules, ethical laws, the laws of nature, and in matters of his own experience. The elements of mechanics and chemistry—

these are objects of instruction which are incomparably more adapted to the young student for exercises in thinking, while having the additional advantage of appealing directly to the senses. The most delicate test of correct thinking is furnished by the experiment. The most natural way to make the intellect independent is through the occupation with the exact sciences, physics and chemistry, with elementary experiments forming a transition from play to the seriousness of reality; but *not through translations of the speeches, long since deprived of all vital interest,* of Greek or Roman *lawyers,* or of the *phraseology of dead languages* with their intricate syntax and superfluous particles.

"*I seize every opportunity to censure this unnatural condition,* and I blame it in this connection because it injures health. . . . I regret vividly that precisely in Germany, the home of physiology, the country in which it is honored the most, where the greatest means are placed at its disposal and laboratories resembling palaces are built for it, that here where the number of its learned adherents is the largest, the science is least known among the people at large. . . . Every educated person has been compelled in his youth to learn a lot of details—for instance, of Greek mythology, the history of the Church, of the Old and New Testaments, grammar, etc.—which in later years never again entered into the circle of his ideas, and only burdened his memory without the least advantage for his intellectual development, and his mental and moral education. As to the inner condition of his own body, the connection of the heart's beating with the breathing process, of the process of alimentation with the production of animal heat, and as to what is meant by muscles, nerves, ganglia, and how the gradual transformation of the tissues goes on in youth and old age—that is not taught, though there would be time enough for it, if less attention was paid to unnecessary matters."

If we contrast with these remarks of a scholar and scientist, who evidently knows whereof he speaks, the utterances of a lawyer like Lord Coleridge, or of a dealer in æsthetics like Mr. Matthew Arnold, we are struck with the absolute pertinence of the former, and the thin generality of the latter. "Sweetness and light" come with health, physical and mental; logical acumen comes from an accurate knowledge of things brought to the test of rigid experiment. Felicity of expression, or perfect harmony between the thought and its outward dress, is not limited to Greek and Latin writers, but is as general as literature itself. And if the progress from general knowledge of disconnected events to special knowledge of phenomena connected by invisible and yet omnipresent law everywhere marks the advance of human thought, why, then, should the intelligent study of the latter be a less efficient guide to "sweetness and light," or to the "highest education," than the study of literatures that dealt for the most part with problems which possess only slight interest, or none at all, for the best thinkers of to-day?

THE JURY SYSTEM.

By HENRY H. WILSON.

THIS is an age in which ancestral faiths, traditional customs, and primitive institutions alike, are receiving the attacks of iconoclasts. These attacks are always vigorous, usually just, frequently learned, but sometimes hasty and ill-considered. There was a time when institutions which had become quite useless were still continued and revered simply because they were ancient. In our day there is danger that institutions whose origin, growth, and practical utility are little understood may be swept away amid the general assault, merely because they bear the marks of age. Institutions are not the inventions of individuals, but are the outgrowth of the general sentiments and impulses of the time and place of their origin. Every institution, however absurd or worthless it may seem to us, must, at one time, have supplied the actual wants of a part of the human race. It is, therefore, but reasonable to presume that every institution which we have inherited contains some principle that may still be useful. Before assuming to pass judgment upon the merits or demerits of the jury as an element of our judicial system, it may, therefore, be well to inquire into its distinguishing features, and to ascertain, as far as may be, the origin of its several characteristics. Most prominent among the peculiar features of the modern jury are—1. That they are called from the vicinage, or from a limited territory, over which the court in which they sit has jurisdiction. 2. That they possess no previous knowledge of the merits of the case which they are impaneled to try. 3. That they consist of a definite number previously determined, usually twelve. 4. That unanimity or consent of all is necessary to render a verdict. 5. That they are chosen by lot from a certain number of qualified citizens previously selected. Of these in their order let us inquire the origin, growth, and present utility.

1. When, in its earliest stages, the jury was composed of the witnesses who knew more or less about the facts in dispute, it was natural and indeed necessary to call them from the vicinity where the transaction occurred. This reason becomes the more apparent, when it is remembered that the ordinary commercial transactions among our rude ancestors were accompanied with great ceremony and publicity. For example, if a man wished to go abroad to buy a horse, he must first announce his intention to do so to his neighbors, and upon his return he must give all the circumstances of the purchase, that the requisite number of witnesses, or men who knew the facts, could be had to form a jury, should his title ever be questioned. Should he fail to observe these precautions, he was presumed to have stolen the horse, or to have obtained it in some unlawful way.* While, in this com-

* Forsyth, "Trial by Jury," p. 71.

mercial age, when business extends over such wide territories, and when commercial transactions are usually evidenced more or less by written instruments, a debtor may be sued wherever he can be found, except in a few special cases, yet, on the other hand, crimes which, from the nature of the case, are evidenced usually and almost wholly by living witnesses, must still be tried in the vicinage or county where they were committed. While most civil actions may now be brought wherever the defendant may be found, yet the jury must be called from the vicinity of the forum in which they are tried. In the early history of the jury, vicinage meant simply the immediate neighborhood, while the same term is now used to denote the whole territory over which the court has jurisdiction. Calling the jury from the vicinage would seem to have the advantage of strengthening local self-government. Litigants usually have the assurance that their rights are to be determined, not by strangers who may be used to different customs and habits of life, but by their neighbors, upon whose rights they in turn may be called upon to adjudicate. And this feature of the jury has the further advantage that, while the jurors know nothing about the facts of the particular case, yet the parties have the benefit of whatever good repute they may sustain among their neighbors. So, while the reasons that gave rise to this restriction in calling a jury no longer exist, yet, when reasonable provisions are made for a change of venue in cases of violent popular feeling, there are some advantages derived from it, and there seems to be no good reason for a change.

2. We are next to consider the jury with reference to their previous knowledge of the facts in dispute. As before intimated, in the early stages of the system the jurors were called because they knew more or less about the facts in the case, and if, upon examination, it should be found that any one who was called was entirely ignorant of the facts to be tried, he was excluded, and another was called in his stead.* This process was continued until all those who could add nothing to the jury's knowledge of the case were excused, and the requisite number of those possessing such information were found. They were then sworn to render a true verdict, not upon the evidence produced in court, but upon the knowledge they themselves possessed, or upon the words of their fathers.† This explains the seeming anomaly of attaint for a false verdict. Should either party be dissatisfied with the verdict, he could demand a jury of double the usual number, to try the truthfulness of the former verdict.‡ This was simply trying the whole panel for perjury because they possessed the requisite knowledge, and had sworn that they would render a true verdict upon that knowledge.

It often happened that controversies would arise when twelve men

* Forsyth, "Trial by Jury," p. 105. † Stubbs, "Constitutional History," vol. i, p. 616.
‡ Forsyth, "Trial by Jury," p. 149.

could not be found who possessed the information necessary, and so, to those who knew the facts, were added others who joined in the verdict, relying on the knowledge and good faith of their fellow-jurors. From this the step was short and easily taken to that stage where witnesses not on the panel were called to give testimony concerning facts within their knowledge.* Here we find a jury, composed of informed and uninformed jurors, all joining in a common verdict.† Those who knew the facts in issue were, however, finally separated from those who did not,‡ and while the former gradually assumed the character of the modern witnesses who simply detail the facts under the sanction of an oath, the latter became the modern jury essentially as we now have it—that is, triers of facts upon evidence produced by others. So, while we challenge a juror because he knows too much about the facts to be tried, our ancestors objected to him because he did not know enough about them. Perhaps no other feature of the whole system of trial by jury has called forth so much adverse criticism as this. It is justly said that to rigorously enforce this rule in an age of newspapers and telegraph would exclude every intelligent citizen from juries called to try cases of any considerable notoriety. To meet the demands of our changing civilization, most if not all the States of the Union have, by statute, relaxed this once universal rule of the common law. An opinion founded on rumor or newspaper-reading will not now exclude a juror, and several of the States have gone to the doubtful length of authorizing the presiding judge to permit a juror to sit even though he have a decided opinion as to the merits of the case, provided he will swear that, notwithstanding such opinion, he believes he can render a fair and impartial verdict. It would be mere mockery to submit facts to a man who would not agree to determine them fairly and impartially; and if there be any place in which this rule is rigidly enforced it ought not to be urged against the whole system, when it can be remedied so easily without detracting at all from what is of real value in it. The reasonable application of the rule excluding from the jury those who have formed opinions upon *ex-parte* statements of the facts to be tried, certainly tends to insure a true verdict. No evidence should be laid before those who are to weigh it, except that which can be subjected to the crucial test of cross-examination. The frequent instances of a smooth, plausible, persuasive narrative in chief being totally contradicted by a shrewd cross-examination of the same witness shows how unreliable would be any decision made by either judge or jury upon statements heard out of court.

3. As to the origin of the number requisite to form a jury, it is impossible now to say anything definite. The number twelve of which

* Bigelow's "History of Procedure in England," p. 336.

† Forsyth, "Trial by Jury," p. 128.

‡ Stubbs, "Constitutional History," vol. i, p. 620.

the jury is composed in all probability came from the accustomed number of compurgators whom the plaintiff or defendant brought into court in early times, before the jury was known, to vouch for his veracity.* This being the quantum of proof required to render a party's testimony credible, it was natural that the same quantum of proof—that is, the verdict of twelve jurors possessing the necessary information—should be required to establish the existence or non-existence of the alleged facts. Thus determining the number of jurors necessary to render a verdict was simply fixing the amount of proof necessary to establish a fact if disputed. When jurors gradually ceased to be witnesses the number twelve was still retained, probably because there was no particular reason for changing it. Why there should have been twelve compurgators, why that was fixed upon as the quantum of proof necessary, it is impossible to say with any degree of certainty. Various reasons have been given by various antiquaries, none of which seem to have much more than speculation to support them.

Whatever may have been the origin of the number twelve, the reasons which gave rise to it have doubtless long ceased to exist, yet it may be difficult to point out why it should be changed. Should a majority be able to return a verdict, it would be an advantage to have the jury composed of some odd number, but so long as the law requiring unanimity remains, or should two thirds or three fourths be allowed to render a verdict, there seems no sufficient reason for changing the number. Should any change in this respect be made, it would seem expedient to make the number of jurors in some degree correspond to the importance of the issues to be tried.

4. The fourth characteristic feature of the jury which I shall consider is the requirement of unanimity in the verdict. This, like the number, is due to the fact that the ancient jury was composed of witnesses. Twelve lawful men must declare upon oath the existence of a fact before a verdict could be rendered. But, should they disagree, others were added until twelve out of the whole number were of one mind, which process was called afforcing the jury. This process resulted in allowing a bare majority to render a verdict whenever that majority consisted of twelve.† From this it is clear that it was the quantum of proof required, and not the probability of correctness arising from unanimity, that gave rise to the rule that twelve men must consent to the verdict. Since jurors are no longer witnesses, the rule has survived the circumstances that gave it birth.

Laws affecting millions of people are enacted by a mere majority and are equally binding on all ; courts of last resort frequently decide by a bare majority as to the validity or proper application of those laws ; and it is exceedingly difficult to understand why the unanimous verdict of twelve men is necessary to establish the existence of the facts to which such laws apply. When we remember how differently

* Forsyth, "Trial by Jury," p. 62. † Stubbs, "Constitutional History," vol. i, p. 616.

men are impressed by the occurrence of things that transpire before their eyes, how impossible it is for us always to agree upon the most ordinary affairs of life, when we remember that the jury is called only because two men, who are the litigants, can not agree, we will see the absurdity of putting twelve men into the jury-box to hear the most contradictory evidence of a particular fact, and then say that they must all agree! In many cases this agreement, when reached, is only apparent, and occasionally a false verdict is doubtless procured by the tenacity of some determined juryman. And still more frequently are juries discharged because they can not agree, and the parties and the public are subjected to the expense of another trial.

To give moderate room for honest difference of opinion, to disarm occasional prejudice and render corruption fruitless, I think in all civil causes three fourths of the jury ought to be able to return a verdict. It has been urged that the rule requiring unanimity is necessary to insure that every juror shall be heard and the grounds of his opinion considered. Indeed, this has been defended as the only redeeming feature of the whole system of trial by jury. If, after hearing all the evidence adduced, after counsel have exhausted their powers in presenting their respective sides of the case, after the presiding judge has pointed out the issues to be determined and laid down the rules of law applicable to them—I say, if, after all this, nine out of the twelve are agreed and are ready to render a verdict without the advice of the other three, it is very probable that the preponderance of evidence is on their side. In Nevada the three-fourths rule in civil cases has been in successful operation nearly twenty years, and bench, bar, and people alike, seem to be well satisfied with the result. Although this provision is in their State Constitution,* yet the Legislature by a two-thirds vote might introduce the rule of unanimity. That no attempt has been made to do so speaks volumes for the practical workings of the three-fourths rule. While I think that three fourths may safely be allowed to return a verdict in civil causes, I am inclined to believe that in criminal causes considerations of humanity demand, and the State can afford to grant every individual, such a strong presumption of innocence that only a unanimous verdict of twelve of his peers shall be able to overcome it. In civil causes, where a preponderance of evidence entitles either party to a verdict, it is illogical to require unanimity, but in criminal cases, where the defendant must be proved guilty beyond a reasonable doubt, it would be absurd to say that he may be convicted while a single voice from the jury-box is heard protesting that he is innocent. Should it be impossible for a jury in a criminal case to agree, they are discharged, and the defendant is put on trial again before another jury. So justice can be defeated only by the unanimous consent of twelve sworn men of the neighborhood, and, if justice may sometimes be delayed and extra expense incurred

* Constitution of Nevada, Article I, section 3.

by the disagreement of a jury, the State can afford to wait, and no expense should be balanced against the possibility of innocence. So I think that justice will be best insured by retaining the rule requiring unanimity in criminal cases, and in all civil causes permitting three fourths to render a verdict.

5. The fact that jurymen are chosen by lot has been the subject of no little ridicule, and yet I think no other method would, on the whole, prove as satisfactory. When juries were composed of those who knew the facts in dispute, the panel must have been drawn from a limited number, and often the whole number of witnesses were not sufficient to make a complete panel. At that time, knowledge of the matter in controversy determined who should be called to sit as jurors; but, when the jury became a tribunal for the trial of facts upon the testimony of others, the jurors were called from the whole number of citizens possessing the requisite qualifications. In most of the States of the Union the qualifications of a juror are the same as those of a voter, and the panel is chosen by lot. In this way the personal element is, if not eliminated, at least restrained, and the impersonal element—blind chance—that knows neither friend nor foe, decides who shall be the arbitrators. In popular election Justice may be defeated, but Fortune always gives her an even chance.

Having described some of the leading characteristics of the modern jury, I shall now consider some of its advantages—first, as a judicial tribunal; and, secondly, as a political institution. No one now questions the utility of the separation of the legislative or law-making power from the judicial or law-interpreting power. No less important is the separation of the power that decides upon the facts from the power that applies the law to the facts when so determined. The former is the province of the jury, and the latter that of the judge. It is the duty, and the whole duty, of the jury to determine whether certain facts do or do not exist. It is sometimes said that in criminal cases the jury are the judges of the law as well as the fact. This misapprehension arises, I think, from the nature and effect of the verdict rendered in such cases. On all issues joined in criminal cases the jury may bring in a general verdict of "guilty" or "not guilty," and, if the latter, the defendant can not be tried again, no matter how erroneous the verdict may be. And this, too, is the result, even though the verdict be contrary to the express instruction of the court. The jury are, however, bound to follow the instructions of the court in all matters of law, and if they do not they are false to their trust, however remediless the state may be. If, on the other hand, the jury return a special verdict, that is, that certain facts do exist, the court is bound either to act upon those facts as true, or set the verdict aside and submit the facts to another jury. Now, suppose the judge should usurp the power of the jury, and should, notwithstanding the verdict, declare the alleged facts untrue, or decide that the facts though true do not constitute a crime, although by express statute they do, and suppose the judge so deciding, however erroneously, should discharge the defendant, would not the result be the same, and the state equally remediless? To this it will hardly be answered that judges can always be depended upon to do their duty, while jurors can not. The truth is, that the sole duty of the jury is to find the facts, and that of the judge to apply the law, and when either does more, except in those cases where the judge tries both, it is a usurpation of power.

Bearing in mind the fact that the only work of the jury is to determine the truth or falsity of certain alleged facts, let us inquire whether or not and how well it is adapted to this purpose. It is well known that technical training in any branch of learning has a peculiar influence on the mind. The mind by such training develops certain idiosyncrasies, and nothing is more common than to see an eminent specialist whose judgment is quite untrustworthy out of his specialty. A mind so trained usually adopts certain more or less artificial tests of truth, to which every proposition is submitted with a predetermination as to the relative weight of certain classes of evidence. Nothing is more boundless than the variety of facts that may be submitted for judicial determination, and these facts do not usually belong to any specialty, but arise out of the ordinary transactions of all men. No trade or profession can claim a monopoly of facts, and I am of the opinion that twelve men, coming to the work unbiased and untrammeled by any technical rules or artificial tests, are more likely to arrive at the truth in the ordinary affairs of life than any one, or indeed any number of specialists.

Perhaps the most frequent error alleged in appeals to the superior courts is that the verdict of the jury is against the weight of evidence, which is the nature of an appeal from the verdict of the jury on the facts, and yet it is safe to say that not one case in fifty is reversed on that ground. And, for every case reversed because the jury were wrong, more than a score are reversed for some error committed by the presiding judge in matters of law. I am aware that it is often said that only those who have the bad side of cases want to try them to a jury. This statement has little or no foundation in fact. Recently one of the foremost jurists of this country, who certainly is not overmuch attached to the jury system, said: "I am also forced to admit, however, that even in civil cases my experience as a judge has been much more favorable to jury trials than it was as a practitioner. And I am bound to say that an intelligent and unprejudiced jury, when such can be obtained, who are instructed in the law with such clearness, precision, and brevity as will present their duty in bold relief, are rarely mistaken in regard to the facts which they are called upon to find."* I think experience has shown what reason would

* Judge Miller's address before the New York Bar Association, "Albany Law Journal," vol. xviii, p. 409.

suggest, that the jury, with the modifications I have pointed out, is well adapted for its special work—the finding of facts.

But even stronger are the reasons for retaining the jury as a political institution. Some one has tersely said that it is not so necessary that the people get justice as that they should think they do. While this is, perhaps, putting it a little too strongly, yet there is much truth in it. Judges are usually chosen from a rank far above the mass of litigants, and the latter doubtless often feel that they are appealing for justice to one who has but little in common with the class to which they belong. And at this time, when there is a strong tendency to lengthen the tenure of judicial offices, it would be dangerous to cut off the popular branch of our judicature. The question that most threatens this country at present is the question of capital and labor. The tyranny that menaces us is not the tyranny of kings, but that of corporate capital. Whether the bench is really corrupted by the vast moneyed interests of the country is not material to the issue, if there is a deep-rooted suspicion of it in the minds of the people. Most men would feel safer, in a contest with one of these modern leviathans, to submit the facts in dispute to twelve men called from the vicinage, but what twelve no one could point out until the litigants had made the last challenge and the jury is in the custody of a sworn officer and beyond the reach of corrupting influences. Juries are doubtless sometimes corrupt, and sometimes go wrong by mistake, but the verdict of a jury, however erroneous, affects only one case, and neither establishes a bad precedent nor materially lessens our confidence in the system. The verdict deciding only the facts of the particular case has no influence upon the rights of any but the parties to that suit, and it is altogether improbable that the same twelve men will ever be called upon to sit together to try another case. So, however erroneous may be the verdict, and although every one may concede that it is wrong, no serious consequences follow, and the litigants in the next case proceed with the usual confidence in the justice of their fellow-men. It is only those who have a bad cause, or have lost confidence in mankind, that fear the jury. But how is it with the judges? Instead of their power ending with a single case, in the Federal courts and in seven States of the Union they hold their offices during life, and in the others for a term ranging from six to twenty-one years; and our present cumbrous method of impeachment, which can be effectual for nothing less than a "high crime or misdemeanor," affords but slight protection against ignorance, tyranny, or even corruption on the bench. If through ignorance or prejudice a judge has arrived at a wrong conclusion in one case, and from that conclusion there is no appeal, how can he be trusted in the next. And, still more, if he has yielded to the corrupting influences of power, or, what is practically the same thing, if the people believe he has so yielded, in one case, who but the powerful can trust him afterward? Ignorance or corruption in a jury may affect a particular case, but ignorance or corruption of a judge affects the whole system upon which depend the rights of all. If a corrupt jury taints the waters for a moment, to become pure again the next, a corrupt judge poisons at its head the fountain from which all must drink. I am inclined to think that the corrupting influences of corporations upon our courts is greatly exaggerated, but it would be idle to underrate the strength of public opinion on this subject. When so many suspect the purity of the bench, we should consider well before we eliminate the popular element from our courts of justice. Let us do nothing to exclude in fact or alienate in feeling the people from one of our most important institutions lest the evil spirit should whisper in the ear of poverty the all-too-powerful argument of Romeo:

> "Art thou so bare, and full of wretchedness,
> And fear'st to die? famine is in thy cheeks,
> Need and oppression starveth in thy eyes,
> Contempt and beggary hang upon thy back,
> The world is not thy friend, nor the world's law;
> The world affords no law to make thee rich;
> Then be not poor, but break it and take this."

What do the opponents of the jury offer in its stead? The only substitute that has yet been proposed is an increase of judges and trial to the court in all cases. We have already seen that one of the most useful features of the system of trial by jury is the separation of the power that tries the facts from that which decides the law. A question of fact is tried upon evidence, in the weighing and considering of which the mind should be trammeled by no artificial tests or technical rules. On the other hand, to determine questions of law requires long experience and accurate knowledge of rules and principles evolved from the common experience of mankind. The judge must be learned in the common law scattered through thousands of volumes of reported cases, as well as thoroughly acquainted with the statutory and constitutional law of the land. A finding of fact in one case can not, from the nature of the circumstances, be any aid in determining another set of facts upon different evidence in another case, and hence a finding of fact, or a verdict of a jury, can have no authority as a precedent. On the other hand, a determination of a principle of law is final not only in that particular case, but in all similar cases in that jurisdiction—thus a court of last resort, in deciding a single case, may settle a principle of law upon which scores of other cases depend. Now, it is this separation of the trial of the law and the facts—functions essentially different in their nature and requiring entirely different kinds of training and preparation—that has enabled our courts to build up, develop, and unify our system of jurisprudence. This division of labor, which has had much to do in producing the certainty, completeness, and symmetry of our law, would be wholly lost by the proposed change. It is suggested that, instead of a jury of twelve untrained men, three or five judges experienced in the law should determine both the law and the fact, and that such decision be final. This would certainly have the virtue of producing speedy justice, if justice at all. But what would be the result? Let us suppose a case. The Legislature passes a law which the judicial tribunal of one county holds to be unconstitutional, while that of another county declares it constitutional, and in two other counties it is construed to mean two quite different things, and so on through fifty counties, each of which has an independent, distinct, and final judicature. We see at a glance that there must be one supreme judicature whose jurisdiction is conterminous with that of the Legislature, whose will it interprets. The confusion now existing between the thirty-eight States in this regard is the source of much regret, and might have been fatal to the existence of the Union had it not been for the Federal Supreme Court, whose silent but constant influence gradually overcame the violence of contending factions. Then, by whatever tribunal cases are first tried, we must always have one Supreme or Appellate Court, and it is fair to presume that about as many cases would find their way into the higher courts, if first tried to the court, as if tried by a jury. And the proposed system would have the further disadvantage that, the higher a case were carried through the successive tribunals, the less would be the probability of a correct determination of the facts. While the appellate tribunals are usually best qualified to settle a question of law, they are, from their technical training and tendency to generalize, least qualified to determine a question of fact. Nor can we reasonably expect a reduction in expense by employing high-salaried specialists to do that which the ordinary laymen can do much better.

It is suggested, however, that justice would more certainly be meted out to litigants if the whole subject of controversy were in the hands of a few experienced men. Might not the same be said of the legislative branch of our Government? A score of well-trained lawyers could doubtless enact a more consistent and probably a better code of laws than any of our heterogeneous Legislatures, yet this would scarcely induce the people to make the change. Indeed, the strongest, cheapest, and best government is an absolute despotism in the hands of a strong, wise, good man. But the character of an institution ought to be estimated by its effects on the people, and that is on the whole the best which produces the best results. It is not only what people are called upon to actually do, but also the possibilities that lie before them, that affects their character. The occasional deposit of a ballot is not of itself much of a public education, but the possibilities and responsibilities that the elective franchise brings with it can scarcely be overestimated in their influence on the character of a people. Much the same is the influence of the popular branch of our system of judicature. While the direct influence of sitting occasionally as a juror ought not to be underestimated, yet I think still greater good comes from the increased responsibility of the people at large. There will be fewer criminals when every citizen feels that he is in some sense a conservator of the peace. The direct educating influence of trial by jury has often been remarked by those who have studied the influences that mold the character of nations. Bentham, who certainly will not be charged with venerating anything because it is old, in speaking of the jury as a public educator says: "Every judicatory, of which a jury forms a part, is a school of justice; without the name, it is so in effect. In it the part of master is performed by the judge; the part of scholars by the jurymen; and what takes place, takes place in a company more or less numerous of spectators. The representation there given is given by a variety of actors, appearing in so many different parts."* I believe that the people will not willingly give up an institution to which they owe so much of their self-reliance and ability to govern themselves until stronger reasons than any yet suggested are presented.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXIV.

SINCE the publication of my last paper, I have learned the proper name of the Swiss compound there described as *fondevin*, according to my recollection of its pronunciation in Switzerland. In an old edition of Mrs. Rundell's "Domestic Cookery," it is described as *fondu*. A similar dish is described in that useful book "Cre-Fydd's Family Fare," under the name of *cheese soufflé* or *fondu*. I had looked for it in more pretentious works, especially in the most pretentious and the most disappointing one I have yet been tempted to purchase, viz., the twenty-seventh edition of Francatelli's "Modern Cook," a work which I can not recommend to anybody who has less than £20,000 a year and a corresponding luxury of liver.

Amid all the culinary monstrosities of these "high-class" manuals, I fail to find anything concerning the cookery of cheese that is worth the attention of my readers. Francatelli has, under the name of "Eggs à la Swisse," a sort of *fondu*, but decidedly inferior to the common *fondu* of the humble Swiss osteria, as he lays the eggs upon slices of cheese, and prescribes especially that the yolks shall not be broken; omits the milk, but substitutes (for high-class extravagance' sake, I suppose) "a gill of double cream," to be poured over the top. Thus

* Bentham's works, vol. ii, p. 125.

the cheese is not intermingled with the egg, lest it should spoil the appearance of the unbroken yolks, its casein is made leathery instead of being dissolved, and the substitution of sixpenny worth of double cream for a halfpenny worth of milk supplies the high-class victim with fivepence halfpenny worth of biliary derangement.

In Gouffe's "Royal Cookery-Book" (the *Household Edition* of which contains a great deal that is really useful to an English housewife) I find a better recipe under the name of *cheese soufflés.* He says: "Put two and one fourth ounces of flour in a stewpan, with one and a half pint of milk; season with salt and pepper; stew over the fire till boiling, and, should there be any lumps, strain the *soufflé* paste through a tammy-cloth; add seven ounces of grated Parmesan cheese, and seven yolks of eggs; whip the whites till they are firm, and add them to the mixture; fill some paper cases with it, and bake in the oven for fifteen minutes."

Cre-Fydd says: "Grate six ounces of rich cheese (Parmesan is the best); put it into an enameled saucepan, with a teaspoonful of flour of mustard, a saltspoonful of white pepper, a grain of cayenne, the sixth part of a nutmeg, grated, two ounces of butter, two tablespoonfuls of baked flour, and a gill of new milk; stir it over a slow fire till it becomes like smooth, thick cream (but it must not boil); add the well-beaten yolks of six eggs, beat for ten minutes, then add the whites of the eggs beaten to a stiff froth; put the mixture into a tin or a cardboard mold, and bake in a quick oven for twenty minutes. Serve immediately."

Here is a true cookery of cheese by solution, and the result is an excellent dish. But there is some unnecesary complication and kitchen pedantry involved. The following is my own simplified recipe:

Take one fourth of a pound of grated cheese; add it to a gill of milk in which is dissolved as much powdered *bicarbonate of potash* as will stand upon a threepenny-piece; mustard, pepper, etc., as prescribed above by Cre-Fydd.* Heat this carefully until the cheese is completely dissolved. Then beat up three eggs, yolk and whites together, and add them to this solution of cheese, stirring the whole. Now take a shallow metal or earthenware dish or tray that will bear heating; put a little butter on this, and heat the butter till it frizzles. Then pour the mixture into this, and bake or fry it until it is nearly solidified.

A cheaper dish may be made by increasing the proportion of cheese—say, six to eight ounces to three eggs, or only one egg to a quarter pound of cheese for a hard-working man with powerful digestion.

The chief difficulty in preparing this dish conveniently is that of

* Before the Adulteration Act was passed, mustard-flour was usually mixed with well-dried wheaten-flour, whereby the redundant oil was absorbed, and the mixture was a dry powder. Now it is different, being pure powdered mustard-seed, and usually rather damp. It not only lies closer, but is much stronger. Therefore, in following any recipe of old cookery-books, only about half the stated quantity should be used.

obtaining suitable vessels for the final frying or baking, as each portion should be poured into, and fried or baked in, a separate dish, so that each may, as in Switzerland, have his own *fondu* complete, and eat it from the dish as it comes from the fire. As demand creates supply, our ironmongers, etc., will soon learn to meet this demand if it arises. I am about writing to Messrs. Griffiths & Browett, of Birmingham, large manufacturers of what is technically called "hollow-ware"—i. e., vessels of all kinds knocked up from a single piece of metal without any soldering—and have little doubt that they will speedily produce suitable *fondu* dishes according to my specification, and supply them to the shopkeepers.

The bicarbonate of potash is an original novelty that will possibly alarm some of my non-chemical readers. I advocate its use for two reasons: First, it effects a better solution of the casein by neutralizing the free lactic acid that inevitably exists in milk supplied to towns, and any free acid that may remain in the cheese. At a farm-house where the milk is just drawn from the cow it is unnecessary for this purpose, as such new milk is itself slightly alkaline. My second reason is physiological, and of greater weight. Salts of potash are necessary constituents of human food. They exist in all kinds of wholesome vegetables and fruits, and in the juices of *fresh* meat, but *they are wanting in cheese*, having, on account of their great solubility, been left behind in the whey.

This absence of potash appears to me to be the one serious objection to the free use of cheese-diet. The Swiss peasant escapes the mischief by his abundant salads, which eaten raw contain all their potash salts, instead of leaving the greater part in the saucepan, as do cabbages, etc., when cooked in boiling water. In Norway, where salads are scarce, the bonder and his housemen have at times suffered greatly from scurvy, especially in the far north, and would be severely victimized but for special remedies that they use (the mottebeer, cranberry, etc., grown and preserved especially for the purpose. The Laplanders make a broth of scurvy-grass and similar herbs). Mr. Lang attributes their recent immunity from scurvy, which was once a sore plague among them, to the introduction of the potato.

Scurvy on board ship results from eating salt meat, the potash of which has escaped by exosmosis into the brine or pickle. The sailor now escapes it by drinking citrate of potash in the form of lime-juice, and by alternating salt-junk with rations of tinned meats.

I once lived for six days on bread and cheese only, tasting no other food. I had, in company with C. M. Clayton, son of the Senator of Delaware (who negotiated the Clayton-Bulwer Treaty), taken a passage from Malta to Athens in a little schooner, and expecting a three days' journey we took no other rations than a lump of Cheshire cheese and a supply of bread. Bad weather doubled the expected length of our journey.

We were both young, and, proud of our hardihood in bearing privations, were stanch disciples of Diogenes; but on the last day we succumbed, and bartered the remainder of our bread and cheese for some of the boiled horse-beans and cabbage-broth of the forecastle. The cheese, highly relished at first, had become positively nauseous, and our craving for the vegetable broth was absurd, considering the full view we had of its constituents, and of the dirtiness of its cooks.

I attribute this to the lack of potash salts in the cheese and bread. It was similar to the craving for common salt by cattle that lack necessary chlorides in their food. I am satisfied that cheese can never take the place in an economic dietary otherwise justified by its nutritious composition, unless this deficiency of potash is somehow supplied. My device of using it with milk as a solvent supplies it in a simple and natural manner.

XXV.

My first acquaintance with the rational cookery of cheese was in the autumn of 1842, when I dined with the monks of St. Bernard. Being the only guest, I was the first to be supplied with soup, and then came a dish of grated cheese. Being young and bashful, I was ashamed to display my ignorance by asking what I was to do with the cheese, but made a bold dash, nevertheless, and sprinkled some of it into my soup. I then learned that my guess was quite correct; the prior and the monks did the same.

On walking on to Italy I learned that there such use of cheese is universal. Minestra without Parmesan would there be regarded as we in England should regard muffins and crumpets without butter. During the forty years that have elapsed since my first sojourn in Italy my sympathies are continually lacerated when I contemplate the melancholy spectacle of human beings eating thin soup without any grated cheese.

Not only in soups, but in many other dishes, it is similarly used. As an example, I may name "Risotto à la Milanese," a delicious, wholesome, and economical dish—a sort of stew composed of rice and the giblets of fowls, usually charged about twopence to threepence per portion at Italian restaurants. This is always served with grated Parmesan. The same with the many varieties of paste, of which macaroni and vermicelli are the best known in this country.

In all these the cheese is sprinkled over, and then stirred into the soup, etc., while it is hot. The cheese being finely divided is fused at once, and, being fused in liquid, is thus delicately cooked. This is quite different from the "macaroni cheese" commonly prepared in England by depositing macaroni in a pie-dish, and then covering it with a stratum of grated cheese, and placing this in an oven or before a fire until the cheese is desiccated, browned, and converted into a horny, caseous form of carbon that would induce chronic dyspepsia in the stomach of a wild-boar if he fed upon it for a week.

In all preparations of Italian pastes, risottos, purées, etc., the cheese is intimately mixed throughout, and softened and diffused thereby in the manner above described.

The Italians themselves imagine that only their own Parmesan cheese is fit for this purpose, and have infected many Englishmen with the same idea. Thus it happens that fancy prices are paid in this country for that particular cheese, which is of the same class as the cheese known in our midland counties as "skim dick," and sold there at about fourpence per pound, or given by the farmers to their laborers. It is cheese "that has sent its butter to market," being made from the skim-milk which remains in the dairy after the pigs have been fully supplied.

I have used this kind of cheese as a substitute for Parmesan, and I find it quite satisfactory, though it has not exactly the same fine flavor as the best qualities of Parmesan, but is equal to that commonly used by the Italian millions. The only fault of our ordinary whole-milk English and American cheeses is that they are too rich, and can not be so finely grated on account of their more unctuous structure, due to the cream they contain.

I note that in the recipes of high-class cookery-books, where Parmesan is prescribed, cream is commonly added. Sensible English cooks, who use Cheshire, Cheddar, or good American cheese, are practically including the Parmesan and the cream in natural combination. By allowing these cheeses to dry, or by setting aside the outer part of the cheese for the purpose, the difficulty of grating is overcome.

I have now to communicate another result of my cheese-cooking researches, viz., a new dish—*cheese-porridge*—or, I may say, a new class of dishes—cheese-porridges. They are not intended for epicures, not for swine who only live to eat, but for men and women who eat in order to live and work. These combinations of cheese are more especially fitted for those whose work is muscular, and who work in the open air. Sedentary brain-workers like myself should use them carefully, lest they suffer from over-nutrition, which is but a few degrees worse than partial starvation.

Typical cheese-porridge is ordinary oatmeal-porridge made in the usual manner, but to which grated cheese is added, either while in the cookery-pot or after it is taken out, and yet as hot as possible. It should be sprinkled gradually and well stirred in.

Another kind of cheese-porridge or cheese-pudding is made by adding cheese to *baked* potatoes—the potatoes to be taken out of their skins and well mashed while the grated cheese is sprinkled and intermingled. A little milk may or may not be added, according to taste and convenience. This is better suited for those whose occupations are sedentary, potatoes being less nutritious and more easily digested than oatmeal. They are chiefly composed of starch, which is a heat-giver or fattener, while the cheese is highly nitrogenous, and supplies the elements in which the potato is deficient, the two together forming a fair approach to the theoretically demanded balance of constituents.

I say *baked* potatoes rather than boiled, and perhaps should explain my reasons, though in doing so I anticipate what I intended to say when on the subject of vegetable food.

Raw potatoes contain potash salts which are easily soluble in water. I find that when the potato is boiled some of the potash comes out into the water, and thus the vegetable is robbed of a very valuable constituent. The baked potato contains all its original saline constituents which, as I have already stated, are specially demanded as an addition to cheese-food.

Hasty-pudding made, as usual, of wheat-flour, may be converted from an insipid to a savory and highly nutritious porridge by the addition of cheese in like manner.

The same with boiled rice, whether whole or ground, also sago, tapioca, and other forms of edible starch. Supposing whole rice is used, and I think this the best, the cheese may be sprinkled among the grains of rice and well stirred or mashed up with them. The addition of a little brown gravy to this gives us an Italian risotto.

Peas-pudding is not improved by cheese. The chemistry of this will come out when I explain the composition of peas, beans, etc.

I might enumerate other methods of cooking cheese by thus adding it in a finely divided state to other kinds of food, but if I were to express my own convictions on the subject I should stir up prejudice by naming some mixtures which some people would denounce. As an example I may refer to a dish which I invented more than twenty years ago—viz., fish and cheese pudding, made by taking the remains from a dish of boiled codfish, haddock, or other *white* fish, mashing it with bread-crumbs, grated cheese, and ketchup, then warming in an oven and serving after the usual manner of scalloped fish. Any remains of oyster-sauce may be advantageously included.

I find this delicious, but others may not. I frequently add grated cheese to boiled fish as ordinarily served, and have lately made a fish sauce by dissolving grated cheese in milk with the aid of a little bicarbonate of potash. I suggest these cheese mixtures to others with some misgiving as regards palatability, after learning the revelations of Darwin on the persistence of heredity. It is quite possible that, being a compound of the Swiss Mattieu with the Welsh Williams, cheese on both sides, I may inherit an abnormal fondness for this staple food of the mountaineers.

Be this as it may, so far as the mere palate is concerned, I have full confidence in the chemistry of all my advocacy of cheese and its cookery. Rendered digestible by simple and suitable cookery, and added, with a little potash salt, to farinaceous food of all kinds, it affords exactly what is required to supply a theoretically complete and a most economical dietary, without the aid of any other kind of animal food. The potash salts may be advantageously supplied by a liberal second course of fruit or salad.—*Knowledge.*

SCIENCE AND SAFETY AT SEA.

By RICHARD A. PROCTOR.

IN the autumn of 1879 the steamship Arizona, five thousand tons, at that time the swiftest ocean-going steamship in existence, was urging her way, at the rate of some fifteen knots an hour, on the homeward course from New York, whence she had sailed but a day or two before. It was night, and there was a light haze, but of danger from collision with a passing ship there was little or none. The captain and crew knew of no special reason for watchfulness, and the passengers were altogether free from anxiety. Indeed, it so chanced that at a time when, in reality, the most imminent danger threatened every soul on board, many of the saloon-passengers were engaged in purchasing at auction the numbers for the next day's run—runs below three hundred and fifty knots being sold at a very low rate indeed. Suddenly a crash was heard, the ship's swift progress was stopped, and a few minutes later every one knew that the Arizona had run dead upon an enormous iceberg, the spires and pinnacles of which could be seen hanging almost over the ship, and gleaming threateningly in the rays of her mast-head light. But the risk that threatened her living freight was not that of being crushed by falling ice. The bows of the Arizona were seen to be slowly sinking, and presently there was a well-marked lurch to starboard. The fore compartment and a smaller side compartment were filling. It was an anxious time for all on board. Many an eye was turned toward the boats, and the more experienced thought of the weary miles which separated them from the nearest land, and of the poor chance that a passing steamer might pick up the Arizona's boats at sea. Fortunately, the builders of the Arizona had done their work faithfully and well. Like another ship of the same line which had been exposed to the same risk, save that her speed was less, and therefore the danger of the shock diminished, the Arizona, though crippled, was not sunk. She bore up for St. John's, and her passengers were taken on later by another steamer.

The danger which nearly caused the loss of the Arizona—collision with an iceberg—is one to which steamships, and especially swift steamships, are exposed in exceptional degree. Like this danger, also, it is one which renders the duty of careful watching, especially in the night and in times of haze or fog, a most anxious and important care.

But, unlike the risk from collision with another ship, the risk from collision with icebergs can not be diminished by any system of side-lights or head-lights or stern-lights, except in just such degree (unfortunately slight) as a powerful light at the foremast-head, aided by strong side-lights or bow-lights, may serve to render the gleam of the treacherous ice discernible somewhat farther ahead. But to a steamship running at the rate of fourteen or fifteen knots an hour, even in the clearest weather, at night, the distance athwart which a low-lying iceberg can be seen, even by the best eyes, is but short. She runs over it before there is time for the watch to make their warning heard, and for the engineers to stop and reverse their engines.

But science, besides extending our senses, provides us with senses other than those we possess naturally. The photographic eyes of science see in the thousandth part of a second what our eyes, because in so short a time they can receive no distinct impression at all, are unable to see. They may, on the other hand, rest on some faintly luminous object for hours, seeing more and more each moment, where ours would see no more—perhaps even less—after the first minute than they had seen in the first second. The spectroscopic eyes of science can analyze for us the substance of self-luminous vapors or of vapors absorbing light, or of liquids, etc., where the natural eyes have no such power of analysis. The sense of feeling, or rather the sense for heat, which Reid originally and properly distinguished as a sixth sense (not to be confounded, as our modern classification of the senses incorrectly confounds it, with the sense of touch), is one which is very limited in its natural range. But science can give us eyes for heat as keen and as widely ranging as the eyes which she gives us for light. It was no idle dream of Edison's, but a thought which one day will be fraught with useful results, that science may hereafter recognize a star by its heat, which the most powerful telescope yet made fails to show by its light. Since that was said, the younger Draper (whose loss followed so quickly and so sadly for science on that of his lamented father) has produced photographic plates showing stars which can not be seen through the telescope by which those photographs were taken. As yet the delicate heat-measurers devised by science have not been applied to astronomical research with any important results. But Edison's and Langley's heat-measurers have been used even in this way, and the very failure which attended the employment of Edison's heat-measurer (the tasimeter, or, literally, the strain-measurer, described shortly before in the "Times") during the eclipse of 1878 shows how delicate is the heat-estimating sense of science. When the light of the corona—which has no heat that the thermometer, or even that far more delicate heat-measurer, the thermopile, will recognize—fell on the face of the tasimeter, the index which Edison supposed likely to move just perceptibly actually flew beyond the index-plate. Thus, though the heat of the corona could not be measured, the extreme delicacy of the tasimeter was demonstrated unmistakably. Langley's heat-measurer is scarcely less sensitive, and probably more manageable. But in point of fact each instrument is more sensitive than the heat-sense of science is required to be, to do the work I have now to indicate ; and an instrument can readily be constructed which shall be, in the right degree, less sensitive than they are, though it might be difficult at present to invent any that should be more senstive.

The sense of sight is not the only sense affected as an iceberg is approached. There is a sensible lowering of temperature. But to the natural heat-sense this cooling is not so obvious or so readily and quickly appreciated that it could be trusted instead of the outlook of the watch. The heat-sense of science, however, is so much keener that it could indicate the presence of an iceberg at a distance far beyond that over which the keenest eye could detect an iceberg at night; perhaps even an isolated iceberg could be detected when far beyond the range of ordinary eye-sight in the day-time. Not only so, but an instrument like the thermopile, or the more delicate heat-measurers of Edison and Langley, can readily be made to give automatic notice of its sensations (so to speak). As those who have heard Professor Tyndall's lectures any time during the last twenty years know, the index of a scientific heat-measurer moves freely in response either to gain or loss of heat, or, as we should ordinarily say, in response either to heat or cold. An index which thus moves can be made, as by closing or breaking electrical contact, or in other ways, to give very effective indication of the neighborhood of danger. It would be easy to devise half a dozen ways in which a heat-indicator (which is of necessity a cold-indicator), suitably placed in the bows of a ship, could note, as it were, the presence of an iceberg fully a quarter of a mile away, and speak of its sensations much more loudly and effectively than the watch can proclaim the sight of an iceberg when much nearer at hand. The movement of the index could set a fog-horn lustily announcing the approach of danger ; could illuminate the ship, if need be, by setting at work the forces necessary for instantaneous electric lighting ; could signal the engineers to stop and reverse the engines, or even stop and reverse the engines automatically. Whether so much would be necessary—whether those among lost Atlantic steamships which have been destroyed, as many have been, by striking upon icebergs, could only have been saved by such rapid automatic measures as these—may or may not be the case ; but that the use of the infinitely keen perception which the sense-organs of science possess for heat and cold would be a feasible way of obtaining much earlier and much more effective notice of danger from icebergs than the best watch can give, no one who knows the powers of science in this direction can doubt.—*London Times.*

SKETCH OF ORMSBY MACKNIGHT MITCHEL.

WITH the year 1842 practically commences the history of astronomical science in America. In that year, ORMSBY MACKNIGHT MITCHEL, a young graduate of West Point, and Professor of Mathematics at Cincinnati, having met with success in lecturing before his classes, was invited to give a course in the college hall. So successful was he in this course, and so great was the interest that he awakened in the subject, that he resolved to turn it to account, and enlist his hearers in the work of building an observatory. As the wealthier cities of the Eastern States had not yet moved in the direction, his plan was regarded by many as impracticable, but, after vigorous personal application, he succeeded in obtaining sufficient subscriptions to warrant a commencement of the work. The enterprise took shape by the organization of the Cincinnati Astronomical Society. Professor Mitchel had no observatory to model from, no practical knowledge of astronomy, and no instrument-makers from whom to purchase instruments or object-glasses. All this must be taught in older countries, and he resolved to go to Europe to this end. In order to husband his resources, he proceeded first to Washington, in the hope that he might be given some mission from the State Department, the remuneration for which would pay his expenses. Mr. Webster, then Secretary of State, informed him that his request was impossible, and nearly everybody, including President Tyler, was inclined to sneer at him as an impractical enthusiast. There was one notable exception —John Quincy Adams spoke words of kindness and encouragement. His application failed, and he proceeded on his journey, crossing the ocean in a sailing-vessel. Upon arriving in England, he looked for an object-glass, but found none worthy of his attention. From England he proceeded to Paris, and called upon M. Arago at the observatory there, who received him kindly; but, not finding what he desired in France, he proceeded to Germany, where he found a fine glass in the Frauenhofer works at Munich, which he purchased. Returning to England, he entered as a student in the Royal Observatory at Greenwich, and for some months devoted himself to the study of practical astronomy. Upon his return to America, he applied himself vigorously to the work of getting his observatory building ready for the reception of the equatorial telescope that he had ordered in Munich. He desired to secure the services of Mr. John Quincy Adams to deliver the oration at the laying of the corner-stone, and went to Niagara, where he learned Mr. Adams was sojourning at the time, to induce him to go to Cincinnati for that purpose. Notwithstanding the opposition of Mr. Adams's family, on account of his advanced age and infirmity, and the difficulties attending so long a journey in a stage-coach, so great was the ex-President's interest in the matter, and so certain did he feel it to be his duty, that he consented. On November 9, 1842, he delivered the address.

The time required to mount the glass, financial depression, and various discouragements prevented the completion of the building and the arrival of the telescope till the spring of 1845, when Professor Mitchel commenced his duties. He occupied himself in the ordinary routine of astronomical work. He paid considerable attention to perfecting instruments for attaining greater delicacy of observation. He claimed to be the first (though he found a rival to dispute this honor with him) to make a clock record its beats, thus obtaining a graphical and more minute measurement of time.

The pioneer of American observatories was not destined to be long-lived. Before many years rolled round, the smoke from the growing city at the base of the hill on which it stood rendered observations impossible. Its immediate successor, containing its instruments, is located some five or six miles from the original site, and other observatories, built afterward, occupy many a hill-top throughout America.

At the time the observatory was finished, an accident occurred which at first seemed very unfortunate for Professor Mitchel, but which in the end served to call out the full extent of his practical powers. The building of the college, from which he drew his only means of support, took fire and burned to the ground. The observatory was without endowment, and he had engaged to be its director for ten years without compensation, relying for support on his college professorship. He determined to enter the field as a professional lecturer on astronomy. With characteristic boldness he proceeded to Boston, believing that if he could succeed in that critical city, where the arts and sciences had been so thoroughly cultivated, and which numbered among its own citizens so many men of high scientific attainment, he could succeed elsewhere. He met with perfect success, and thus commenced that series of brilliant efforts in every city in the United States which lasted for fifteen years.

He published, in 1848, "Planetary and Stellar Worlds"; in 1860, "Popular Astronomy"; he also published, from 1846 to 1848, the "Sidereal Messenger," a periodical; and after his death a fragment, entitled "Astronomy of the Bible," was given to the public. These works, though the progress of science and of thought has left them now far behind, are still read by some who can discern in them the ardent poetic nature of their author. But his great work in science was in exciting an interest, wherever he appeared in person, to talk of the wonders of the heavens. He never attempted to *amuse* an audience, and never dropped below the dignity of the sublime subject of which he spoke. When flights of eloquence came to him, they seemed to meet him from among the lofty realms to which he ascended. Thither he carried his hearers, not by diagrams, not by actual pictorial representations, but by language alone. He possessed the power of magnetism to a remarkable degree. He could at once gain the sympathy of his audience, and always held it till he had ceased to speak. To him, far more than to any other man, is due the interest that grew up in astronomical science in America between the years 1842 and 1860, for there was scarcely a town or city in the United States in which he did not speak during that period.

In 1859 he delivered a course of lectures in the Academy of Music in New York for the benefit of an observatory that it was proposed to erect in Central Park. The last lecture of this course was the last he ever delivered. It was a fitting close to a brilliant work. The Academy was crowded almost to the ceiling. On the platform were seated many of the most prominent men in New York. As he led his audience out into space, to planet and sun and system, it became powerfully moved. When he closed, the ordinary methods of applause seemed inadequate. His hearers rose from their seats and cheered—an act not uncommon at meetings of a political nature, but probably without precedent at an astronomical lecture.

In 1860 Professor Mitchel was called to the directorship of the Dudley Observatory at Albany, the building of which he had himself designed.

At the opening of the late civil war, Professor Mitchel felt called upon to turn the military education he had received to the account of the Government that had given it. He was appointed a brigadier-general of volunteers. At the time of his appointment, Cincinnati—his former home—was threatened by the Confederates, and he was sent to defend it. After fortifying the city, he desired to occupy East Tennessee. By order of the Secretary of War, he organized a force for the purpose; but it was necessary to move through a department commanded by another general. That general would not consent, and the expedition had to be abandoned.

In April, 1862, he found himself in command of a division of General Buell's army (detached from the main column, then proceeding on the route to Corinth), and directed to observe the country south of him. Without orders, he proceeded by forced marches to Huntsville, Alabama, surprised and captured that part of the railroad and territory lying between Stevenson and Decatur, with seventeen locomotives and eighty cars, and held the territory he had been ordered to observe. For this service President Lincoln promoted him to be major-general. He asked for troops with which to march through Georgia, but Mr. Lincoln replied that all available forces had been given to General McClellan and General Halleck. He then asked to be transferred to a more active field, but Mr. Lincoln directed him to remain for future operations in the territory where his "military genius had effected so much." Upon General Buell's arrival with the rest of the Army of the Ohio at Huntsville, in July, 1862, General Mitchel urged an immediate advance into East Tennessee. General Buell delayed, and General Mitchel asked to be relieved. It was not, however, till the President determined to use him in a special service that he ordered him to report at Washington.

Mr. Lincoln proposed to send an army down the Mississippi under his command. He selected the force and wrote the order; but just at that time concluded to appoint General Halleck his military adviser. When General Halleck arrived at Washington he declined to appoint General Mitchel to this command. For two months he was unemployed, and in September, 1862, was sent, by General Halleck's order, to the then quiescent Department of the South, in South Carolina. Here he died of yellow fever on the 30th of October, 1862. His term of military service was fourteen months. During this time he found but one opportunity to act upon his own uncontrolled judgment.

Professor Mitchel was born in Union County, Kentucky, August 28, 1810. At twelve years of age, having acquired a tolerably fair knowledge of Latin and Greek and the elements of mathematics, he became a clerk in Miami, Ohio, but afterward removed to Lebanon, in the same State where he had been educated. He entered the Military Academy at West Point in June, 1825, having himself earned the money with which he was enabled to reach the school. After being graduated in 1829, he became acting Assistant Professor of Mathematics in the Academy, and served in that capacity for two years. He then removed to Cincinnati, where he practiced law till 1834, when he became Professor of Mathematics, Philosophy, and Astronomy, in Cincinnati College, a position in which he remained for ten years, or till the college-building was burned.

Of the more important features of his work at the observatory, "Nature" says, in an article on "Observatories in the United States" (July 9, 1874): "At the request of Professor Bache, the telegraph company connected the observatory with their stations for determining longitude, Cincinnati being then a central point in such work. The astronomer royal, under whose instruction Mitchel had passed three months in 1842, urged, in an encouraging letter, that 'the first application of his meridional instruments should be for the exact determination of his geographical latitude and longitude, and that his observing energies should be given to the large equatorial.' With this advice, he directed his attention largely to the remeasurement of Struve's double stars south of the equator.

"Airy and Lamont had invited him to make minute observations of the satellites of Saturn, since in the latitude of Cincinnati the planet is observed at a more favorable altitude than at Pulkova, twenty degrees farther north. To these, and chiefly 'to the physical association of the double, triple, and multiple stars,' he gave his close attention. He made interesting discoveries in the course of this review. 'Stars which Struve had marked as oblong were divided and measured; others marked double were found to be triple.' He proposed a new method for observing, and new machinery for recording north polar distances or declinations. Professor Peirce reported favorably on this method at the meeting of the American Association in 1851, and Professor Bache, as Superintendent of the Coast Survey, indorsed their approval in his report for that year, presenting also a full account of work done by the new method in observations made by the enthusiastic astronomer and his patient wife, who assisted him through all. It was claimed that the results rivaled the best work done at Pulkova. Mitchel was the first 'to prepare a circuit interrupter with an eight-day clock, and to use it to graduate the running fillet of paper'; and to invent and use the revolving-disk chronograph for recording the dates of star-signals. Professors Bache and Walker had declined to adopt the first of these improvements in astronomical appliances, through an apprehension of injury to the astronomical clock. Mitchel's work proved the apprehension to be groundless. His revolving disk is an invaluable invention.

"To the perfection of such methods and instruments, together with the routine work of observation, he gave all the energies not of necessity employed in outside labors devolving on him for his support. Unhappily these, at an early date, became almost absorbing. For the Astronomical Society, having secured their observatory and their director, had failed to secure a basis for its support."

Of his lectures, "Nature" remarks that he stirred up an enthusiasm by them "which quickened the movements resulting in the establishment of some of the first observatories of this day in the United States."

General Mitchel always acted with the incentive of genius rather than talent, if such a distinction exists. Hence his proposals were often regarded as impracticable. Their practicability depended upon his energy, resource, and magnetism. Without these, they would have been mere visionary schemes.

His simplicity and purity of character, his earnest patriotism and military foresight, are all minutely recorded in his correspondence. It is expected that the record will some day pass—one of its many chapters—into the voluminous history of the rebellion.

CORRESPONDENCE.

MOSQUITOES AND MALARIA.

Messrs. Editors:

"WHO shall decide when doctors disagree?" Not long since was put forth the theory that the "bite" of the mosquito is a genuine antidote for malaria, and one of the arguments used to sustain the assertion was that Nature provides remedies alongside all forms of disease, and that, wherever malaria abounded, mosquitoes did much more abound, and were busily engaged, to the best of their ability, in injecting a tonic under the skin of poor ague-stricken humanity, which would effectually cure the disease if the humane work of the winged surgeons was not interfered with; and now comes Professor King, in the September number of your journal, with the startling claim that the mosquito is the very *cause* of malarial diseases!—and the problem, Shall we encourage or kill the insect? is still unsolved.

Having had some experience with these much-denounced insects in the woods and by the inland lakes in the northern part of the Lower Peninsula of Michigan, and on and beside the lagoons of Southern Florida and even in the hotel sleeping-rooms in many parts of the land, I feel compelled to differ with Professor King in some of his alleged "facts," and I fear some of my statements will at least throw a doubt over the supposed "established facts" of the professor.

The professor argues that a locality abounds in mosquitoes, and that malaria is found to prevail in the same locality, and therefore it is quite probable that the malarial diseases there are produced by the mosquitoes.

Suppose we assume that it is quite as probable that the condition of heat, moisture, soil, and vegetation, merely makes the locality a spot favorable to the generation of both mosquitoes and malaria, without any connecting relation one with the other. Suppose, again, we find localities where the mosquito, during a part of the year, is, by the power of numbers and fierceness of attack, almost king of the woods, and yet there is no malaria to be feared or found.

I have been in several localities on Indian River and Mosquito Lagoon, on the southeast coast of Florida, where I would not like to have been on the outside of my netting, under the little shelter-cabin of our sailboat, but I have never seen more numerous and, in localities, more voracious mosquitoes than in our northern forests in Michigan. The efforts on the part of these insects to produce malarial disease, in some form, if this is their mission, were never more persistent than there. I have from the best authority the fact that it is no very uncommon thing for hardy woodsmen, in the spring months, to be driven from their work in the forest by the mosquitoes and black flies; but the general rule is, in the milder attacks, for the choppers to become so accustomed to the mosquitoes, day and night, as to pay little attention to them, they "let 'em bite," only disturbing them when, by an unusual attack, they overstep the reasonable demands for blood. Many of these men have come under my personal observation during a residence of from two to six weeks each year for seven years at our summer resort on Grand Lake, three miles back from Lake Huron. As I knew them to be working day after day in the low cedar lands, often in wet swamps, and drinking the swamp water where they could find a pool under some old moss-bed, and often sleeping in rude log or board shanties in the same locality, I have often asked them if they did not get the ague, or "chills" and fever. The answer was always, "Never." I have seen many little children, from the babe up, with naked legs, feet, arms, and no head-covering but the hair, absolutely covered more with mosquito-bites than garments, all through the season, but I have never known a case of malarial disease in any form among them. In view of these observations, I must conclude the case is hardly made out that mosquitoes produce malarial diseases, although in many localities the two are co-existent.

The professor says it is a fact of common observation that mosquitoes are more numerous in the late summer months. I am not sure of other localities, but in Upper Michigan, at our resort, and all through Northern Michigan, the fact is exactly the reverse. We usually require nettings during July. About the 1st of August the mosquitoes begin to disappear, and we can sleep without nettings; but, during May, June, and July, if they created malarial diseases, there would be lively shakes among the settlers, where malarial diseases are now unknown, or of extremely rare occurrence.

I do not know but the sea-coast mosquito is a more wicked fellow, but our North Michigan mosquitoes, I believe, are engaged in better work than creating malaria. In fact, I am not sure but that the "bites" of mosquitoes, in the cases of our northern cedar-cutters, and their freedom from disease in great exposure furnish the "antidote" for the malarial tendency of the swamp air and swamp water, and furnish an argument for the antidote theory rather than otherwise.

We can hardly accord to Professor King the soundness of his argument, that because miasma and mosquitoes prevail at night, therefore the mosquito is the author of miasma. Does the mosquito produce the miasma in the air, or create the disease by his "bite"? Suppose we say bats fly only at night, and dew falls only at night, therefore the bats create the dew?

The night air may be congenial to both malaria and mosquitoes, as it may be to both bats and dew, without any further relationship. If Professor King will spend a week or a month in May or June in our northern cedar-lands, I will warrant him more mosquito-bites to the square inch of exposed person than there are pounds of atmospheric pressure on the same surface, and I will also guarantee him safety from all malarial disease. F. R. Stebbins.

Adrian, Michigan, *October* 8, 1883.

A REPLY TO EDITORIAL STATEMENTS.

Messrs. Editors:

In your editorial comments on the classical question, you refer to Germany as favorable to the old education on account of royalty and the Bismarckian *régime;* you also quote from "Science" a condemnation of German scientific writers. Allow me, in the briefest manner, to set you right on these two points. Whatever you may think of Bismarck, you should, in the present discussion, at least state that Bismarck does not favor Greek, but thinks it is only studied for a make-believe of mental superiority; also that he has emphatically stated that the state must take its civil officers wherever they can be found, efficiency being the only test, not the approval, etc., of the university; and, thirdly, you should bear in mind that Bismarck is no favorite with the Berlin University, the latter being much more of your opinion as to the "*régime*" now existing in Prussia than of an opinion favorable to Bismarck.

While I share your views as to the aristocratic tendencies that take shelter under the Latin-Greek education, I yet believe that respect for royalty in Germany is fostered mainly by the common school, while the universities are decidedly democratic in their influence.

As regards the lack of clearness and order formerly so common in German scientific writers, I beg to call your attention to the many excellent scientific writers that Germany can *now* point to, when a comparison with other countries is instituted. I believe a somewhat careful investigation would startle those who accept the common dogma that German scientific writers are obscure and deficient in order. Schleiden, the botanist, Carl Vogt, Du Bois-Reymond, Virchow, Haeckel, are only a few of the best-known German scientists who excel in order and clearness, and in the graces of style. No modern literature has scientific works superior in order, clearness, and style, to those of George Forster and Jacob Moleschott, and yet the former excelled, and the latter still excels, in scientific work. In a country like Germany, where so many write, bad writing is apt to be more readily noticed. As for the absence of important generalizations by German scientists, I think this subject should be treated separately. Kepler's grand generalizations were written in Latin; Leibnitz published many of his in French; there are other authors distinguished for important generalizations, who, if they can not compare with Darwin, yet occupy a high rank—for instance, Dr. J. R. Mayer, who first formulated the great law of heat-equivalents, and hence of the conservation of force.

I should be glad to find that your *sense of justice* is strong enough to make the corrections your statements and the extract require. C. A. E.

Iowa City, *December* 26, 1883.

Our sense of justice is perhaps not very strong, but it is put to no strain by publishing the foregoing. We referred to the "Bismarckian *régime*" only as a name for the present phase of the administration of the German Government, and our argument could not depend upon any man's personal views, because it rested upon the broad declaration of the university authorities that the ascendency of the classics must be maintained for church and state reasons. It is interesting to know that Bismarck regards Greek as a humbug, but he would probably be the last man to deny that shams may have their political uses.

The quotation from "Science" was made, not because we approved or considered pertinent all that it said, but because it testified decisively to the neglected condition of the native speech on the part of a people long given over to the worship of classical ideals. Our correspondent recognizes "the lack of clearness and order formerly so common in German scientific writers." He, however, enumerates several recent writers that are not open to this charge. But are not those exceptions to a general practice? and would it not have been somewhat more to the point to inform us whether or not these writers were assiduous cultivators of the classics?—Ed.

EDITOR'S TABLE.

COLLEGIATE INFLUENCE UPON THE LOWER EDUCATION.

THERE is one aspect of the broad classical controversy of momentous importance, but which has been much neglected in the general discussion of the subject. We refer to the relation of our collegiate system to the system of education in the schools of lower grade. It is only by scrutinizing this relation that we can really appreciate the extent of the practical antagonism between the classical and the scientific systems ot study, and recognize how completely the colleges are all on one side in this issue.

We are abundantly assured that, whatever may have been the case in the past, there is now no ground of complaint that the dead languages usurp too much attention, while the sciences are correspondingly neglected. The curriculums are appealed to to show that classical studies are no longer in the way of science, which is every year receiving increasing attention in these institutions. New laboratories, observatories, and museums, are pointed at to show the augmenting facilities of scientific study, and we are told that, by the growing optional system, the student is more and more allowed a choice of subjects when he enters college, which enables him, if he likes, to give a larger portion if not his entire time to science.

But all this does not mean so much as it appears to mean. We are not for a moment to regard the influence of the colleges as limited to the students who come under their direct control. They exert a varied and powerful influence upon the secondary schools, upon the methods of early teaching, and upon both the youthful and adult mind of the community at large, which is overwhelmingly in behalf of the classics, and solid against science. They not only determine the prior studies of the great numbers who enter college, but they set the standards of education for multitudes who never pass to the higher institutions. They sustain and they enforce an ideal of culture which shapes the policy and fixes the character of the whole system of instruction that deals with the common education of the people. The alleged liberality implied by the optional system is misleading, if it is taken to imply any real liberty of the student to choose his studies untrammeled by college requirements, for not the slightest option is allowed as between the dead languages and the sciences in that prior period when the youthful mind receives its bent in the lower or preparatory schools. The relaxation of classical demands after admission to college, so far from indicating a diminished exaction of dead-language studies, is accompanied by an increasing stringency of requirement in these subjects before college is entered. With increasing option in college the standard of preparation is raised, which means that more Greek and Latin is forced upon the preparatory schools. The point of strain is shifted, but this is done in such a way as greatly to aggravate the evils of classical study. The worst influence of the colleges upon general education, as we have often maintained, is their reactive effect upon the preparatory schools, and the whole secondary system of instruction to which the youthful mind of the country is subjected. By their demands upon these institutions, the colleges lend their influence to maintain throughout the community an ideal of culture that is predominantly and in effect exclusively classical. Modern studies have no status, no recognition in the preparatory stage of those who propose to obtain a so-called liberal education. The alleged concessions to the spirit of progress are therefore illusive. The concessions made to science after entrance into college are not allowed in the period of early study when they would be far more valuable. Nothing substantial is conceded to science when our colleges keep their classical standards of admission so high that all the time of pupils is consumed in Latin and Greek preparation. No concession is made to science when proficiency in scientific studies gained at school is not allowed to count in entering college. No such concession is made by a collegiate system that does not provide by imperative requirement for some thorough grounding in scientific branches in the preliminary schools, and which does not allow solid proficiency of scientific attainment to open the way to the highest college honors.

But the radical antagonism of our colleges to educational progress through their reactive influence upon the lower school system is only to be fully appreciated when we understand in what that progress consists. In its philosophy, traditional education is very much where it was a hundred years ago, but it is undeniable that many important principles have been reached which are of the greatest moment as guides to better educational practice. A century of science is not to go for nothing in the treatment of this subject. There are relations among the great divisions of modern knowledge which are fundamental in laying down courses of study. There is an order in the development of the human faculties which is fundamental to the art of rational and successful teaching. There is an ideal of the highest purpose in cultivating the intellect—the investigation of the truth of nature by various processes—which has been developed by the advance of science. Systematic and comprehensive efforts have been made to reduce this new ideal to practice in the lower sphere of education. Efforts have been made to teach first the things which belong first in the course of mental unfolding, to bring the young mind into closer relations with the facts of experience, to cultivate more thoroughly the all-important habit of observation, and to provide for the training of the active and inventive powers by simplified experiment and various manipulations, and finally to make the operations of study exercises in investigation and in original and independent thought upon subjects within the common sphere of intelligence, and adapted to educate the judgment. It is no longer a question that these supreme objects can be secured to very considerable degree by proper methods of dealing with the minds of youth, and great progress has been made in recent times in working out the practical methods by which they are attained. But the whole movement belongs to the lower schools, and the whole influence of our college system upon those schools is not to help but to hinder it. In illustration and confirmation of this view, we quote some remarks made by Dr. Barnard, President of Columbia College, at the dinner given in New York to Professor Tyndall in 1873:

I say, then, that our long-established and time-honored system of liberal education—and when I speak of the system, I mean the whole system, embracing not only the colleges, but the tributary schools of lower grade as well—does not tend to form original investigators of Nature's truths; and the reason that it does not is, that it inverts the natural order of proceeding in the business of mental culture, and fails to stimulate in season the powers of observation. And when I say this, I must not be charged with treason to my craft—at least not with treason spoken for the first time here, for I have uttered the same sentiment more than once before in the solemn assemblies of the craft itself.

I suppose, Mr. President, at a very early period of your life you may have devoted, like so many other juvenile citizens, a portion of your otherwise unemployed time to experiments in horticulture. In planting leguminous seeds you could not have failed to observe that the young plants come up with their cotyledons on their heads. If, in pondering this phenomenon, you arrived at the same conclusion that I did, you must have believed that Nature had made a mistake, and so have pulled up your plants and replanted them upside-down. Men and women are but children of a larger growth. They see the tender intellect shooting up in like manner, with the perceptive faculties all alive at top; and they, too, seem to think that Nature has made a mistake, and so they treat the mind as the child treats his bean-plant, and turn it upside-down to make it grow better. They bury the promising young buds deep in a musty mold formed of the decay of centuries, under the delusion that out of such *débris* they may gather some wholesome nourishment; when we know all that they want is the light and warmth of the sun to stimulate them, and the free air of heaven in which to unfold themselves. What heartless cruelty pursues the little child-martyr every day and all the day long, at home or at school alike; in this place bidden to mind his book and not to look out of the window—in that, told to hold his tongue and to remember that children must not ask questions! . . .

Among the great promoters of scientific progress, how large is the number who may, in strict propriety, be said to have educated themselves. Take, for illustration, such familiar names as those of William Herschel, and Franklin, and Rumford, and Rittenhouse, and Davy, and Faraday, and Henry. Is it not evident that Nature herself, to those who will follow her teachings, is a better guide to the study of her own phenomena than all the training of our schools? And is not this because Nature invariably begins with the training of the observing faculties? Is it not because the ample page which she spreads out before the learner is written all over, not with words, but with substantial realities? Is it not because her lessons reach beyond the simple understanding and impress the immediate intuition? That what she furnishes is something better than barren information passively received—it is positive knowledge actively gathered?

If, then, in the future we would fit man properly to cultivate Nature, and not leave scientific research, as, to a great extent, we have done heretofore, to the hazard of chance, we must cultivate her own processes. Our earliest teachings must be things, and not words. The objects first presented to the tender mind must be such as address the senses, and such as it can grasp. Store it first abundantly with the material of thought, and the process of thinking will be spontaneous and easy.

This is not to depreciate the value of other subjects, or of other modes of culture. It is only to refer them to their proper place. Grammar, philology, logic, human history, *belles-lettres*, philosophy—all these things will be seized with avidity and pursued with pleasure by a mind judiciously prepared to receive them. On this point we shall do well to learn, and believe we are beginning to learn something, from contemporary peoples upon the Continent of Europe.

Object-teaching is beginning to be introduced, if only sparingly, into our primary schools. It should be so introduced universally. And in all our schools, but especially in those in which the foundation is laid of what is called a liberal education, the knowledge of visible things should be made to precede the study of the artificial structure of language and the intricacies of grammatical rules and forms.

The knowledge of visible things—I repeat these words that I may emphasize them, and, when I repeat them, observe that I mean *knowledge* of visible things, and not information about them—knowledge acquired by the learner's own conscious efforts, not crammed into his mind in set forms of words out of books.

But how do our colleges stand as a body in regard to these explicit requirements of educational progress? Their whole power is exerted to defeat them. They force Latin and Greek upon all the preparatory schools; they make grammar and verbal studies, which should belong later in the course, imperative in early years; they supplement the classics by mathematics, and give the go-by to all the natural sciences. There is not the slightest provision in the studies introductory to college for any cultivation of the mind by immediate intercourse with the facts of nature. We have before us "A Comparative View of the Requisitions for Admission to Representative American Colleges, correct to 1880-'81," printed in the prospectus of the Berkeley School of New York city. Latin, Greek, and mathematics are of course the staple studies, and the amount of requirement in these subjects is given in detail. Under the head of miscellaneous are included such further subjects as the several institutions hold important for admission to college. The common element here is English grammar, but neither Yale, Princeton, Columbia, Brown, Dartmouth, Williams, Amherst, Trinity, Michigan University, Vassar, Smith, nor Johns Hopkins, requires a shred of scientific preparation of any kind, unless school-geography is allowed to pass for science. Harvard requires some acquaintance with physics and *either* chemistry or botany, and Cornell includes physiology among the preparatory studies. By all these leading and influential collegiate institutions, which arrogate to themselves the prerogative of conferring a "liberal education," the study of Nature is absolutely left out in the early period of study, and nothing worthy of the name of science is recognized or required, when the foundations of intellectual character are being laid. There is one everlasting grind in grammar—Greek grammar, Latin grammar, English grammar—until the mental habits are formed by verbal studies; and then when the student enters college he is offered some restricted liberty of taking up scientific subjects.

Undoubtedly, the great issue of science against the classics is made up and to be met here. The continuance of the system of discrimination against modern knowledge, and in favor of dead languages, is not to be tolerated. The college premiums on old studies condemned by the common sense of mankind, and doubly damaging in early youth, must be withdrawn. Those institutions can not too soon take measures to get out of the way of the improvement of the lower schools. It is becoming more and more obvious, as shown by the current discussion of the subject, that there is urgent necessity for a readjustment of the relations of the higher and lower systems of instruction, and in evidence of this we quote the following instructive passages from an excellent article by Mr. R. R. Bowker, in the "Princeton Review" for January, on "The College of To-day":

This brings us face to face with the at present difficult problem of the relations of the college to the general education out of which its curriculum must proceed. It is noticeable that while there has been much activity in the improvement of the higher education, and much progress, following the suggestions of Froebel and Pestalozzi, in primary education, the immediate education remains much where it was, and blocks the road in the middle. Our common schools are still "grammar-schools," although, as has been noted, educators are in agreement that "grammar," as such, is the one thing that should not be taught until the very highest grades are reached. And the colleges can not do their proper work, nor can an approximately correct curriculum be put into practice, until many features of the middle schools are not only reformed but revolutionized. The scheme of the proper education, following the child from its first lessons, should be developed in view of two chief conditions: the order in which the natural development of the mind fits it for the reception of successive studies; and the practical fact that, since the number to be educated decreases each year beyond the early years, the essential subjects must be presented early in the course. Happily, these two conditions largely coincide. The present curriculum of the middle schools has developed from the practical recognition of this last condition, in ignorance of the first, but through much misconception as to which are essential subjects. It is, of course, important that every child should be taught to speak, to write, to read, to figure, correctly; but it is now known that the child learns correct speech, for instance, chiefly through its observing faculties, by imitation, and not through its reflective faculties, by study of grammar. The child develops through the what, the how, the why—first the fact, next its relations, lastly its causes; and yet the lower schools will be teaching the laws of grammar, and leaving the facts of nature, as the elements of botany, for which the child-mind is hungering and thirsting, to the advanced student. The college professor of the natural sciences, for instance, should find the foundations laid for him when the student enters college, whereas now he must begin at elementary facts. A correct college curriculum is scarcely possible as middle education stands now. Recognizing, then, the fact that the order in which the mind can best learn is the order in which it can best be taught, it becomes of the utmost importance that the college, admitting the necessity of present compromise, should exert its full influence to reorganize the education below.

It thus appears that the antagonism of the classical institutions to the popular schools in their real purpose is of a very radical kind. Our colleges, by their history and traditions, are academic, scholastic, and literary institutions, designed at least theoretically to form a learned class; while on the other hand the great body of the subordinate schools is devoted to the general education of the people, which should be practical and useful, based upon common needs and a preparation for the working duties of life. The colleges by their policy are chiefly solicitous to make the lower schools tributary to their own prosperity; but they must take larger views of their own interests by ceasing their indirect resistance to the progress of education in the lower schools, and by efficiently helping it forward. In an enlarged view, as Mr. Bowker well remarks, "the colleges can not do their proper work, nor can an approximately correct curriculum be put into practice until many features of the middle schools are not only reformed but revolutionized." But this revolution of the middle schools is a revolution that must begin in the colleges themselves, by which their exclusive exaction of a classical preparation is abandoned, and the sciences are given an equal chance with the dead languages. The classical gentlemen may league together to resist this change, but it will be of little avail; sooner or later it is sure to come. We observe by the last report of the President and Treasurer of Harvard College, 1882–'83, that this question is under serious consideration by the authorities of that institution, and, if they shall see fit to take the step now so urgently demanded, other institutions will be certain to follow.

President Eliot says (page 16): "The College Faculty is the body in which almost all the considerable changes, made during the past sixteen years in the educational methods of Harvard College, and of the schools which regularly feed it, have been first studied in detail, and then wrought into practical shape; and it is at present engaged, not for the first time, in the discussion of the gravest question of university policy which has arisen, or is likely to arise, in this generation—namely, the extent to which option among the different subjects should be allowed in the examination for admission to college."

LITERARY NOTICES.

Excursions of an Evolutionist. By John Fiske. Boston: Houghton, Mifflin & Co. Pp. 379. $2.

Mr. Fiske has laid the reading public under many obligations by the reissue of these more recent papers, which embody his matured views on a wide and varied range of topics. Nothing need be said in commendation of the literary work of a writer who has been long recognized as unrivaled in the art of lucid, effective, and pleasing exposition. But we are not to forget that these accomplishments have been put to the noblest service, and make him the most admirable interpreter of a new epoch in the advance of human thought. Mr. Fiske's writings belong eminently to a transition era in philosophic and scientific progress, and are in a high sense authoritative representations of it. And this is much to say of any one man's relation to a mental movement more comprehensive in its bearings upon widely received opinion than any that has ever before taken place.

There can be no doubt that Mr. Fiske's "Cosmic Philosophy" must rank first among the few masterpieces of expository statement contributed by this age on the subject of evolution. It is *the* book for the people upon this subject. It is not only an eminently instructive but a most charming work.

The author handles the great problems involved with originality and power, and at the same time with a clearness, a felicity of illustration, and a fascination of style, that give the work an unequaled claim upon popular regard. And we do not for a moment mean by this that the treatise is lowered in quality to adapt it to uncultivated minds. Its peculiar excellence is, that while it treats of abstract and difficult questions, in such a way that the uninitiated may pursue the discussions with satisfaction, the most adept minds will also be profoundly interested. We have seen a school-boy absorbed in the work; and Mr. Charles Darwin, after having gone slowly and carefully through it, wrote to the author, "I never in my life read so lucid an expositor—and therefore thinker—as you are"; and he adds, "It pleased me to find that here and there I had arrived from my own crude thoughts at some of the same conclusions with you, though I could seldom or never have given my reasons for such conclusions." The testimony of Mr. Darwin is corroborated by that of many others, the effect of which is to accord to Mr. Fiske an eminent and enviable place among those who have command of the questions that are now occupying the most earnest attention of the thinking world.

These considerations are important in their bearing upon our estimate of the present volume. The most fertile conception ever launched into the intellectual sphere is that of universal evolution. As deep as the forces of nature, it is as broad as the phenomena of nature. It is a new view of the movement of things, a new interpretation of their most comprehensive relations. There is hardly any great subject that escapes its influence. It has necessitated a recasting of the sciences, and a thorough-going reorganization of knowledge. So productive and all-influential an idea can be but partially dealt with in the most systematic and elaborate treatises; outstanding problems still remain to be solved and new applications of the doctrine worked out. Mr. Fiske has pursued the subject, after the publication of his elaborate book several years ago, in various aspects and in new directions, developing many points that were there but briefly touched upon. The volume before us consists mainly of these supplemental excursions in various directions, but all animated and characterized by the fundamental doctrine to which his first work was devoted. We recommend it to all students of the course of modern thought and the critical questions of the time, and can give our readers no better idea of the variety and instructiveness of its contents than by quoting the titles of the subjects treated. These are:

1. Europe before the Arrival of Man. 2. The Arrival of Man in Europe. 3. Our Aryan Forefathers. 4. What we learn from Old Aryan Words. 5. Was there a Primitive Mother-Tongue? 6. Sociology and Hero-Worship. 7. Heroes of Industry. 8. The Causes of Persecution. 9. The Origins of Protestantism. 10. The True Lesson of Protestantism. 11. Evolution and Religion. 12. The Meaning of Infancy. 13. A Universe of Mind Stuff. 14. In Memoriam. Charles Darwin.

INTERNATIONAL SCIENTIFIC SERIES. VOL. XLVII.

Fallacies. A View of Logic from the Practical Side. By Alfred Sidgwick, Berkeley Fellow of Owens College, Manchester. D. Appleton & Co. Pp. 375. Price, $1.75.

It is curious that the subject, which is at the same time the most important, the most practical, and which involves questions of the deepest intellectual interest—that is, the science and art of correct reasoning—should somehow have come to be regarded as the dullest and heaviest of all subjects. No doubt this repulsiveness of logic is very much due to that ancient pedantic formality which was imparted to it in scholastic times and has continued ever since, and also to the fact that its practical objects have been forgotten in the development of its processes. University drill in logic has become itself the end without much reference to its reduction to utilitarian practice. Whatever may be the cause of the unattractiveness of logic, much of it must certainly be due to prejudices arising from its imperfect presentation. In his book on "Fallacies," Professor Sidgwick has made a very successful attempt to rescue the subject from its repellent forms, and to deal with it in a way that shall be interesting to the general reader. The book is, therefore, written as much as possible from an unprofessional point of view, and in a way to require no previous technical training. Although any treatment of fallacies must, to a great extent, deal with methods of proof, and must, therefore, demand a certain amount of general logical theory, yet by trying to keep chiefly in view the practical and applicable side of the science of logic, and subordinating all else to this, Professor Sidgwick claims to have been able to neglect the discussion of much debatable matter, and to avoid definite adherence to a school. Mill and Bain are chiefly followed, but the author has attempted to utilize their most important results without being compelled to accept the whole of their philosophy. The following passages from Professor Sidgwick's introductory chapter may serve to illustrate the point of view from which he regards his subject, and also his fresh and unconventional manner of writing upon it:

> Logic holds what may well be called an uncomfortable position among the sciences. According to some authorities, it can not be properly said that a body of accepted logical doctrines exists; according to others, the facts and laws that form such doctrine are so completely undeniable, that to state them is hardly to convey new or important information. Hence, if a writer on the science tries to avoid truism, and so to give practical importance to his statements, there is danger both of real but crude innovation, and also of over-simple belief in the value of merely verbal alterations. Moreover, at its best, logic has many persistent enemies, and by no means all of them are in the wrong; so that those who view the science as the thief or burglar views the law, find themselves apparently supported and kept in countenance by others who really have the right to view it as perhaps the artist views the rules that hamper genius. Through its deep connection with common sense, logic is often a source of exasperation to philosophy proper; while common sense, on the other hand, is apt to dread or dislike it as unpractical or over-fond of casuistical refinements. Failing thus to win a steady footing, it turns, sometimes, to physical science for a field of operations; but physical science has its proper share of boldness, and often leaves the cautious reasoner behind. As for art—which finds even common sense too rigid—here logic is liable to meet with opposition at every grade; from the righteous impatience of poetic souls that are genuinely under grace, down to the incoherent anger of mere boastful vagueness, or to the outcry of the sentimental idler.
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> In the midst of these perplexities, it is difficult to choose a quite satisfactory course. Some excuses may, however, be offered for the line that has here been taken; and, first, I would plead, as against the charge of irregularity or presumption, the fact that I have wished to keep a single purpose in view, avoiding all questions that fail to bear directly upon it. Usually in works on logic, the object has been to say something valuable upon all the questions traditionally treated as within the field of the science, and, in attempting this, the single, practical purpose is apt to become obscured. It is only in consequence of my avoidance of side-issues that any appearance of novelty in the treatment has followed. Moreover, it is not teaching, but suggestion that is chiefly here intended. It is always allowable to write rather in the co-operative spirit than the didactic, and this has certainly been my aim throughout. And the same apology may apply to the charge of forcing verbal changes upon the reader; the novelties of statement are here put forward merely as possible aids in keeping our single purpose clear, and, in fact, I found them almost unavoidable.
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> As regards physical science, it must be confessed that logic merely follows after it, systematizing methods already adopted there, and found to lead to good results. And I hold that to combat fallacy is the *raison d'être* of logic; and that science, though not infallible, is more free from discoverable fallacies than any other field of thought. Again, while experimental methods may no doubt be capable of much improvement, it seems a tenable view that the duty should be left to a special and very advanced department of inquiry. There might, perhaps, be formulated a system of advice for discovery in general—rules and hints important even to the leading men of science. But, in the mean time, logic (as usually understood) can hardly help containing a good deal of elementary matter, and is compelled to take for granted in the learner a power of making very elementary mistakes. It seems that the best scientific discovery must always be in advance of inductive logic, in much the same way as the best employment of language runs in advance of grammar. Still, there may be some use in trying to direct and help those who are not already scientific, or only in the earlier stages of the pursuit; nor need the name of logic compel logicians to claim a dignity beyond their power. One can not fulfill successfully the duties of lord chancellor and justice of the peace at once.

A Natural History Reader. For School and Home. Compiled and arranged by James Johonnot, author of "Principles and Practice of Teaching," etc. New York: Pp. 414. D. Appleton & Co. Price, $1.25.

The work of the compiler of this volume has been executed with intelligence, taste, and good practical judgment, and he has made of it a most interesting book of natural history for general reading. It is an excellent sign of the healthy growth of an interest in science when works of this kind are called for and introduced into schools. The literature of science must undoubtedly precede its actual and more thorough cultivation, and a great point will have been gained when this literature secures a prominent and established place in the schools. It is a concession to the rights of knowledge. Hitherto we have stopped with rhetoric, careless of the contents of thought, and in subserviency to the dogma that style and expression are everything. Such works as this are tributes to a sounder view, and evidences of advancement in the right direction. On this subject Professor Johonnot well remarks:

"Under the later system, the truth is recognized that the object of all school exercises is to promote mental growth, to which end ideas and thoughts are indispensable. Words, like bank-notes, are regarded not for their intrinsic but for their representative value. In so far as they clearly reveal the gold of thought, they may be taken for genuine coin, but, failing in this, they are worthless counterfeits. The kinds of ideas and thoughts are also a matter of serious moment. In each stage of the mind's growth, those only should be used that will command the attention by the interest excited, that will stimulate the reflective activities of the mind, and that will incite to further observation and investigation.

"With these objects kept clearly in view, reading and the general acquisition of language become secondary and not primary processes. They are incident to the general objects of instruction. Reading-matter is selected upon the same principles as studies—that which will interest, stimulate, and incite. At every stage of growth it is such as will best serve the present purposes of the mind, and, at the same time, promote the next step in advance. The pupil reads because he is anxious to know. His progress is rapid, because he is interested. His manner of reading is correct, because he understands the thought, and thought controls the expression."

We must add that the "Natural History Reader" is an attractive and a handsome book. It is beautifully illustrated, poems are interspersed with the prose chapters, and it is elegantly printed. Its selections are from the most recent writings of naturalists, and the information they convey will be found fresh and up to the times.

Lectures on Painting. Delivered to the Students of the Royal Academy. By Edward Armitage, R. A. New York: G. P. Putnam's Sons. Pp. 337. $1.75.

Professor Armitage has given in this book a selection of twelve from the lectures delivered by him during the term of his professorship in the Royal Academy, between 1876 and 1882. He has published them under the impression that they might be interesting to other students than those of the Royal Academy, "and possibly even to those who do not intend to follow art as a profession, but who would be glad to have a little daylight thrown on a subject which, though much written and lectured about of late years, does not seem to have been often treated in a simple, practical manner." The subjects of the lectures are, "Ancient Costume," "Byzantine and Romanesque Art," "The Painters of the Eighteenth Century," "David and his School," "The Modern Schools of Europe," "Drawing," "Color," "Decorative Painting," "Finish," "The Choice of a Subject," "The Composition of Decorative and Historical Pictures," and the "Composition of Incident Pictures."

Archivos do Museu Nacional do Rio de Janeiro (Archives of the National Museum of Rio de Janeiro). Dr. Ladislao Netto, General Director. Vol. III, 1878, pp. 194, with Six Plates; Vol. IV, 1879, pp. 154, with Six Plates; Vol. V, 1880, pp. 470. Rio de Janeiro: Typographia Economica.

The "Archives" are a quarterly publication of papers on scientific subjects that properly come under the purview of the Museum. The present volumes include the publications for the second half of 1878, and for 1879 and 1880. In the third volume are included papers on the venom of the rattlesnake, by Dr. Lacerda; on the geology of the diamond-bearing region of the Province of Paraná, by Orville A. Derby; observations on geological features in the Bay of Todos os Santos, by Mr. Derby and Richard Rathbun; and other papers of a more special character. The fourth volume contains a number of anthropological and linguistic studies on the natives of the country, and papers on subjects of entomology and geology. The fifth volume is given to the "Flora Fluminensis," a Flora, in

Latin, of the Province of Rio, composed in the last century by Fr. José Marianno da Conceição Velloso, and first published in 1825.

Tertiary History of the Grand Cañon District. By Clarence E. Dutton. Washington: Government Printing-Office. Pp. 264, with Forty-two Plates, accompanied by an Atlas of Twenty-three Plates.

The Grand Cañon of the Colorado is characterized by some of the most wonderful rock-formations and the most gorgeous yet desolate scenery to be found anywhere on the earth. Captain Dutton has made the study and the description of it a labor of love, and the present volume, with its striking illustrations and the accompanying atlas with its grand panoramas and bird's-eye views, many of them, as well as the illustrations in the volume, colored according to nature, constitute one of the most welcome contributions to our literature and knowledge which the United States Geological Survey has made. Mr. Dutton's account of the geology, formation, characteristics, and scenery of the cañon takes notice of every aspect in which the wonder is likely to be viewed. Among the details of the account, to which we would invite attention, are the carved niches or panels in the red-wall limestone, and the exquisite tracery of the rounded and inward curves and projected cusps of the walls, which are represented in plates 41 and 42 of the volume.

Electricity in Theory and Practice; or, the Elements of Electrical Engineering. By Lieutenant Bradley A. Fiske, U. S. N. New York: D. Van Nostrand. 1883. Pp. 265. Price, $2.50.

Whoever will carefully read Lieutenant Fiske's lucid exposition will have no excuse for persistence in the hazy notions concerning the relation of electrical effects, and the power requisite to produce them, not uncommon among even the intelligent and educated public. Very few persons, perhaps, are in the position, in regard to their knowledge of electricity, of the man who wanted to know why they should have a steam-engine and a dynamo-machine to make an incandescent lamp go, or of that English couple who purchased a Swan lamp and spent much time trying to light it with a match; but the ignorance which abounds on the subject is still very considerable. With the great and increasing development of the practical application of electricity, it is especially desirable that the general public, both in its character of investor and consumer, should have definite and clear conceptions of the fundamental principles involved in these applications. These Lieutenant Fiske has essayed to furnish in the present volume.

He introduces his subject with an elementary consideration of magnetism, which he follows with a chapter upon statical electricity. The relation of work and potential, and of the different electrical units to each other, is very clearly explained. A chapter is devoted to the laws of currents, and to primary and secondary batteries. In speaking of the electric light, no attempt is made, and very properly, to describe different forms, but to explain the essential principles involved in this class of apparatus. The chapter on electrical measurements is an admirable, concise statement of the subject, as is also that on telegraphy and on the telephone. The chapters upon electro-magnetic induction and upon the dynamo are excellent; but upon the latter Lieutenant Fiske might well have devoted some little attention to the designing of dynamos. He states in his preface that he intended his book to form a bridge between the theory of electricity and its practical application. There is probably no one case in which the practical constructor finds more difficulty in passing from theory to practice than in this of the designing of dynamos. He may know what a unit magnet-pole is and the magnetic effect of a unit-current, but he still is able to but very vaguely see his way to apply this knowledge in determining the size of his field-magnets, the amount and size of wire on them, and the like proportions of his armature, to get the best results. Very few machines, we imagine, have been built so largely by rule of thumb as the dynamo, and therefore information of this sort could not fail of being of great value.

The book closes with a chapter upon the electric railway, giving a general view of the subject, and descriptions of the systems carried out by Siemens Brothers, and that devised by Mr. Edison and S. D. Field.

The Mounds of the Mississippi Valley, historically considered. By Lucien Carr, Peabody Museum. Cambridge, Mass. Pp. 107.

This essay, which forms a part of the "Memoirs" of the Kentucky Geological Survey, is an argument in favor of the theory that the mound-builders were the ancestors of the present Indians. The advocates of the theory that the mounds were built by some other race rest to a large extent upon the assumptions that the Indians were not sufficiently advanced to execute the works that have been examined; that they were not agriculturists, as the mound-builders must have been; and that they were not subject to such central authority, or controlled by any such impelling motive, as seems to have been necessary for the construction of such extensive works. Mr. Carr's effort is to controvert these assumptions. He argues, with the aid of many citations from historians, chroniclers, and travelers, that the Indians of the Mississippi Valley lived in fixed villages, which they were in the habit of fortifying by palisades; that they raised corn in large quantities and stored it; thet they all worshiped the sun, as the mound-builders are supposed to have done; and that works similar to those of the mound-builders, if not quite as extensive, are known to have been erected by Indians.

A Practical Treatise on Materia Medica and Therapeutics. By Roberts Bartholow, M. A., M. D., LL. D. Fifth edition, revised and enlarged. New York: D. Appleton & Co. 1884. Pp. 738.

The appearance of a new edition of this well-known work so soon after the edition of 1881 is due, in part, as the author tells us in his preface, to the recent changes in the "United States Pharmacopœia." Although the work has been adapted to the new official standard in general, we fail to find any reference to the changes in the morphia strength of the opium preparations, and the doses prescribed are the same as in the earlier editions. This is the more to be regretted since the new Pharmacopœia does not itself give any doses.

Many additions demanded by the advance of science have been made in the body of the work, so that nearly one hundred pages in all have been added to the book, making it a complete exponent of the present state of knowledge in this direction.

In Part I the routes by which medicines are introduced into the organism are classified and briefly described. Under this head the author treats insufflation, the use of the nasal douche and atomizers, etc., and gives a valuable chapter upon hypodermatic (hypodermic) methods, with a list of the remedies, solutions, and doses employed, and cautions as to the points to be avoided in hypodermatic injections. Then follows an article on transfusion, with references, as in other cases, to the authorities consulted. In Part II the actions and uses of remedial agents are very fully described. In this part we find the uses of water, externally and internally, of heat, of air, and of massage, discussed, as well as the actions of drugs in general, and the effects of various kinds of aliments and beverages. Formulæ are given for the preparation of animal broths and diet-drinks; the koumiss-cure, whey-cure, and buttermilk-cure, each receive some attention. Directions are also given for the preparation of gruels, jellies, peptonized milk, and other restorative agents.

The various pharmacopœal preparations are briefly mentioned, their strength noted, and the dose given, while their physiological and therapeutical use receives more attention. Processes for their preparation are not given.

In addition to a very copious general index, the work is provided with a very full "clinical index," which will serve to suggest the remedies that may be employed in any particular disease, but which may also prove an injury in other ways as furnishing an aid to quackery, and offering an encouragement to "counter-prescribing" by druggists.

Human Proportion and Anthropometry. By Dr. Robert Fletcher. Cambridge, Mass.: Moses King. Pp. 37, with Plates.

This is a lecture delivered at the National Museum, Washington, D. C., and includes an examination and explanation of the ancient Egyptian and the Polykleitan canons of proportion, with a review of the results of recent anthropometric measurements.

The Motions of Fluids and Solids on the Earth's Surface. By Professor William Ferrel. Reprinted, with Notes, by Frank Waldo. Washington: Government Printing-Office. Pp. 51.

This essay, the first and most important of the valuable mathematical essays of Professor Ferrel on the motions of the atmosphere, is reprinted as the first part of a paper, the object of which is to place in the hands of the investigator and student the important writings on the subject, elucidated with notes. It is to be followed by a second part, including the writings of several European mathematicians, who have engaged in the study.

Meteorological and Physical Observations on the East Coast of British North America. By Orray Taft Sherman. Washington: Government Printing-Office. Pp. 202.

This volume contains the observations and deductions made by the meteorologist of the scientific party of the schooner Florence, which spent the winter of 1877–'78 in Cumberland Sound, latitude from 64·50° to 67°, and completes the scientific record of the expedition. The observations relate to tidal phenomena, temperature, hygrometry, the winds, atmospheric pressure, the weather, and the color of the sky, cloudiness, precipitation, and auroral phenomena.

Annual Report of the Operations of the United States Life-saving Service, for the Fiscal Year ending June 30, 1882. Washington: Government Printing-Office. Pp. 504.

The report well illustrates the efficiency and usefulness of the service to which it relates. The department has 189 stations, of which 144 are on the Atlantic, 37 on the lakes, seven on the Pacific, and one at the Falls of the Ohio, Louisville, Kentucky. It had cognizance, during the year covered by the present report, of 345 disasters to vessels of different classes, directly involving 2,398 persons. Of these persons, 2,386 were saved, and only twelve were lost. Of $4,766,227 of property involved, $3,106,-457 were saved. Interesting statements are made respecting the success that has attended the use of the surf-boat, the self-righting and self-bailing life-boat, the breeches-buoy, the wreck-gun, the heaving-stick, the India-rubber dress, and other life-saving apparatus. Circumstantial accounts are given of each of the cases of shipwreck and rescue; statistics are shown of wrecks and casualties in American waters and disasters to American vessels in other waters, since 1879; and the instructions of the service to mariners in case of shipwreck are furnished.

Charts and Tables showing Geographical Distribution of Rainfall in the United States. By H. H. C. Dunwoody. Washington: Government Printing-Office. Pp. 51, with 13 Charts.

The charts exhibit the geographical distribution of the average monthly and average yearly rainfall in the United States, as determined by observers of the Signal Service. The tables give the actual rainfall occurring during each month at the regular Signal-Service stations and army posts, with the average rainfall for each month, season, and year, and serve to show the fluctuations of rainfall in different sections of the country during the last ten years.

The North Atlantic Cyclones of August, 1883. By Lieutenant W. H. H. Southerland, U. S. Navy. Washington: Government Printing-Office. Pp. 22.

This report includes the records of the cyclones of August 19th to August 27th, and of August 27th to September 1st, with maps of their course, compiled from the logs of vessels which came under their influence. Nautical directions are appended for manœuvring in, and avoiding the center of, cyclones in the North Atlantic.

Horological and Thermometric Bureau of Yale College Observatory. Third Annual Report. By Leonard Waldo. New Haven: Tuttle, Morehouse & Taylor. Pp. 26.

Watches continue to be received for testing from a variety of makers, and show a decided improvement in quality of performance. The establishment of a school of horology is suggested, but endowments are wanting. Time-signals are regularly transmitted from the observatory to the railroads of the State. Certificates have been issued of 5,295 thermometers, against 4,552 in 1881–'82 and 1,957 in 1880–'81.

Chemical Problems, with Brief Statements of the Principles involved. By James C. Foye, Ph. D. New York: D. Van Nostrand. Pp. 141. 50 cts.

The value of problems as means for securing accuracy in a knowledge of the subject, and as tests for attainments, is generally recognized by the best educators. The present work was prepared to meet a need felt by the author, who is a professor in Lawrence University, Wisconsin, in instructing his classes. Its plan is very simple. After defining the terms used, and briefly stating the principle to be illustrated, a typical problem is solved, and from the solution a formula of general application is deduced, which is followed by problems to be worked by the student. These, as a rule, bear upon the fundamental principles of chemistry.

Steam-Heating. An Exposition of the American Practice of warming Buildings by Steam. By Robert Briggs. New York: D. Van Nostrand. Pp. 108. 50 cts.

Unless some application of electricity is devised to supersede it, steam is, in all probability, destined to be the agent by which our houses will be heated in the future. Aside from its superior cleanliness as compared with most other methods of heating apartments, the facility with which the warming and ventilation are managed, when it is once established, is a strong recommendation in its favor. Mr. Briggs's treatise includes a great deal that the builder and householder will find useful on the subject, particularly on the practical side.

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POPULAR MISCELLANY.

Sub-aerial Decay of Rocks.—Professor T. S. Hunt publishes, in the "American Journal of Science," an elaborate paper on the "Decay of Rocks," in which he insists that recent geological studies afford evidence that a sub-aërial decay both of silicated crystalline and calcareous rocks has taken place universally and from the most ancient epochs, and that it was very extensive in pre-Cambrian times. He further insists that the materials resulting from this decay are preserved *in situ*, in some regions by overlying strata; in others by the position of the decayed material with reference to denuding agents; and that the process of decay, though continuous through later geological ages, has, under ordinary conditions, been insignificant in amount since the glacial period, on account of the relatively short time that has elapsed, and also, probably, on account of changed atmospheric conditions in the later time. The process of decay, he believes, "has furnished the materials for the clays, sands, and iron-oxides from the beginning of Palæozoic time to the present, and also for the corresponding rocks of Eozoic time, which have been formed from the older feldspathic rocks by the partial loss of protoxide bases. The bases thus separated from crystalline silicated rocks have been the source, directly and indirectly, of all limestones and carbonated rocks, and have, moreover, caused profound secular changes in the constitution of the ocean's waters. The decay of sulphureted ores in the Eozoic rocks has given rise to oxidized iron-ores, and also to deposits of rich copper-ores in various geological horizons." Finally, Professor Hunt maintains that "the rounded masses of crystalline rock left in the process of decay constitute not only the bowlders of the drift, but, judging from analogy, the similar masses in conglomerates of various ages, going back to Eozoic time; and that not only the forms of these detached masses, but the outlines of eroded regions of crystalline rocks, were determined by the preceding process of sub-aërial decay of these rocks."

"Colds."—The views of Dr. Page on the subject of "catching cold," published in the "Monthly" for January, having been sharply criticised as unsound and extreme, we give below an extract on the same subject from the London "Lancet," a scientific medical authority of the highest grade: "A person in good health, with fair play, easily resists cold. But when the health flags a little, and liberties are taken with the stomach or the nervous system, a chill is easily taken, and, according to the weak spot of the individual, assumes the form of a cold, or pneumonia, or, it may be, jaundice. Of all causes of 'cold,' probably fatigue is one of the most efficient. A jaded man coming home at night from a long day's work, a growing youth losing two hours' sleep over evening parties two or three times a week, or a young lady heavily 'doing the season,' young children at this festive season over-fed and with a short allowance of sleep, are common instances of the victims of 'cold.' Luxury is favorable to chill-taking; very hot rooms, soft chairs, feather beds, create a sensitiveness that leads to catarrhs. It is not, after all, the 'cold' that is so much to be feared as the antecedent conditions that give the attack a chance of doing harm. Some of the worst 'colds' happen to those who do not leave their house or even their bed, and those who are most invulnerable are often those who are most exposed to changes of temperature, and who by good sleep, cold bathing, and regular habits, preserve the tone of their nervous system and circulation. Probably many chills are contracted at night or at the fag-end of the day, when tired people get the equilibrium of their circulation disturbed by either overheated sitting-rooms or underheated bedrooms and beds. This is especially the case with elderly people. In such cases the mischief is not always done instantaneously, or in a single night. It often takes place insidiously, extending over days or even weeks. It thus appears that 'taking cold' is not by any means a simple result of a lower temperature, but depends largely on personal conditions and habits, affecting especially the nervous and muscular energy of the body."

How and where Malaria thrives.—The health-officers of New Britain, Connecticut, have made an instructive report concerning the prevalence of malarial diseases in that town, and their connection with certain supposed causes. The causes of malarial and other miasmatic diseases are not identical, though they are similar, and the two classes not infrequently occur in a given locality at the same time; and the hygienic measures required to prevent them all are the same. The essential conditions for the development of malaria appear to be: the presence of the malarial germ; a high temperature and dry atmosphere; and favorable conditions of the soil; and the absence of either of them will suspend or prevent the action of the poison. We have power only over the third condition. "A generous rain in the vicinity has, we think, invariably suspended its action. And yet a previous condition of moisture is essential to its manifestation. All deposits of vegetable matter, such as muck, sink-drainage, heaps of decaying vegetable matter, or even wet, spongy land, furnish the essentials for its support; but it is requisite that the soil shall have been very wet, or covered with water some portions of the year." A generous crop of grass, and perhaps of other vegetable substance, has been known to prevent malaria. In 1880 nearly all the families in the neighborhood of some lots which were largely a deposit of muck had malaria. The lots were plowed, dragged, and sowed with grass-seed, and the appearance of the crop of grass and weeds was attended by a disappearance of chills and fever. Two or three other instances are mentioned in the same town, in which fever-and-ague was banished by giving a similar treatment to tracts of swampy and mucky soil. Another case is specified where malaria was prevented by the drying up of the sewerage and sink-water which usually found its outlet through a system of ditches cut in muck. Preparations were making to lay tiles in the ditches and fill them up, but, before this was done, a heavy rain washed them out, and "caused the prevailing sickness to abate as suddenly as it had commenced." From the first, malaria has not prevailed in those parts of the city where vegetable deposits and filth have been absent, and the health of the streets in which sewers have been laid has been remarkably good.

Can Dogs be taught to read?—Under the title "Instinct," Sir John Lubbock writes as follows in a recent number of the "Spectator":

"Sir: Mr. Darwin's 'Notes on Instinct,' recently published by my friend Mr. Romanes, have again called attention to the interesting subject of instinct in animals. Miss Martineau once remarked that, considering how long we have lived in close association with animals, it is astonishing how little we know about them, and especially about their mental condition. This applies with especial force to our domestic animals, and above all, of course, to dogs. I believe that it arises very much from the fact that hitherto we have tried to teach animals, rather than to learn from them—

to convey our ideas to them, rather than to devise any language, or code of signals, by means of which they might communicate theirs to us. No doubt, the former process is interesting and instructive, but it does not carry us very far. Under these circumstances, it has occurred to me whether some such system as that followed by deaf-mutes, and especially by Dr. Howe with Laura Bridgman, might not prove very instructive, if adapted to the case of dogs. Accordingly I prepared some pieces of stout cardboard, and printed on each in legible letters a word, such as 'food,' 'bone,' 'out,' etc. I then began training a black poodle, 'Van' by name, kindly given me by my friend Mr. Nickalls. I commenced by giving the dog food in a saucer, over which I laid the card on which was the word 'food,' placing also by the side an empty saucer, covered by a plain card. 'Van' soon learned to distinguish between the two, and the next stage was to teach him to bring me the card; this he now does, and hands it to me quite prettily, and I then give him a bone, or a little food, or take him out, according to the card brought. He still brings sometimes a plain card, in which case I point out his error, and he then takes it back and changes it. This, however, does not often happen. Yesterday morning, for instance, he brought me the card with 'food' on it nine times in succession, selecting it from among other plain cards, though I changed the relative position every time. No one who sees him can doubt that he understands the act of bringing the card with the word 'food' on it, as a request for something to eat, and that he distinguishes between it and a plain card. I also believe that he distinguishes, for instance, between the card with the word 'food' on it and the card with 'out' on it. This, then, seems to open up a method which may be carried much further, for it is obvious that the cards may be multiplied, and the dog thus enabled to communicate freely with us. I have as yet, I know, made only a very small beginning, and hope to carry the experiment much further, but my object in troubling you with this letter is twofold. In the first place, I trust that some of your readers may be able and willing to suggest extensions or improvements of the idea. Secondly, my spare time is small, and liable to many interruptions; and animals also, we know, differ greatly from one another. Now, many of your readers have favorite dogs, and I would express a hope that some of them may be disposed to study them in the manner indicated. The observations, even though negative, would be interesting; but I confess I hope that some positive results might follow, which would enable us to obtain a more correct insight into the minds of animals than we have yet acquired."

Salts in Rivers and in the Sea.—The sea, it is well understood, is fed with salt as well as with water, by the rivers. The question then arises naturally, How is it that the rivers—admitting that they are mildly salt, although they appear to be fresh—differ from the ocean in the kind as well as in the strength of their saltness? Mr. W. Mattieu Williams answers the question by showing that, when sea-water is evaporated, sulphate of lime is the first salt to be deposited, while chloride of sodium, sulphate of magnesia, chloride of potassium, and the bromides, are deposited later. Hence, when the sea-water reaches the point of saturation with sulphate of lime, no more can be dissolved in it, but all additional supplies must be deposited. Moreover, if a soluble salt of lime were brought into the sea, its lime would combine with the sulphuric acid there combined with magnesia, or soda, or potash, which would, in obedience to a curious chemical law, leave those bases to combine with that one which would form an insoluble compound. Thus the total quantity of lime in sea-water is limited by the solubility of sulphate of lime, and this amounts to only about one part in four hundred of water.

The Caribs and the Greeks.—Mr. A. J. Van Koolnijk has published in the "Journal of the Dutch Geographical Society" an account of Carib tombs and relics which have been found in the Island of Aruba, off Dutch Guiana. Among the relics are potteries of good workmanship, elaborately ornamented and painted in a variety of colors obtained on the island. Some of the more common ornaments are figures of frogs and frogs' heads, which indicate that the Indians had considerable respect for those animals. Many of the ornaments, the handles of the vessels, and the skill with which the reliefs were finished, reminded the discoverers of Greek patterns. Some of the vessels, too, bore figures which were thought to be inscriptions or hieroglyphics, and a remarkable resemblance was traced between these characters and the letters of the Greek alphabet. This leads our Dutch antiquary to consider the question whether there may not have been some kind of a connection between these Caribs and the ancient Greeks. Ch. Rümelin is quoted as having suggested the possibility of looking for the origin of the northern tribes of Colombia, through the Guanches of the Canary Islands, to the Foulahs of the Soodan. Cyries also speaks of having seen hieroglyphic figures representing the sun, moon, and various animals, roughly cut on the granite rocks of Guiana at such heights that ladders had to be used to reach them.

The Stone Age in Africa.—Herr Richard Andree has accumulated a large mass of evidences of the existence of a stone age in Africa—a point which has hitherto been involved in much doubt. The Djurs, on the White Nile, still hammer their iron with a block of granite; smoothed stones are still used for hammer and anvil between the east coast and the Tanganyika Lake; the Hottentots and Bushmen dig roots with perforated stones; the Arabs in Egypt curry their shorn sheep with flint; the Bushmen tip their arrows with bone, and the Gabiri, in Bagirmi, with clay. Stories, which are reminiscences of the days of stone instruments, are told among the Hereros, and among the Bazimba of Madagascar. When the Europeans discovered the Canary Islands, they found the Guanches in the midst of a stone age. This much we know of the present use of stone. The historical evidences are scarce. Diodorus Siculus says the Libyans threw stones at their enemies, and Agatharcides says that the Ethiopians tied stone points to their arrows, while Strabo says they tipped them with antelope-horn. Vessels and implements of stone have become quite common among the "finds" of Egypt, and in all the countries and the deserts to the western border of Morocco. While not more is known about the stone evidences than about the other features of the intermediate countries, flints and stone vessels, of both crude palæolithic and more highly-finished forms are found at numerous places in the southern point of Africa, from the mouth of the Orange River to Delagoa Bay. The implements are very similar in form and material to the European finds, and present the same puzzle in the occurrence of nephrite among them. Assuming that evidences will be found at least as abundantly in the countries which have not yet been examined for them, the conclusion is drawn that the Africans, although they have been using iron as far back in historical times as our knowledge extends, had also a stone age.

Indistinctness of Race Divisions.—Professor Léon Rosny, in his forthcoming work on the "Danubian Principalities," says, speaking of the nationality of the Roumanians, that that people confirms a view which he has held for years, and which is also M. Renan's view, that the matter of nationality is very largely a question of feeling. Many different elements may have contributed to the formation of a Roumanian nationality, but the chief one has been the fancy that the people of Moldavia and Wallachia were descended from a mixture of the ancient Dacians with Trajan's soldiers, and were, therefore, the Romans of the East, whose mission it was to guard the interests of the Latin race in that part of Europe. Reminiscences of Roman antiquity are still current in the country, as, for example, in a popular dance, the Kalusar, which represents the rape of the Sabine women. Conversely, the Tartars of the Dobrudja are composed of a great variety of types, from that of the pure European to that of the most pronounced Mongolian, but they all pass alike for Tartars. These things suggest, again and again, the thought that the characteristic traits which are held to be most decisive in determining the differences between the groups of mankind are in reality very flexible and changeable. Physical tokens are of service only for the establishment of two or three grand divisions among men, and the value even of these divisions is becoming more and more subject to criticism. Linguistic distinctions, on which ethnographic classifications have for some time been assumed, are likewise very fallacious. People have been capable of changing their vocabulary and their grammar, and even of discarding their whole language and adopting another of different spirit. The groups of the human race are, as a whole, the product of historical changes in the different phases of their existence, and the influence of the surroundings in which they have developed themselves. Professor Halévy supports M. Rosny's theory, and believes that nations may change their language, their disposition, and their moral character, according to the surroundings among which they live, and according to their institutions. Africans, for example, show a change from the moment they become Mohammedans. The word "race" should no longer be used in ethnology. "When I was in Abyssinia," he says, "during the war between England and King Theodore, it was quite impossible to distinguish a Hindoo in the British service, when he was stripped, from a native Abyssinian. Even Theophrastus was aware of the striking similarity, and classed the Indians and Abyssinians together as Ethiopians."

The Check in the Growth of France.—The attention of French economists has been drawn for several years to the fact that the population of their country is not increasing, but shows rather a tendency, in many parts of the country, to diminish. The tendency is steadily manifested, in several departments, to a greater degree than in others, and has been maintained with considerable uniformity in those departments where it is most marked. The departments in which the decrease is most observable are the group in Languedoc and the group in Normandy. Of the five Norman departments, only one, that of the Lower Seine, shows an increase, and the increase there is solely due to the attraction of the large towns of Havre and Rouen. The tendency of population to gravitate toward the cities, at the expense of the rural districts, is as marked in France as in other countries, and contributes its quota toward retarding the growth of the country as a whole; for mankind are less prolific in towns than in the country. A few departments show an increase of population, and these, curiously, are about evenly divided between the richest and the poorest departments in the nation. The cause of the stationary condition of the population is found, by those who endeavor to account for it, in the evenly comfortable situation of the people. They are contented with things as they are, and avoid having large families, in order to evade extra exertion and prevent the diminution of their estates that would follow if there were many heirs to divide them among. Every one aims to live and save, so as to leave his children as well off as himself, and a little better off if possible. Hence very few have more than three children. All the large towns have increased enormously during the present century, at such a rate that, if the population of the whole country had increased at the same rate, France would have had seventy-five million inhabitants, or would have been as densely populated as England. Had it not been, in fact, for the augmentation of the populations of Paris, Lyons, and Marseilles, the population of all France would have actually diminished during the last five years. This augmentative population, except as it is of foreign origin, contributes, as we have seen, to the tendency to depletion of the aggregate.

Anthropology in Italy.—Anthropology is studied in Italy with considerable zeal, and nearly every large town has its collection and its specialist of repute. The country, as may be judged from the figure it has made in history, is rich in monuments dating from a very great antiquity. In upper Italy earth-walls have recently been discovered on the mountain-heights, which are attributed to the Celts. The plains of Lombardy and Emilia have furnished numerous remains of lake-dwellings, which have been studied by Pigorini, Strobel, and Chierici, and are represented in the collections of Parma and Reggio. Not less important are the Etruscan necropolis of Margabotto and that of the Cerlosa of Bologna. Bologna has its newly built *Museo Civico* under the direction of Gozzodini, and the accomplished geologist Capelini, who has discovered traces of cannibalism in a cave on the Island of Palmaria. The Olmo skull, which Cocchi regards as post-Pliocene, and which may be compared with the Cro-Magnon and Steeten skulls, is in the geological collection of this city. Mantegazza has founded an anthropological and ethnological museum in Florence, with Miloni in charge of the Etruscan and Schiaparelli of the archæological departments. Perugia, too, has Etruscan antiquities, and Belluci is collecting prehistoric stone implements there. Pigorini has established a prehistorical and ethnological museum at Rome, where Michael St. de Rossi has won much honor by his researches. Nicolucci, who has founded an anthropological collection at the University of Naples, has examined about a hundred skulls, and has found them to be meso-cephalic Grecian skulls, very like those still typical in the region.

Two East African Tribes.—Some interesting information respecting East African tribes has been obtained by the London Geographical Society from the notes of the Rev. T. Wakefield, missionary at Ribé, near Mombasa. Kavirondo appears to be the most important country on the eastern shore of the Victoria Nyanza, and is described as a great grass-clad plain, with a few detached hills and clumps of trees, but altogether without forests. The people are tall and powerfully built, of a deep black, and with thick lips and flat noses. They wear their hair short, or dress it elaborately, or shave it all off but a tuft on the crown, or shave half the head, or a few patches only, according to their taste. The women tattoo the stomach and the back, but the men do so only rarely. Dress is almost unknown. The women are content with a string worn round the waist, to which they attach a tail-like appendage made of bark. They wear no ornaments, but smear themselves with disagreeable (to whites) substances. The men wear iron bracelets on their fore-arms, and above their elbows. Their spears are long and have short blades, and their shields are made of buffalo-hides. Neither swords nor knives are in use. Both sexes work in the fields. Millet, beans, bananas, and large crops of sweet-potatoes are grown, and two harvests are gathered in the year. A thick porridge, on festive occasions, made with milk, constitutes the staple food, and is eaten with the hands. Cattle, sheep, and goats are raised. The huts are circular and roomy, and high enough for a man to stand upright within them. Another people, the Wa-Ukara, are likewise tall and muscular, and have a similar variety of tastes about their hair, They paint their bodies red, with clay mixed in oil, and their arms and legs with white; tattoo their stomachs and upper arms and have few ornaments. Women wear kilts of bark-cloth and skins, and men a longer garment of like material. They live in circular huts, built over pits three feet deep, and covered with conical roofs. They marry only when full-grown, and pay the dowry for their wives in cattle and goats. They grow a variety of crops, and pound their corn or millet in a wooden mortar, or grind it on a flat stone, beneath which a cowhide is spread out to receive the flour. Their domestic animals are cattle, goats, sheep of a superior kind, dogs, and fowls, but cats are not known. Their blacksmiths manufacture hoes, axes, and spears; and they produce cooking-pots of clay and baskets of wicker-work. Ukara contains a large number of populous villages.

NOTES.

Near Mandan, in the neighborhood of the junction of the Hart and Missouri Rivers, are what appear to be two large cemeteries of an ancient race. One of them is composed of what are described as trenches filled with bones of man and beast, and covered with several feet of earth so as to form considerable mounds. With the bones are associated broken pottery, vases of flint, and agates. The pottery is described as being of a dark material, handsomely decorated, delicate in finish, and very light, pointing to the existence of a considerable degree of civilization.

The death has been announced of Mr. Robert B. Tolles, of Boston, the distinguished maker of American microscopes and telescopes of great powers.

Dr. Grassi is said to have made the important discovery that flies are active agents in the propagation of disease. They take the ova of parasitical worms into their mouths and discharge them unchanged in convenient places, often upon substances to be used as human food. Dr. Grassi is so deeply impressed with the magnitude and seriousness of the consequences that he hopes some effectual means may soon be found of destroying flies.—*Science Monthly.*

Special attention is given by the British Government officers, in Cyprus, to the destruction of the locusts, with a view to their extermination. The governor reports that in 1882 he was successful in keeping the pests down, and he considers the method of screens so effectual that he proposes to rely on catching the live locusts, and not to gather their eggs. The accepted practice in China, Russia, and Turkey is based on a different view.

Brigadier-General Andrew A. Humphreys, who died in Washington on the 28th of November, in the seventy-fourth year of his age, performed many important services in the shape of scientific surveys and works of engineering. He was Superintendent of the Coast Survey from 1844 to 1849, of the Topographic and Hydrographic Survey of the Mississippi Delta from 1849 to 1851, and of surveys for railroads and geographical explorations west of the Mississippi to 1861. He was again engaged in the examination of the Mississippi levees for about a year after the war, after which he was placed in command of the Corps of Engineers and in charge of the Engineer Bureau. The report on the "Physics and Hydraulics of the Mississippi," prepared by him in conjunction with Lieutenant H. L. Abbott, has much scientific value.

M. de Sarzec, a French Oriental archæologist, suggested some time ago that the ancient Eastern stone-cutters used diamond-pointed tools in their more delicate work on diorite and other hard stones. He is corroborated by Mr. Flinders Petrie, an English Egyptologist, who has found in his minute examinations of ancient work lines of a character that could not apparently have been cut in those stones (diorites and granites) with any metallic tool, but must have been made with a gem-point.

M. Robert Haensel, of Reichenberg, Bohemia, has succeeded in accurately photographing a flash of lightning. His pictures, of which he has taken several, show the light of the flash under the form of long-continuous sparks, traversing the atmosphere. In one of them the point where the spark meets the earth is very clearly defined. With the spark, the landscape also is well produced, and a means is given for estimating the length of the luminous train, which, in one instance, is calculated to be 1,700 metres, or more than a mile.

An International Society of Electricians has been formed at Paris, under the honorary presidency of M. Cochet. It is open for admission to membership to every Frenchman or foreigner interested, whether in a general, scientific, industrial, or commercial way, in the progress of theoretical or applied electricity. The price of membership is twenty francs, or about four dollars, a year.

M. George Bontemps, a French chemist, distinguished particularly for his labors in the application of the sciences to glass-making, died at Amboise, France, November 14th, aged eighty-four years. He began his chemical studies under Gay-Lussac and Thenard, and has been connected with glass-making, in nearly every branch of which he has participated, since 1818. He introduced several improvements in the art, among them the revival of the manufacture of ruby glass in 1826, after it had ceased for two centuries, and was successful in making good optical glass. He published many papers related to glass-making, and a large work on the subject.

M. de Quatrefages recently presented to the French Academy of Sciences a report by M. E. Cartailhac on a flint-quarry that was worked during the stone age at Mur-de-Barrez, in Aveyron. It consisted of vertical pits dug through the Aquitanian limestone to the level of the flint-beds, at depths of from two to four metres. The walls of the pits bore evident marks of the pick, a tool of deer-horn, of which a considerable number of specimens were found in the bottoms of the pits. These pits are the first that have been found in France, and are very much like the ones which have been discovered at Spiennes, in Belgium, and Cisbury, in England.

M. Ivon Villarceau, a French astronomer and mathematician, died on the 23d of December, aged seventy-one years. He was educated to be an engineer, but became connected with the observatory, where he distinguished himself by his investigations of the periodicity of comets, his calculations of the motions of the stars, and his services in determining latitudes and longitudes.

The common objection among womankind, says the "Pall Mall Budget," to letting their ages be known is not shared by the ladies of Japan, who actually display the facts as to their age in the arrangement of their hair. Girls from nine to fifteen wear their hair interlaced with red crape, describing a half-circle round the head, the forehead being left free with a curl at each side. From fifteen to thirty the hair is dressed very high on the forehead, and put up at the back in the shape of a fan or butterfly, with interlacings of silver cord and a decoration of colored balls. Beyond thirty, a woman twists her hair round a shell-pin, placed horizontally at the back of the head. Widows also designate themselves, and whether or not they desire to marry again.

The subject fixed for the Howard medal, to be awarded next year by the English Statistical Society, is "The Preservation of Health, as it is affected by Personal Habits, such as Cleanliness, Temperance, etc."

AUGUSTUS WILLIAM HOFMANN.

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THE COMING SLAVERY.

By HERBERT SPENCER.

THE kinship of pity to love is shown among other ways in this, that it idealizes its object. Sympathy with one in suffering suppresses, for the time being, remembrance of his transgressions. The feeling which vents itself in "poor fellow!" on seeing one in agony, excludes the thought of "bad fellow," which might at another time arise. Naturally, then, if the wretched are unknown or but vaguely known, all the demerits they may have are ignored; and thus it happens that when, as just now, the miseries of the poor are depicted, they are thought of as the miseries of the deserving poor, instead of being thought of, as in large measure they should be, as the miseries of the undeserving poor. Those whose hardships are set forth in pamphlets and proclaimed in sermons and speeches which echo throughout society are assumed to be all worthy souls, grievously wronged, and none of them are thought of as bearing the penalties of their own misdeeds.

On hailing a cab in a London street, it is surprising how generally the door is officiously opened by one who expects to get something for his trouble. The surprise lessens after counting the many loungers about tavern-doors, or after observing the quickness with which a street-performance, or procession, draws from neighboring slums and stable-yards a group of idlers. Seeing how numerous they are in every small area, it becomes manifest that tens of thousands of such swarm through London. "They have no work," you say. Say rather that they either refuse work or quickly turn themselves out of it. They are simply good-for-nothings, who in one way or other live on the good-for-somethings—vagrants and sots, criminals and those on the way to crime, youths who are burdens on hard-worked parents, men who appropriate the wages of their wives, fellows who share the gains of prostitutes; and then, less visible and less numerous, there is a corresponding class of women.

Is it natural that happiness should be the lot of such? or is it natural that they should bring unhappiness on themselves and those connected with them? Is it not manifest that there must exist in our midst an immense amount of misery which is a normal result of misconduct and ought not to be dissociated from it? There is a notion, always more or less prevalent and just now vociferously expressed, that all social suffering is removable, and that it is the duty of somebody or other to remove it. Both these beliefs are false. To separate pain from ill-doing is to fight against the constitution of things, and will be followed by far more pain. Saving men from the natural penalties of reckless living eventually necessitates the infliction of artificial penalties in solitary cells, on tread-wheels, and by the lash. I suppose a dictum on which the current creed and the creed of science are at one may be considered to have as high an authority as can be found. Well, the command "if any would not work neither should he eat" is simply a Christian enunciation of that universal law of Nature under which life has reached its present height—the law that a creature not energetic enough to maintain itself must die; the sole difference being that the law which in the one case is to be artificially enforced is, in the other case, a natural necessity. And yet this particular tenet of their religion which science so manifestly justifies is the one which Christians seem least inclined to accept. The current assumption is that there should be no suffering, and that society is to blame for that which exists.

"But surely we are not without responsibilities, even when the suffering is that of the unworthy?"

If the meaning of the word "we" be so expanded as to include with ourselves our ancestors, and especially our ancestral legislators, I agree. I admit that those who made, and modified, and administered, the old poor-law, were responsible for producing an appalling amount of demoralization, which it will take more than one generation to remove. I admit, too, the partial responsibility of recent and present law-makers for regulations which have brought into being a permanent body of tramps, who ramble from union to union; and also their responsibility for maintaining a constant supply of felons by sending back convicts into society under such conditions that they are almost compelled again to commit crimes. Moreover, I admit that the philanthropic are not without their share of responsibility; since, while anxiously aiding the offspring of the unworthy, they do nothing for the offspring of the worthy save burdening their parents by increased local rates. Nay, I even admit that these swarms of good-for-nothings, fostered and multiplied by public and private agencies, have, by sundry mischievous meddlings, been made to suffer more than they would otherwise have suffered. Are these the responsibilities meant? I suspect not.

But now, leaving the question of responsibilities, however conceived, and considering only the evil itself, what shall we say of its treatment? Let me begin with a fact.

A late uncle of mine, the Rev. Thomas Spencer, for some twenty years incumbent of Hinton Charterhouse, near Bath, no sooner entered on his parish duties than he proved himself anxious for the welfare of the poor, by establishing a school, a library, a clothing club, and land-allotments, besides building some model cottages. Moreover, up to 1833 he was a pauper's friend—always for the pauper against the overseer. There presently came, however, the debates on the poor-law, which impressed him with the evils of the system then in force. Though an ardent philanthropist, he was not a timid sentimentalist. The result was that, immediately the new poor-law was passed, he proceeded to carry out its provisions in his parish. Almost universal opposition was encountered by him; not the poor only being his opponents, but even the farmers on whom came the burden of heavy poor-rates. For, strange to say, their interests had become apparently identified with maintenance of this system which taxed them so largely. The explanation is, that there had grown up the practice of paying out of the rates a part of the wages of each farm-servant—"make-wages," as the sum was called. And though the farmers contributed most of the fund out of which "make-wages" were paid, yet, since all other rate-payers contributed, the farmers seemed to gain by the arrangement. My uncle, however, not easily deterred, faced all this opposition and enforced the law. The result was that in two years the rates were reduced from £700 a year to £200 a year, while the condition of the parish was greatly improved. "Those who had hitherto loitered at the corners of the streets, or at the doors of the beer-shops, had something else to do, and one after another they obtained employment"; so that, out of a population of eight hundred, only fifteen had to be sent as incapable paupers to the Bath Union Workhouse, in place of the one hundred who received out-door relief a short time before. If it be said that the £20 telescope which, a few years after, his parishioners presented to my uncle, marked only the gratitude of the rate-payers, then my reply is the fact that, when, some years later still, having killed himself by overwork, in pursuit of popular welfare, he was taken to Hinton to be buried, the procession which followed him to the grave included not the well-to-do only but the poor.

Several motives have prompted this brief narrative. One is the wish to prove that sympathy with the people and self-sacrificing efforts on their behalf do not necessarily imply approval of gratuitous aids. Another is the desire to show that benefit may result, not from multiplication of artificial appliances to mitigate distress, but, contrariwise, from diminution of them. And a further purpose I have in view is that of preparing the way for an analogy.

Under another form and in a different sphere, we are now yearly extending a system which is identical in nature with the system of "make-wages" under the old poor-law. Little as politicians recognize the fact, it is nevertheless demonstrable that these various public appliances for working-class comfort, which they are supplying at the cost of rate-payers, are intrinsically of the same nature as those which, in past times, treated the farmer's man as half-laborer and half-pauper. In either case the worker receives, in return for what he does, money wherewith to buy certain of the things he wants; while, to procure the rest of them for him, money is furnished out of a common fund raised by taxes. What matters it whether the things supplied by rate-payers for nothing, instead of by the employer in payment, are of this kind or that kind? the principle is the same. For sums received let us substitute the commodities and benefits purchased; and then see how the matter stands. In old poor-law times, the farmer gave for work done the equivalent, say of house-rent, bread, clothes, and fire; while the rate-payers practically supplied the man and his family with their shoes, tea, sugar, candles, a little bacon, etc. The division is, of course, arbitrary; but unquestionably the farmer and the rate-payers furnished these things between them. At the present time the artisan receives from his employer in wages the equivalent of the consumable commodities he wants; while from the public comes satisfaction for others of his needs and desires. At the cost of rate-payers he has in some cases, and will presently have in more, a house at less than its commercial value; for of course when, as in Liverpool, a municipality spends nearly £200,000 in pulling down and reconstructing low-class dwellings, and is about to spend as much again, the implication is that in some way the rate-payers supply the poor with more accommodation than the rents they pay would otherwise have brought. The artisan further receives from them, in schooling for his children, much more than he pays for; and there is every probability that he will presently receive it from them gratis. The rate-payers also satisfy what desire he may have for books and newspapers, and comfortable places to read them in. In some cases too, as in Manchester, gymnasia for his children of both sexes, as well as recreation-grounds, are provided. That is to say, he obtains, from a fund raised by local taxes, certain benefits beyond those which the sum received for his labor enables him to purchase. The sole difference, then, between this system and the old system of "make-wages" is between the kinds of satisfactions obtained; and this difference does not in the least affect the nature of the arrangement.

Moreover, the two are pervaded by substantially the same illusion. In the one case, as in the other, what looks like a gratis benefit is not a gratis benefit. The amount which, under the old poor-law, the half-pauperized laborer received from the parish to eke out his weekly income was not really, as it appeared, a bonus, for it was accompanied by a substantially equivalent decrease of his wages, as was quickly proved when the system was abolished and the wages rose. Just so is it with these seeming boons received by working-people in towns. I do not refer only to the fact that they unawares pay in part through the raised rents of their dwellings (when they are not actual rate-payers); but I refer to the fact that the wages received by them are, like the wages of the farm-laborer, diminished by these public burdens falling on employers. Read the accounts coming of late from Lancashire concerning the cotton-strike, containing proofs, given by artisans themselves, that the margin of profit is so narrow that the less skillful manufacturers, as well as those with deficient capital, fail, and that the companies of co-operators who compete with them can rarely hold their own; and then consider what is the implication respecting wages. Among the costs of production have to be reckoned taxes, general and local. If, as in our large towns, the local rates now amount to one third of the rental or more—if the employer has to pay this, not on his private dwelling only, but on his business-premises, factories, warehouses, or the like, it results that the interest on his capital must be diminished by that amount, or the amount must be taken from the wages-fund, or partly one and partly the other. And if competition among capitalists in the same business and in other businesses has the effect of so keeping down interests that, while some gain, others lose, and not a few are ruined—if capital, not getting adequate interest, flows elsewhere and leaves labor unemployed—then it is manifest that the choice for the artisan under such conditions lies between diminished amount of work or diminished rate of payment for it. Moreover, for kindred reasons these local burdens raise the costs of the things he consumes. The charges made by distributors, too, are, on the average, determined by the current rates of interest on capital used in distributing businesses; and the extra costs of carrying on such businesses have to be paid for by extra prices. So that as in the past the rural worker lost in one way what he gained in another, so in the present does the urban worker; there being, too, in both cases, the loss entailed on him by the cost of administration and the waste accompanying it.

"But what has all this to do with 'the coming slavery'?" will perhaps be asked. Nothing directly, but a good deal indirectly, as we shall see after yet another preliminary section.

It is said that, when railways were first opened in Spain, peasants standing on the tracks were not unfrequently run over, and that the blame fell on the engine-drivers for not stopping, rural experiences having yielded no conception of the momentum of a large mass moving at a high velocity.

The incident is recalled to me on contemplating the ideas of the so-called "practical" politician, into whose mind there enters no thought of such a thing as political momentum, still less of a political momentum which, instead of diminishing or remaining constant, increases. The theory on which he daily proceeds is that the change caused by his measure will stop where he intends it to stop. He contemplates intently the things his act will achieve, but thinks little of the remoter issues of the movement his act sets up, and still less its collateral issues. When, in war-time, "food for powder" was to be provided by encouraging population—when Mr. Pitt said, "Let us make relief in cases where there are a number of children a matter of right and honor, instead of a ground for opprobrium and contempt" *—it was not expected that the poor-rates would be quadrupled in fifty years, that women with many bastards would be preferred as wives to modest women because of their incomes from the parish, and that hosts of rate-payers would be pulled down into the ranks of pauperism. Legislators who in 1833 voted £20,000 a year to aid in building school-houses never supposed that the step they then took would lead to forced contributions, local and general, now amounting to £6,000,000; they did not intend to establish the principle that A should be made responsible for educating B's offspring; they did not dream of a compulsion which should deprive poor widows of the help of their elder children; and still less did they dream that their successors, by requiring impoverished parents to apply to boards of guardians to pay the fees which school-boards would not remit, would initiate a habit of applying to boards of guardians and so cause pauperization.† Neither did those who in 1834 passed an act regulating the labor of women and children in certain factories imagine that the system they were beginning would end in the restriction and inspection of labor in all kinds of producing establishments where more than fifty people are employed; nor did they conceive that the inspection provided would grow to the extent of requiring that, before a "young person" is employed in a factory, authority must be given by a certifying surgeon, who, by personal examination (to which no limit is placed), has satisfied himself that there is no incapacitating disease or bodily infirmity, his verdict determining whether the "young person" shall earn wages or not.‡ Even less, as I say, does the politician who plumes himself on the practicalness of his aims conceive the indirect results that will

* Hansard's "Parliamentary History," xxxii, p. 710.

† "Fortnightly Review," January, 1884, p. 17.

‡ "Factories and Workshops Act," 41 and 42 Victoria, cap. 16.

follow the direct results of his measures. Thus, to take a case connected with one named above, it was not intended through the system of "payment by results" to do anything more than give teachers an efficient stimulus; it was not supposed that in numerous cases their health would give way under the stimulus; it was not expected that they would be led to adopt a cramming system and to put undue pressure on dull and weak children, often to their great injury; it was not foreseen that in many cases a bodily enfeeblement would be caused which no amount of grammar and geography can compensate for. Nor did it occur to the practical politicians who provided a compulsory load-line for merchant-vessels, that the pressure of ship-owners' interests would habitually cause the putting of the load-line at the very highest limit, and that from precedent to precedent, tending ever in the same direction, the load-line would gradually rise—as from good authority I learn that it has already done. Legislators who, some forty years ago, by act of Parliament compelled railway companies to supply cheap locomotion, would have ridiculed the belief, had it been expressed, that eventually their act would punish the companies which improved the supply; and yet this was the result to companies which began to carry third-class passengers by fast trains, since a penalty to the amount of the passenger-duty was inflicted on them for every third-class passenger so carried. To which instance concerning railways, add a far more striking one disclosed by comparing the railway policies of England and France. The law-makers who provided for the ultimate lapsing of French railways to the state never conceived the possibility that inferior traveling facilities would result—did not foresee that reluctance to depreciate the value of property eventually coming to the state would negative the authorization of competing lines, and that in the absence of competing lines locomotion would be relatively costly, slow, and infrequent; for, as Sir Thomas Farrar has shown, the traveler in England has great advantages over the French traveler in the economy, swiftness, and frequency with which his journeys can be made.

But the "practical" politician, who, in spite of such experiences repeated generation after generation, goes on thinking only of proximate results, naturally never thinks of results still more remote, still more general, and still more important than those just exemplified. To repeat the metaphor used above—he never asks whether the political momentum set up by his measure, in some cases decreasing but in other cases greatly increasing, will or will not have the same general direction with other such momenta; and whether it may not join them in presently producing an aggregate energy working changes never thought of. Dwelling only on the effects of his particular stream of legislation, and not observing how other such streams already existing, and still other streams which will follow his initiative, pursue the same average course, it never occurs to him that they may presently unite into a voluminous flood utterly changing the face of things. Or to leave figures for a more literal statement, he is unconscious of the truth that he is helping to form a certain type of social organization, and that kindred measures, effecting kindred changes of organization, tend with ever-increasing force to make that type general, until, passing a certain point, the proclivity toward it becomes irresistible. Just as each society aims when possible to produce in other societies a structure akin to its own—just as, among the Greeks, the Spartans and the Athenians severally struggled to spread their respective political institutions, or as, at the time of the French Revolution, the European monarchies aimed to re-establish monarchy in France, so, within every society, each species of structure tends to propagate itself. Just as the system of voluntary co-operation by companies, associations, unions, to achieve business ends and other ends, spreads throughout a community, so does the antagonistic system of compulsory co-operation under state-agencies spread, and the larger becomes its extension the more power of spreading it gets. The question of questions for the politician should ever be, "What type of social structure am I tending to produce?" But this is a question he scarcely ever entertains.

Here we will entertain it for him. Let us now observe the general course of recent changes, with the accompanying current of ideas, and see whither they are carrying us.

The blank form of a question daily asked is, "We have already done this; why should we not do that?" And the regard for precedent suggested by it is ever pushing on regulative legislation. Having had brought within their sphere of operation more and more numerous businesses, the acts restricting hours of employment and dictating the treatment of workers are now to be made applicable to shops. From inspecting lodging-houses to limit the numbers of occupants and enforce sanitary conditions, we have passed to inspecting all houses below a certain rent in which there are members of more than one family, and are now passing to a kindred inspection of all small houses.* The buying and working of telegraphs by the state is made a reason for urging that the state should buy and work the railways. Supplying children with food for their minds by public agency is being followed in some cases by supplying food for their bodies; and, after the practice has been made gradually more general, we may anticipate that the supply now proposed to be made gratis in the one case will eventually be proposed to be made gratis in the other, the argument that good bodies as well as good minds are needful to make good citizens being logically urged as a reason for the extension. And then, avowedly proceeding on the precedents furnished by the church, the school, and the reading-room, all publicly provided, it is contended

* See letter of Local Government Board, "Times," January 2, 1884.

that "pleasure, in the sense it is now generally admitted, needs legislating for and organizing at least as much as work." *

Not precedent only prompts this spread, but also the necessity which arises for supplementing ineffective measures, and for dealing with the artificial evils continually caused. Failure does not destroy faith in the agencies employed, but merely suggests more stringent use of such agencies or wider ramifications of them. Laws to check intemperance, beginning in early times and coming down to our own times, when further restraints on the sale of intoxicating liquors occupy nights every session, not having done what was expected, there come demands for more thorough-going laws, locally preventing the sale altogether; and here, as in America, these will doubtless be followed by demands that prevention shall be made universal. All the many appliances for "stamping out" epidemic diseases not having succeeded in preventing outbreaks of small-pox, fevers, and the like, a further remedy is applied for in the shape of police-power to search houses for diseased persons, and authority for medical officers to examine any one they think fit, to see whether he or she is suffering from an infectious or contagious malady. Habits of improvidence having for generations been cultivated by the poor-law, and the improvident enabled to multiply, the evils produced by compulsory charity are now proposed to be met by compulsory insurance.

The extension of this policy, causing extension of corresponding ideas, fosters everywhere the tacit assumption that Government should step in whenever anything is not going right. "Surely you would not have this misery continue!" exclaims some one, if you hint a demurrer to much that is now being said and done. Observe what is implied by this exclamation. It takes for granted, first, that all suffering ought to be prevented, which is not true: much suffering is curative, and prevention of it is prevention of a remedy. In the second place, it takes for granted that every evil can be removed: the truth being that, with the existing defects of human nature, many evils can only be thrust out of one place or form into another place or form—often being increased by the change. The exclamation also implies the unhesitating belief, here especially concerning us, that evils of all kinds should be dealt with by the state. There does not occur the inquiry whether there are at work other agencies capable of dealing with evils, and whether the evils in question may not be among those which are best dealt with by these other agencies. And obviously, the more numerous governmental interventions become, the more confirmed does this habit of thought grow, and the more loud and perpetual the demands for intervention.

Every extension of the regulative policy involves an addition to the regulative agents—a further growth of officialism and an increas-

* "Fortnightly Review," January, 1884, p. 21.

ing power of the organization formed of officials. Take a pair of scales with many shot in the one and a few in the other. Lift shot after shot out of the loaded scale and put it into the unloaded scale. Presently you will produce a balance, and, if you go on, the position of the scales will be reversed. Suppose the beam to be unequally divided, and let the lightly loaded scale be at the end of a very long arm; then the transfer of each shot, producing a much greater effect, will far sooner bring about a change of position. I use the figure to illustrate what results from transferring one individual after another from the regulated mass of the community to the regulating structures. The transfer weakens the one and strengthens the other in a far greater degree than is implied by the relative change of numbers. A comparatively small body of officials, coherent, having common interests, and acting under central authority, has an immense advantage over an incoherent public which has no settled policy, and can be brought to act unitedly only under strong provocation. Hence an organization of officials, once passing a certain stage of growth, becomes less and less resistible; as we see in the bureaucracies of the Continent.

Not only does the power of resistance of the regulated part decrease in a geometrical ratio as the regulating part increases, but the private interests of many in the regulated part itself make the change of ratio still more rapid. In every circle conversations show that now, when the passing of competitive examinations renders them eligible for the public service, youths are being educated in such ways that they may pass them and get employment under Government. One consequence is, that men who might otherwise reprobate some further growth of officialism are led to look on it with tolerance, if not favorably, as offering possible careers for those dependent on them and those related to them. Any one who remembers the numbers of upper-class and middle-class families anxious to place their children will see that no small encouragement to the spread of legislative control is now coming from those who, but for the personal interests thus arising, would be hostile to it.

This pressing desire for careers is enforced by the preference for careers which are thought respectable. "Even if his salary is small, his occupation will be that of a gentleman," thinks the father, who wants to get a Government-clerkship for his son. And this relative dignity of state-servants, as compared with those occupied in business, increases as the administrative organization becomes a larger and more powerful element in society, and tends more and more to fix the standard of honor. The prevalent ambition with a young Frenchman is to get some small official post in his locality, to rise thence to a place in the local center of government, and finally to reach some head office in Paris. And in Russia, where that universality of state-regulation which characterizes the militant type of society has been carried farthest, we see this ambition pushed to its extreme. Says Mr. Wallace, quoting a passage from a play, "All men, even shopkeepers and cobblers, aim at becoming officers, and the man who has passed his whole life without official rank seems to be not a human being."*

These various influences, working from above downward, meet with an increasing response of expectations and solicitations proceeding from below upward. The hard-worked and overburdened who form the great majority, and still more the incapables perpetually helped, who are ever led to look for more help, are ready supporters of schemes which promise them this or the other benefit by state agency, and ready believers of those who tell them that such benefits can be given and ought to be given. They listen with eager faith to all builders of political air-castles, from Oxford graduates down to Irish irreconcilables, and every additional tax-supported appliance for their welfare raises hopes of further ones. Indeed, the more numerous public instrumentalities become, the more is there generated in citizens the notion that everything is to be done for them, and nothing by them. Each generation is made less familiar with the attainment of desired ends by individual actions or private combinations, and more familiar with the attainment of them by governmental agencies; until, eventually, governmental agencies come to be thought of as the only available agencies. This result was well shown in the recent Trades-Unions Congress at Paris. The English delegates, reporting to their constituents, said that, between themselves and their foreign colleagues, "the point of difference was the extent to which the state should be asked to protect labor": reference being thus made to the fact, conspicuous in the reports of the proceedings, that the French delegates always invoked governmental power as the only means of satisfying their wishes.

The diffusion of education has worked, and will work still more, in the same direction. "We must educate our masters," is the well-known saying of a Liberal who opposed the last extension of the franchise. Yes, if the education were worthy to be so called, and were relevant to the political enlightenment needed, much might be hoped from it. But knowing rules of syntax, being able to add up correctly, having geographical information, and a memory stocked with the dates of kings' accessions and generals' victories, no more imply fitness to form political conclusions than acquirement of skill in drawing implies expertness in telegraphing, or than ability to play cricket implies proficiency on the violin. "Surely," rejoins some one, "facility in reading opens the way to political knowledge." Doubtless; but will the way be followed? Table-talk proves that nine out of ten people read what amuses them or interests them rather than what instructs them, and that the last thing they read is something which tells them disagreeable truths or dispels groundless hopes. That popular education

* "Russia," i, 422.

results in an extensive reading of publications which foster pleasant illusions, rather than of those which insist on hard realities, is beyond question. Says "A Mechanic," writing in the "Pall Mall Gazette" of December 3, 1883:

> Improved education instills the desire for culture—culture instills the desire for many things as yet quite beyond workingmen's reach; . . . in the furious competition to which the present age is given up they are utterly impossible to the poorer classes; hence they are discontented with things as they are, and the more educated the more discontented. Hence, too, Mr. Ruskin and Mr. Morris are regarded as true prophets by many of us.

And, that the connection of cause and effect here alleged is a real one, we may see clearly enough in the present state of Germany.

Being possessed of electoral power, as are now the mass of those who are thus led to nurture sanguine anticipations of benefits to be obtained by social reorganization, it results that whoever seeks their votes must at least refrain from exposing their mistaken beliefs, even if he does not yield to the temptation to express agreement with them. Every candidate for Parliament is prompted to propose or support some new piece of *ad captandum* legislation. Nay, even the chiefs of parties, these anxious to retain office and those to wrest it from them, severally aim to get adherents by outbidding one another. Each endeavors to score a trick by trumping his antagonist's good card, as we have lately seen. And then, as divisions in Parliament show us, the traditional loyalty to leaders overrides questions concerning the intrinsic propriety of proposed measures. Representatives are unconscientious enough to vote for bills which they regard as essentially wrong in principle, because party-needs and regard for the next election demand it. And thus a vicious policy is strengthened even by those who see its viciousness.

Meanwhile there goes on out-of-doors an active propaganda to which all these influences are ancillary. Communistic theories, partially indorsed by one act of Parliament after another, and tacitly if not avowedly favored by numerous public men seeking supporters, are being advocated more and more vociferously under one or other form by popular leaders, and urged on by organized societies. There is the movement for land-nationalization which, aiming at a system of land-tenure equitable in the abstract, is, as all the world knows, pressed by Mr. George and his friends with avowed disregard for the just claims of existing owners, and as the basis of a scheme going more than half-way to state-communism. And then there is the thorough-going Democratic Federation of Mr. Hyndman and his adherents. We are told by them that "the handful of marauders who now hold possession [of the land] have and can have no right save brute force against the tens of millions whom they wrong." They exclaim against "the shareholders who have been allowed to lay hands upon (!) our great railway communications." They condemn "above all, the active capitalist class, the loan-mongers, the farmers, the mine-exploiters, the contractors, the middlemen, the factory-lords—these, the modern slave-drivers" who exact "more and yet more surplus value out of the wage-slaves whom they employ." And they think it "high time" that trade should be "removed from the control of individual greed and individual profit." *

It remains to point out that the tendencies thus variously displayed are being strengthened by press-advocacy, daily more pronounced. Journalists, always chary of saying that which is distasteful to their readers, are some of them going with the stream and adding to its force. Legislative meddlings which they would once have condemned they now pass in silence, if they do not advocate them; and they speak of *laisser-faire* as an exploded doctrine. "People are no longer frightened at the thought of socialism," is the statement which meets us one day. On another day, a town which does not adopt the Free Libraries Act is sneered at as being alarmed by a measure so moderately communistic. And then, along with editorial assertions that this economic evolution is coming and must be accepted, there is prominence given to the contributions of its advocates. Meanwhile those who regard the recent course of legislation as disastrous, and see that its future course is likely to be still more disastrous, are being reduced to silence by the belief that it is useless to reason with people in a state of political intoxication.

See, then, the many concurrent causes which threaten continually to accelerate the transformation now going on. There is that spread of regulation caused by following precedents, which become the more authoritative the further the policy is carried. There is that increasing need for administrative compulsions and restraints which results from the unforeseen evils and short-comings of preceding compulsions and restraints. Moreover, every additional state-interference strengthens the tacit assumption that it is the duty of the state to deal with all evils and secure all benefits. Increasing power of a growing administrative organization is accompanied by decreasing power of the rest of the society to resist its further growth and control. The multiplication of careers opened by a developing bureaucracy tempts members of the classes regulated by it to favor its extension, as adding to the chances of safe and respectable places for their relatives. The people at large, led to look on benefits received through public agencies as gratis benefits, have their hopes continually excited by the prospects of more. A spreading education, furthering the diffusion of pleasing errors rather than of stern truths, renders such hopes both stronger and more general. Worse still, such hopes are ministered to by candidates for public choice to augment their chances of success;

* "Socialism made Plain," Reeves, 185 Fleet Street.

and leading statesmen, in pursuit of party ends, bid for popular favor by countenancing them. Getting repeated justifications from new laws harmonizing with their doctrines, political enthusiasts and unwise philanthropists push their agitations with growing confidence and success. Journalism, ever responsive to popular opinion, daily strengthens it by giving it voice; while counter-opinion, more and more discouraged, finds little utterance.

Thus influences of various kinds conspire to increase corporate action and decrease individual action. And the change is being on all sides aided by schemers, each of whom thinks only of his pet project, and not at all of the general reorganization which his, joined with others such, are working out. It is said that the French Revolution devoured its own children. Here an analogous catastrophe seems not unlikely. The numerous socialistic changes made by act of Parliament, joined with the numerous others presently to be made, will by-and-by be all merged in state-socialism—swallowed in the vast wave which they have little by little raised.

"But why is this change described as 'the coming slavery'?" is a question which many will still ask. The reply is simple. All socialism involves slavery.

What is essential to the idea of a slave? We primarily think of him as one who is owned by another. To be more than nominal, however, the ownership must be shown by control of the slave's actions—a control which is habitually for the benefit of the controller. That which fundamentally distinguishes the slave is that he labors under coercion to satisfy another's desires. The relation admits of sundry gradations. Remembering that originally the slave is a prisoner whose life is at the mercy of his captor, it suffices here to note that there is a harsh form of slavery in which, treated as an animal, he has to expend his entire effort for his owner's advantage. Under a system less harsh, though occupied chiefly in working for his owner, he is allowed a short time in which to work for himself, and some ground on which to grow extra food. A further amelioration gives him power to sell the produce of his plot and keep the proceeds. Then we come to the still more moderated form which commonly arises where, having been a free man working on his own land, conquest turns him into what we distinguish as a serf; and he has to give to his owner each year a fixed amount of labor or produce, or both, retaining the rest himself. Finally, in some cases, as in Russia until recently, he is allowed to leave his owner's estate and work or trade for himself elsewhere, under the condition that he shall pay an annual sum. What is it which, in these cases, leads us to qualify our conception of the slavery as more or less severe? Evidently the greater or smaller extent to which effort is compulsorily expended for the benefit of another instead of for self-benefit. If all the slave's labor is for his owner the slavery is heavy, and if but little it is light. Take now a further step. Suppose an owner dies, and his estate with its slaves comes into the hands of trustees, or suppose the estate and everything on it to be bought by a company; is the condition of the slave any the better if the amount of his compulsory labor remains the same? Suppose that for a company we substitute the community; does it make any difference to the slave if the time he has to work for others is as great, and the time left for himself is as small, as before? The essential question is, How much is he compelled to labor for other benefit than his own, and how much he can labor for his own benefit? The degree of his slavery varies according to the ratio between that which he is forced to yield up and that which he is allowed to retain; and it matters not whether his master is a single person or a society. If, without option, he has to labor for the society, and receives from the general stock such portion as the society awards him, he becomes a slave to the society. Socialistic arrangements necessitate an enslavement of this kind; and toward such an enslavement many recent measures, and still more the measures advocated, are carrying us. Let us observe, first, their proximate effects, and then their ultimate effects.

The policy initiated by the Industrial Dwellings Acts admits of development, and will develop. Where municipal bodies turn house-builders, they inevitably lower the values of houses otherwise built, and check the supply of more. Every dictation respecting modes of building and conveniences to be provided diminishes the builder's profit, and prompts him to use his capital where the profit is not thus diminished. So, too, the owner, already finding that small houses entail much labor and many losses—already subject to troubles of inspection and interference and to consequent costs, and having his property daily rendered a more undesirable investment—is prompted to sell; and, as buyers are for like reasons deterred, he has to sell at a loss. And now these still multiplying regulations, ending, it may be, as Lord Grey proposes, in one requiring the owner to maintain the salubrity of his houses by evicting dirty tenants, and thus adding to his other responsibilities that of inspector of nuisances, must further prompt sales and further deter purchasers—so necessitating greater depreciation. What must happen? The multiplication of houses, and especially small houses, being increasingly checked, there must come an increasing demand upon the local authority to make up for the deficient supply. More and more, the municipal or kindred body will have to build houses, or to purchase houses rendered unsalable to private persons in the way shown; houses which, greatly depreciated in value as they must become, it will, in many cases, pay to buy rather than to build new ones. And then, when in towns this process has gone so far as to make the local authority the chief owner of houses, there will be a good precedent for publicly providing houses for the rural population, as proposed in the Radical programme,* and as urged by the Democratic Federation, which insists on "the compulsory construction of healthy artisans' and agricultural laborers' dwellings in proportion to the population." Manifestly, the tendency of that which has been done, is being done, and is presently to be done, is to approach the socialistic ideal in which the community is sole house-proprietor.

Such, too, must be the effect of the daily growing policy on the tenure and utilization of the land. More numerous public benefits, to be achieved by more numerous public agencies, at the cost of augmented public burdens, must increasingly deduct from the returns on land; until, as the depreciation in value becomes greater and greater, the resistance to change of tenure becomes less and less. Already, as every one knows, there is in many places difficulty in obtaining tenants, even at greatly reduced rents; and land of inferior fertility in some cases lies idle, or when farmed by the owner is often farmed at a loss. Clearly the margin of profit on capital invested in land is not such that taxes, local and general, can be greatly raised to support extended public administrations, without an absorption of it which will prompt owners to sell, and make the best of what reduced price they can get by emigrating and buying land not subject to heavy burdens, as, indeed, some are now doing. This process, carried far, must have the result of throwing inferior land out of cultivation; after which there will be raised more generally the demand made by Mr. Arch, who, addressing the Radical Association of Brighton lately, and contending that existing landlords do not make their land adequately productive for the public benefit, said "he should like the present Government to pass a Compulsory Cultivation Bill": an applauded proposal which he justified by instancing compulsory vaccination (thus illustrating the influence of precedent). And this demand will be pressed, not only by the need for making the land productive, but also by the need for employing the rural population. After the Government has extended the practice of hiring the unemployed to work on deserted lands, or lands acquired at nominal prices, there will be reached a stage whence there is but a small further step to that arrangement which, in the programme of the Democratic Federation, is to follow nationalization of the land—the "organization of agricultural and industrial armies under state control on co-operative principles."

If any one doubts that such a revolution may be so reached, facts may be cited to show its likelihood. In Gaul, during the decline of the Roman Empire, "so numerous were the receivers in comparison with the payers, and so enormous the weight of taxation, that the laborer broke down, the plains became deserts, and woods grew where

* "Fortnightly Review," November, 1883, pp. 619, 620.

the plow had been."* In like manner, when the French Revolution was approaching, the public burdens had become such that many farms remained uncultivated, and many were deserted: one quarter of the soil was absolutely lying waste; and in some provinces one half was in heath.† Nor have we been without incidents of a kindred nature at home. Besides the facts that under the old poor-law the rates had in some parishes risen to half the rental, and that in various places farms were lying uncultivated, there is the fact that in one case the rates had absorbed the whole proceeds of the soil.

> At Cholesbury, in Buckinghamshire, in 1832, the poor-rate "suddenly ceased in consequence of the impossibility to continue its collection, the landlords having given up their rents, the farmers their tenancies, and the clergyman his glebe and his tithes. The clergyman, Mr. Jeston, states that in October, 1832, the parish officers threw up their books, and the poor assembled in a body before his door while he was in bed, asking for advice and food. Partly from his own small means, partly from the charity of neighbors, and partly by rates in aid, imposed on the neighboring parishes, they were for some time supported."‡

The commissioners add that "the benevolent rector recommends that the whole of the land should be divided among the able-bodied paupers": hoping that, after help afforded for two years, they might be able to maintain themselves. These facts, giving color to the prophecy made in Parliament that continuance of the old poor-law for another thirty years would throw the land out of cultivation, clearly prove that increase of public burdens may end in forced cultivation under public control.

Then, again, comes state-ownership of railways. Already this exists to a large extent on the Continent. Already we have had here a few years ago loud advocacy of it. And now the cry which was raised by sundry politicians and publicists is taken up afresh by the Democratic Federation, which proposes "state-appropriation of railways, with or without compensation." Evidently, pressure from above joined by pressure from below is likely to effect this change, dictated by the policy everywhere spreading; and with it must come many attendant changes. For railway-proprietors, at first owners and workers of railways only, have been allowed to become masters of numerous businesses directly or indirectly connected with railways; and these will have to be purchased by Government when the railways are purchased. Already exclusive carrier of letters, exclusive transmitter of telegrams, and on the way to become exclusive carrier of parcels, the state will not only be exclusive carrier of passengers, goods, and minerals, but will add to its present various trades many

* Lactant., "De M. Persecut.," cc. 7, 23.

† Taine, "La Révolution," pp. 337, 338.

‡ "Report of Commissioners for Inquiry into the Administration and Practical Operation of the Poor-Laws," p. 37, February 20, 1834.

other trades. Even now, besides erecting its naval and military establishments, and building harbors, docks, breakwaters, etc., it does the work of ship-builder, cannon-founder, small-arms maker, manufacturer of ammunition, etc., etc.; and, when the railways have been appropriated "with or without compensation," as the Democratic Federationists say, it will have to become locomotive-engine builder, carriage-maker, tarpaulin and grease manufacturer, passenger-vessel owner, coal-miner, stone-quarrier, omnibus-proprietor, etc. Meanwhile its local lieutenants, the municipal governments, already in many places suppliers of water, gas-makers, owners and workers of tramways, proprietors of baths, will doubtless have undertaken various other businesses. And when the state, directly or by proxy, has thus come into possession of, or has established, numerous concerns for wholesale production and for wholesale distribution, there will be good precedents for extending its function to retail distribution: following such an example, say, as is offered by the French Government, which has long been a retail tobacconist.

Evidently, then, the changes made, the changes in progress, and the changes urged, are carrying us not only toward state-ownership of land and dwellings and means of communication, all to be administered and worked by state-agents, but toward state-usurpation of all industries; the private forms of which, disadvantaged more and more in competition with the state, which can arrange everything for its own convenience, will more and more die away just as many voluntary schools have, in presence of board-schools. And so will be brought about the desired ideal of the socialist.

And now when there has been reached this desired ideal, which "practical" politicians are helping socialists to reach, and which is so tempting on that bright side which socialists contemplate, what must be the accompanying shady side which they do not contemplate? It is a matter of common remark, often made when a marriage is impending, that those possessed by strong hopes habitually dwell on the promised pleasures and think nothing of the accompanying pains. A further exemplification of this truth is supplied by these political enthusiasts and fanatical revolutionists. Impressed with the miseries existing under our present social arrangements, and not regarding these miseries as caused by the ill-working of a human nature but partially adapted to the social state, they imagine them to be forthwith curable by this or that rearrangement. Yet, even did their plans succeed, it could only be by substituting one kind of evil for another. A little deliberate thought would show that under their proposed arrangements their liberties must be surrendered in proportion as their material welfares were cared for.

For no form of co-operation, small or great, can be carried on without regulation and an implied submission to the regulating agencies. Even one of their own organizations for effecting social changes yields them proof. It is compelled to have its councils, its local and general officers, its authoritative leaders, who must be obeyed under penalty of confusion and failure. And the experience of those who are loudest in their advocacy of a new social order under the paternal control of a government shows that, even in private voluntarily-formed societies, the power of the regulative organization becomes great, if not irresistible ; often, indeed, causing grumbling and restiveness among those controlled. Trades-unions which carry on a kind of industrial war in defense of workers' interests *versus* employers' interests find that subordination almost military in its strictness is needful to secure efficient action ; for divided councils prove fatal to success. And even in bodies of co-operators, formed for carrying on manufacturing or distributing businesses, and not needing that obedience to leaders which is required where the aims are offensive or defensive, it is still found that the administrative agency acquires so great a power that there arise complaints about "the tyranny of organization." Judge, then, what must happen when, instead of combinations, small, local, and voluntary, to which men may belong or not as they please, we have a national combination in which each citizen finds himself incorporated, and from which he can not separate himself without leaving the country ! Judge what must under such conditions become the power of a graduated and centralized officialism, holding in its hands the resources of the community, and having behind it whatever amount of force it finds requisite to carry out its decrees and maintain what it calls order ! Well may a Prince Bismarck display leanings toward state-socialism.

And then, after recognizing, as they must if they think out their scheme, the power possessed by the regulative agency in the new social system so temptingly pictured, let its advocates ask themselves to what end this power must be used. Not dwelling exclusively, as they habitually do, on the material well-being and the mental gratifications to be provided for them by a beneficent administration, let them dwell a little on the price to be paid. The officials can not create the needful supplies ; they can but distribute among individuals that which the individuals have joined to produce. If the public agency is required to provide for them, it must reciprocally require them to furnish the means. There can not be, as under our existing system, agreement between employer and employed—this the scheme excludes. There must in place of it be command by local authorities over workers, and acceptance by the workers of that which the authorities assign to them. And this, indeed, is the arrangement distinctly, but as it would seem inadvertently, pointed to by the members of the Democratic Federation. For they propose that production should be carried on by "agricultural and industrial *armies* under state control" ; apparently not remembering that armies presuppose grades of officers, by whom obedience would have to be insisted upon, since otherwise neither order nor efficient work could be insured. So that each would stand toward the governing agency in the relation of slave to master.

"But the governing agency would be a master which he and others made and kept constantly in check, and one which therefore would not control him or others more than was needful for the benefit of each and all."

To which reply the first rejoinder is that, even if so, each member of the community as an individual would be a slave to the community as a whole. Such a relation has habitually existed in militant communities, even under *quasi*-popular forms of government. In ancient Greece the accepted principle was that the citizen belonged neither to himself nor to his family, but belonged to his city—the city being with the Greek equivalent to the community. And this doctrine, proper to a state of constant warfare, is a doctrine which socialism unawares reintroduces into a state intended to be purely industrial. The services of each will belong to the aggregate of all; and for these services such returns will be given as the authorities think proper. So that even if the administration is of the beneficent kind intended to be secured, slavery, however mild, must be the outcome of the arrangement.

A second rejoinder is that the administration will presently become not of the intended kind, and that the slavery will not be mild. The socialist speculation is vitiated by an assumption like that which vitiates the speculations of the "practical" politician. It is assumed that officialism will work as it is intended to work, which it never does. The machinery of communism, like existing social machinery, has to be framed out of existing human nature; and the defects of existing human nature will generate in the one the same evils as in the other. The love of power, the selfishness, the injustice, the untruthfulness, which often in comparatively short times bring private organizations to disaster, will inevitably, where their effects accumulated from generation to generation, work evils far greater and less remediable; since vast and complex and possessed of all the resources, the administrative organization once developed and consolidated must become irresistible. And, if there needs proof that the periodic exercise of electoral power would fail to prevent this, it suffices to instance the French Government, which, purely popular in origin, and subject from time to time to popular judgment, nevertheless tramples on the freedom of citizens to an extent which the English delegates to the late Trades-Union Congress say "is a disgrace to, and an anomaly in, a republican nation."

The final result would be a revival of despotism. A disciplined army of civil officials, like an army of military officials, gives supreme power to its head—a power which has often led to usurpation, as in mediæval Europe and still more in Japan—nay, has thus so led among our neighbors within our own times. The recent confessions of M. de Maupas have shown how readily a constitutional head, elected and trusted by the whole people, may, with the aid of a few unscrupulous confederates, paralyze the representative body and make himself autocrat. That those who rose to power in a socialistic organization would not scruple to carry out their aims at all costs, we have good reason for concluding. When we find that shareholders, who, sometimes gaining, but often losing, have made that railway-system by which national prosperity has been so greatly increased, are spoken of by the council of the Democratic Federation as having "laid hands" on the means of communication, we may infer that those who directed a socialistic administration might interpret with extreme perversity the claims of individuals and classes under their control. And when, further, we find members of this same council urging that the state should take possession of the railways, "with or without compensation," we may suspect that the heads of the ideal society desired, would be but little deterred by considerations of equity from pursuing whatever policy they thought needful—a policy which would always be one identified with their own supremacy. It would need but a war with an adjacent society, or some internal discontent demanding forcible suppression, to at once transform a socialistic administration into a grinding tyranny like that of ancient Peru; under which the mass of the people, controlled by grades of officials, and leading lives that were inspected out-of-doors and in-doors, labored for the support of the organization which regulated them, and were left with but a bare subsistence for themselves. And then would be completely revived, under a different form, that *régime* of status—that system of compulsory co-operation, the decaying tradition of which is represented by the old Toryism, and toward which the new Toryism is carrying us back.

"But we shall be on our guard against all that—we shall take precautions to ward off such disasters," will doubtless say the enthusiasts. Be they "practical" politicians with their new regulative measures, or communists with their schemes for reorganizing labor, the answer is ever the same: "It is true that plans of kindred nature have, from unforeseen causes and adverse accidents, or the misdeeds of those concerned, been brought to failure; but this time we shall profit by past experiences and succeed." There seems no getting people to accept the truth, which nevertheless is conspicuous enough, that the welfare of a society and the justice of its arrangements are at bottom dependent on the characters of its members; and that improvement in neither can take place without that improvement in character which results from carrying on peaceful industry under the restraints imposed by an orderly social life. The belief, not only of the socialists but also of those so-called Liberals who are diligently preparing the way for them, is that by due skill an ill-working humanity may be framed into well-working institutions. It is a delusion. The defective natures of citizens will show themselves in the bad acting of whatever social structure they are arranged into. There is no political alchemy by which you can get golden conduct out of leaden instincts.

THE ELECTRIC RAILWAY.

By Lieutenant BRADLEY A. FISKE, U. S. N.

WITH most men who have not had time to follow the progress made of late in applying electricity to the practical work of the world, this form of energy is chiefly associated with certain experiments at school, by which the tedium of book-studying was enlivened with exhibitions of sparks and shocks and other curious and interesting phenomena, though it may be also connected in their minds with electric hair-brushes, electric corsets, magnetic clothing, etc. They regard it also as convenient for sending dispatches by telegraph, and in general for doing work where delicacy but not much force is requisite; but the idea seldom occurs to them that this versatile power is capable of swiftly moving the mightiest masses, as well as of operating the tiniest apparatus; of turning the wheels of ponderous machinery, as well as of vibrating thousands of times per second the little diaphragm of the telephone; of conveying to far-distant points the waste power of cataracts, as well as the minute forces liberated by the telegraphic key, and of illuminating, with the purest artificial light known, the most extensive and thickly populated cities.

Doubtless, one great cause of the skepticism with which many regard any project for using electricity upon a large scale is the fact that exhaustive experiments in this direction were made in the early part of the century, and the conclusion reached was that, though power and light could both be distributed by electricity, yet the expense would be so enormous as to render impracticable any extended electrical system.

It should not be forgotten, however, that the only great trouble found was the expense, and also that the principal source of this expense has been removed. In those days, the only way of generating an electric current was by the use of the voltaic battery, in which the electrical energy of the current was procured from the heat of the chemical combination going on in the battery; but in 1831 Faraday discovered a much cheaper way of generating electricity, when he found that it could be produced by simply moving magnets in the vicinity of coils of wire, or coils of wire in the vicinity of magnets. The significance of his discovery was so apparent that inventors began at once to devise means for generating currents upon an extended scale, by moving large magnets in the vicinity of large coils of wire by means of machinery; and this mechanical system has now been brought to such perfection that the cost of producing a horse-power of electrical energy can be as easily and almost as accurately calculated as the cost of producing a horse-power in a steam-engine or any other familiar apparatus.

In order to arrive at a clear comprehension of the present state of the art, it will be necessary to remember that any work which we perform must be performed by the expenditure of a certain and absolute amount of energy, and that we can not create this energy, but can only obtain it by changing the form of some other kind of energy. In the voltaic battery, as we have said, the electrical energy is obtained by transforming the heat of the chemical action going on in the cell into electrical energy, so that the amount of the latter that can be got out of any voltaic battery is limited by the amount of energy of the chemical combination. Now, the metal ordinarily used for furnishing chemical energy in a voltaic battery is zinc, and the heat of combination of zinc with oxygen is only about one sixth of that of coal, while its cost is more than twenty times as great; so that, to get the same amount of energy from zinc as from coal, would cost about one hundred and twenty times as much. Now, in the mechanical method of generating electricity, the electrical energy is produced by the mechanical means of moving large magnets near coils of wire; but the mechanical energy necessary to do this is obtained by the combustion of coal (i. e., the chemical combination of coal with oxygen).

It would be incorrect, however, to say that we can in this way produce electricity one hundred and twenty times as cheaply as by a battery, because there is an enormous loss in converting the heat of combustion of the coal into electricity, whereas the voltaic battery produces the electricity directly. The losses in converting the energy of the combustion of coal into mechanical energy are so prodigious that even a theoretically perfect engine could not get hold of more than from twenty to twenty-five per cent of the total energy in the coal, on account of the loss of the heat; so that, if an engine (a good one) has an efficiency of eighty per cent, it can not actually convert into work as much as twenty per cent of the total energy in the coal. The loss now in converting this mechanical energy into the electrical energy in the circuit where it is desired may be taken as about fifteen per cent, so that only about from fifteen to seventeen per cent of the total energy of the burning coal may be looked for in the electrical circuit. But, as the original cost of the coal is only $\frac{1}{120}$ of that of the zinc furnishing an equal amount of energy, we see that the mechanical method of producing electricity is, roughly speaking, about twenty times as cheap as that of generating it by batteries.

The present way of generating large quantities of electricity requires, then, an engine and boiler for converting the chemical energy of burning coal into mechanical energy, and a device whereby this mechanical energy is made to move magnets in the vicinity of coils of wire or coils of wire in the vicinity of magnets, so as to convert the mechanical energy into electrical energy. Such a device is called an electric machine, or, ordinarily, a dynamo-electric machine; and this term is usually abbreviated into "dynamo."

A dynamo of a type in considerable use, and one of the earliest and best forms, is shown in Fig. 1. In this dynamo, coils of wire are wrapped about the long "armature" shown in the center, which is revolved between the poles of the large magnet (A) by a belt coming from a steam-engine, and going around the armature-pulley seen at

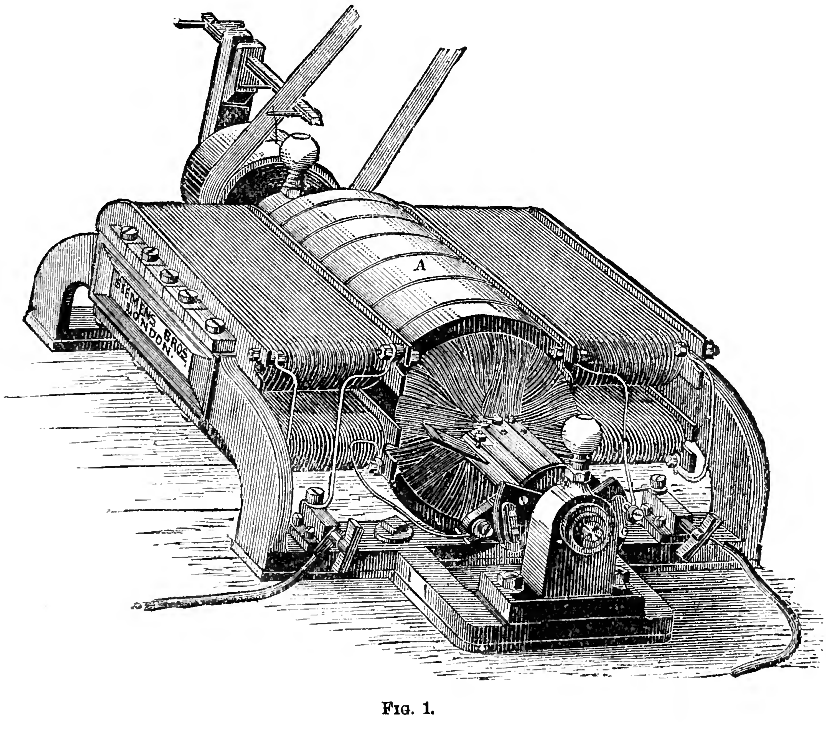

Fig. 1.

the rear. The approach to and recession from the poles of the different coils of wire of the armature generate a succession of currents which are collected by "brushes," and sent out into the circuit as a constant current.

But a most beautiful example of the truth of the theory of the conservation of energy is afforded by the fact that a dynamo will not only generate an electric current if it be revolved by mechanical means, but that it will itself revolve, if an electric current be sent through it from an exterior source ; so that it not only can transform mechanical energy into electrical energy, but can also transform electrical into mechanical energy. When used for this purpose it is called an "electro-motor," and sometimes an "electric engine."

Not only, however, is it necessary for an engine to be capable of doing a certain kind of work ; it is also necessary for it to be capable of doing it economically, and it is for this reason that such a great future is prophesied for electric engines. For, while an excellent and elaborately constructed stationary steam-engine can produce but a small fraction of the energy it absorbs, a good electric engine (or electro-motor) will return seventy-five per cent of the electric energy given it by the generating dynamo. For the reason, however, that no economical means of generating large currents are yet discovered, except the method described of first burning coal, the use of electric machinery is at present restricted to certain industries. Now, one of these industries is believed to be railroading.

The opinion is generally held that railroad companies desire to obtain as large a return as possible upon their investment, and therefore to run their trains as cheaply as possible. If this be true, the value of an electric railway will become obvious, when one remembers that, of necessity, the present locomotive is wasteful in the extreme, and that in an electric railway a large and economical stationary engine renders its mechanical energy to a large and economical dynamo which sends an electric current to an economical motor on an electric locomotive. This motor is connected with the driving-wheels by gearing, belting, or other suitable devices, so that its revolution produces a revolution of the driving-wheels and a consequent progressive motion of the electric locomotive, in the same way that the engine of a steam-locomotive produces a rotary motion of the driving-wheels, and a consequent progressive motion of the steam-locomotive. There is a certain loss of electricity in passing from the dynamo to the motor on the locomotive, both from leakage and from overcoming the resistance of the conductors ; but, for distances not too great, this loss, added to the losses in converting the mechanical energy of the stationary engine into electrical energy, and in reconverting this electrical energy back into mechanical energy by the motor, is not equal to the loss inseparable from even the best steam-locomotives.

It will be, of course, noticed that it is necessary constantly to maintain an electrical connection between the electro-motor on the locomotive and the stationary dynamo, in all positions of the locomotive. To accomplish this effectively, a number of systems have been invented. By one system the rails themselves act as conductors, the current going to the locomotive by one rail and returning by the other; while, in other systems, a third or auxiliary conductor is used. To collect the current and pass it through the motor, two strips of copper or brass in the circuit of the motor extend from the locomotive and press upon the conductors; so that, as the car advances, these keep up a scraping contact. Two wheels in circuit with the motor are also sometimes used as collectors.

The distinction of being the first to conceive and suggest the idea of an electric railway seems to belong to Dr. Werner Siemens, of the celebrated firm of Siemens & Halske, which has been more identified with the practical development of electrical science than any other firm in the world. In pursuance of his idea, Dr. Siemens constructed the first electrical railway at Berlin in 1879.

In this railway, whose length was about three hundred and fifty yards, and whose gauge was about three feet and three inches, a third or auxiliary conductor was used to convey the current from the dynamo to the motor. This conductor lay between and parallel to the other two rails, and the current was taken from it by a metal brush connected with the motor, which extended from the car and pressed upon the conductor. After going through the motor, the current went to both rails and by them back to the dynamo, the rails acting as the "return." The motor was placed upon a car, attached to which were three other cars, the first thus acting as the locomotive. Such was the interest excited by this novel system of transportation, and such its success, that it continued in operation for several months, and carried thousands of people, the money received for fares being contributed, it is said, to charitable institutions in the city.

The success of this experimental railway led the Messrs. Siemens to plan another upon a more extended scale; and they applied to the authorities for permission to build an elevated road in Berlin, six miles long, on which single cars, each fitted with an electro-motor, were to be run by means of electricity. Permission to do this was refused, on account of the inconvenience to the inhabitants which would result from the structure; but, ultimately, leave was given the same firm to build a surface electric railway from Lichterfelde, one of the suburbs, to the military academy. This railway is still running, and its operation has throughout, for more than two years, been of the most satisfactory character. No auxiliary conductor is used, the current going from the dynamo along one rail, through one of the wheels, through the motor, through a wheel on the opposite side of the car, and thence to the other rail, which acts as the "return." No trains are made up, but each car is fitted with an electro-motor, which lies beneath the flooring. As the authorities declare these cars to fall under the same heading as tram-cars, the speed at which they may be run is limited by law to twelve miles per hour.

This speed is realized with ease, but a much greater rate could be attained, if it were allowed.

It can hardly be hoped, however, that such a simple system as this could be adopted for running cars in the streets of a city, for other difficulties would be introduced. The fact that the rails in the streets must, of necessity, be close to the surface of the ground, and that they are to be stepped upon by men and horses, shows at once the necessity of having the conductor out of the way, and the danger of having the current traverse the rails. At the Electrical Exposition held at Paris in 1881, Messrs. Siemens & Halske had an electric railway in operation, in which a third or auxiliary conductor was used; but this ran along on posts like a telegraph-wire, the current being conveyed from this conductor to the motor by means of a flexible conductor, which was connected at one end with the motor on the car, and at the other with a contact-carriage, or trolly, which was drawn along the conductor by the car as it advanced.

In mines, in tunnels, and in all places where the smoke of burning coal is objectionable, it would seem that the electric railway possesses unrivaled advantages. As the motor gives off no smoke, makes little noise, occupies but a small space, and does not have to carry its own

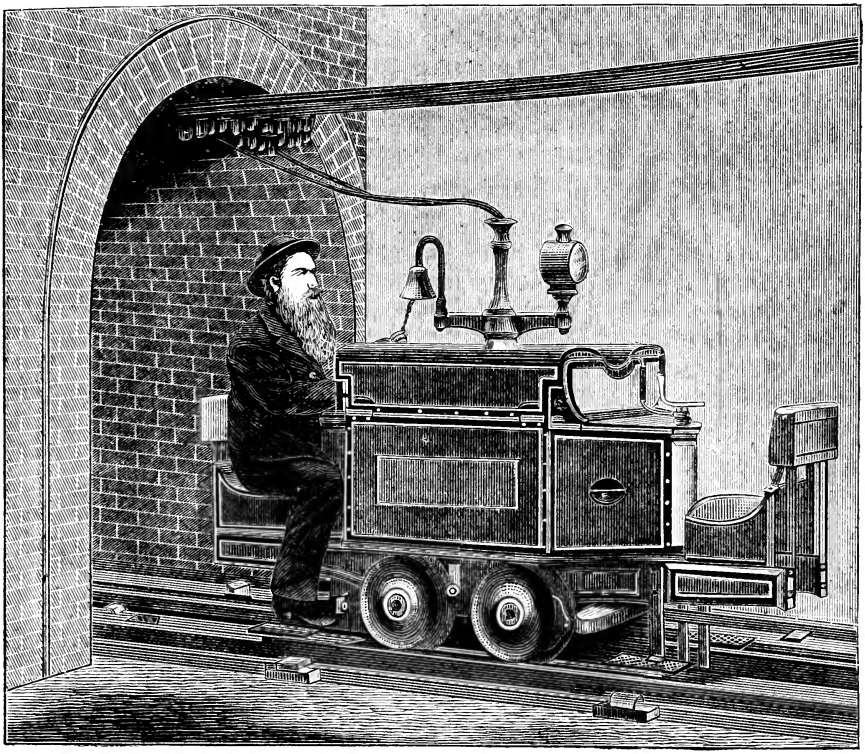

Fig. 2.

fuel, it possesses many points of superiority over the present cumbersome, noisy, smoky locomotive. Indeed, in long passages such as those in the mines at Zankerode, where a Siemens electric railway is now running, a steam-locomotive would be not only undesirable but impossible.

In the Zankerode-mine railway, the current is sent from the dynamo along the roof of the tunnel through one of the inverted T-rails shown in Fig. 2, which thus acts as a conductor, and upon which slides a contact-carriage connected with the motor on the car by one of the flexible conductors, also shown. The return current coming from the motor goes to the other inverted T-iron by the other flexible conductor, and thence back to the dynamo.

The most extensive electric railway now in use is that constructed by Messrs. Siemens in Ireland, which runs from Portrush to Bushmills, a distance of about six miles. As at present operated, a dynamo revolved by a stationary steam-engine supplies the necessary current; but it is intended to utilize the waste power of a waterfall situated about three quarters of a mile from the end of the line, as soon as the necessary works can be constructed. The cost of running the electric locomotives is found to be less than that of running steam-locomotives over the same track, and it will be much reduced as soon as the utilization of the power of the waterfall (twenty-four feet) is made possible.

By another system of electric propulsion, it has been attempted to carry batteries of electric accumulators in the car, instead of conveying the current to the car by conductors. By this system, as yet undeveloped, a large stationary engine is to be used to turn a dynamo which will generate a current that will charge the accumulators or "storage-batteries," as they are sometimes called; these accumulators to lie under the seats or in some other convenient place, and render the current to the motor direct.

As accumulators may play an important part in electric railroading, and as much that is incorrect has appeared in print concerning them, a few words of description may not be out of place.

Probably the most prevalent conception of an accumulator is a box or other receptacle in which electricity is put and from which it can be drawn when desired; and for practical purposes this idea is sufficiently correct. From a scientific point of view, however, it is more satisfactory to regard an accumulator as a battery in which the electrical energy of the current which it renders arises from a chemical action due primarily to another current which was sent through it. To speak more in detail, the ordinary accumulator (Fig. 3) consists of two lead plates standing in acidulated water and capable of behaving like an ordinary voltaic battery, after they have been acted upon by a strong current. This current, called the charging current, when it goes through the liquid, decomposes it, the oxygen, separated, going to one lead plate and the hydrogen to the other lead plate. The oxygen attacks the lead plate to which it goes, thus forming peroxide of lead, and the hydrogen reduces any oxide that may be on the other lead plate, thus producing pure lead, some of the surplus hydrogen forming as a film upon the surface. The charging current is then reversed, so that the latter plate is now attacked, and is then reversed again; the effect of these operations being to render the surfaces of both lead plates porous so that they present a large surface, and can therefore hold a great deal of peroxide of lead. When the charging current is broken, the oxygen, which has been forcibly separated from the liquid, seeks to recombine in the same way that a stone which has been forcibly separated from the earth seeks the earth when liberated. If now the two lead plates be joined with a wire, the effect of the oxygen in the peroxide of lead trying to recombine is to generate an electrical current in the opposite direction to the original one; and this is the current which is utilized. The value of accumulators would be much increased if this return current could be made greater, and if the weight and cost of the accumulators themselves could be made less. At present, however, their use is restricted by reason of their great cost and weight, and by the small ratio (about fifty per cent in practice) of the electrical energy returned to that expended in charging them. Nevertheless, the fact that the accumulator system of electric railroading obviates the necessity for any conductors, which sometimes are inconvenient and expensive, and which themselves occasion great loss of electrical energy, leads many to believe that for short routes, as upon street-car lines of cities, accumulators will be very efficient.

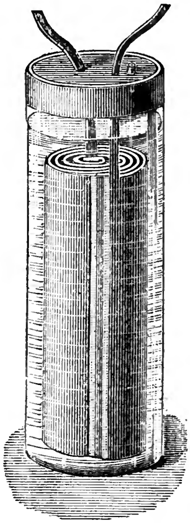

Fig. 3.

At the Chicago Exposition of Railway Appliances, which has just closed, the system of Messrs. T. A. Edison and S. D. Field, of New York, was tried, and with undeniable success. By this system a third conductor is used; but it is not placed upon poles, as in the Siemens system (for this would not be practicable in the streets of a city), but lies in a long sunken trough which runs between and parallel to the rails. The trough is covered, and a long and very narrow slit runs the whole length of the cover. Through this slit extends a strong metallic rod which is connected mechanically with a contact-carriage lying upon the conductor, and which is mechanically and electrically connected with the car.

It is claimed that by means of a scraper, carried by the contact-carriage, there will be no trouble occasioned by any accumulation on the conductor of ice, snow, or mud, but that the car can be satisfactorily run in all kinds of weather.

Fig. 4 represents the generator and track as arranged at the Chicago Exposition. It will be noticed that one pole of the generator (dynamo) is connected with the auxiliary middle rail, and the other with one of the two side-rails which are metallically connected together, as shown. The current goes to the motor on the car by the middle conductor, and is returned to the generator by the side-rails.

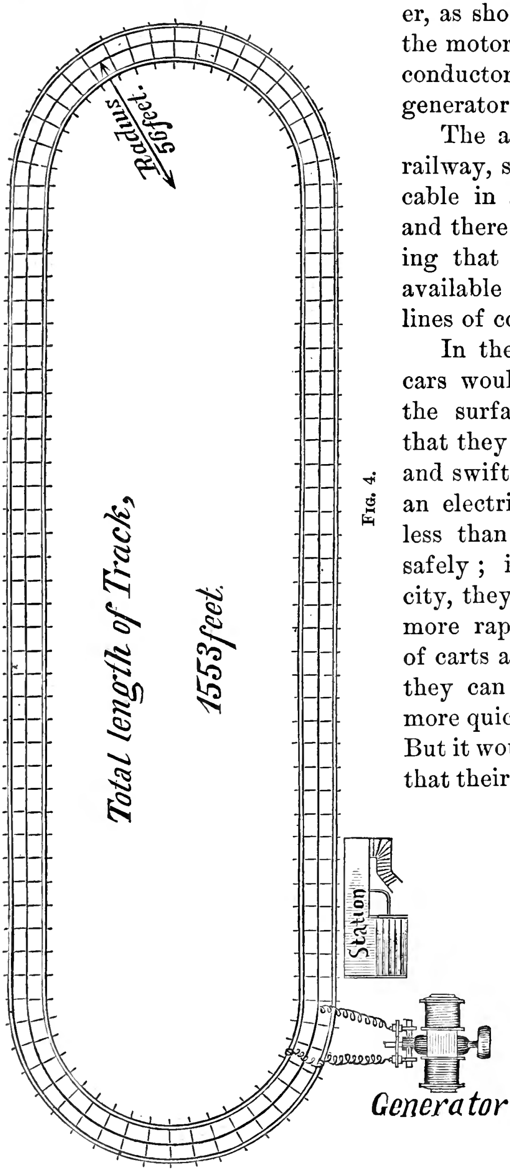

Fig. 4.

The advantages of the electric railway, should it be made practicable in all respects, are obvious, and there is good reason for believing that in time it will be made available and economical even for lines of considerable length.

In the streets of a city, electric cars would be advantageous upon the surface roads for the reason that they could be run more quietly and swiftly than horse-cars, and, as an electric car can be stopped in less than its own length, just as safely; in crowded parts of the city, they could thread their way more rapidly through the crowds of carts and other vehicles, because they can be stopped and started more quickly and require less room. But it would be upon elevated roads that their advantages would be pronounced, for we should then escape much of the noise and all of the smoke and smell that now attend the passing of elevated trains.

By reason of our ability to make every electrical car its own locomotive, it is clear that we can secure greater safety in traveling, and greater frequency in the times of arrival and departure, so that to reach the depot half a minute too late would not be so serious a thing as it now is. As each car is very light, it can be stopped in a much shorter distance than is now possible with a heavy train; and, even if a collision should occur, it would not be such a horrible thing as a collision between two ponderous trains, not only because of the lightness of the electric cars, but also because they do not carry steam and fire as locomotives do. Another advantage of the lightness of the cars lies in the fact that they will exert less "wear and tear" upon the tracks, and therefore occasion less outlay for repairs.

When the present mode of traveling in Pullman cars is compared with the mode in use not very long ago, by which people were cramped for hours and even days in a coach without springs worth calling by that name, and were jolted and tossed about over uneven roads, we conclude that traveling at the present time is a very luxurious thing. But what will it be when we can sit at an open window, and glide along at the rate of sixty miles an hour, without the fear of smoke or cinders; when electric bells are at hand leading to the inaccessible retreats where porters now secrete themselves safe from discovery; when we can start from our homes to take a car for Boston, as we now start to take an elevated train, knowing that, if we miss one car, another will be soon at hand; when electric incandescent lamps, which can not, in case of accident, scatter burning oil in all directions, shall fill the car with a mild and steady light; when dispatches can be received on board a train in motion as well as at an office; when the cars shall be heated and meals prepared by electric stoves which can not, in case of accident, set fire to the car—all the electricity needed for these and numberless other purposes being derived from the same convenient source—the conductor carrying the current which furnishes the propelling power?

That any such ideas as to what electricity can accomplish are visionary and impracticable may seem to be the case to some; that they are so in reality is not believed by many who have given the subject impartial study. Some of these believe that, in the very near future, electric cars will supplant horse-cars; and upon short lines like elevated roads, steam-locomotives; but that it will not be practicable for many years to run electrical cars upon long lines. Such may be the case. But it should be remembered that, in most instances in the history of industrial progress, the practical developments of meritorious systems have surpassed in rapidity and extent the expectations of even impartial men. A very high scientific authority in England once spoke very favorably of the idea of using steam-vessels for accomplishing short distances, and for river navigation, but laughed heartily over the suggestion of their ever going to sea, and offered publicly to eat the boilers and engines of the first one that should cross the Atlantic. Probably there are not many men who, in the light of what has recently been accomplished, would promise to eat the motor of the first electric car that should run from New York to Chicago.

PHOTOGRAPHING A STREAK OF LIGHTNING.

By GASTON TISSANDIER.

A BOHEMIAN observer, M. Robert Haensel, of Reichenberg, has succeeded in accurately photographing a flash of lightning. His pictures, of which he has taken several, show the light of the flash, under the form of long, continuous sparks, traversing the atmosphere. With the spark the landscape also is well produced, and a means is

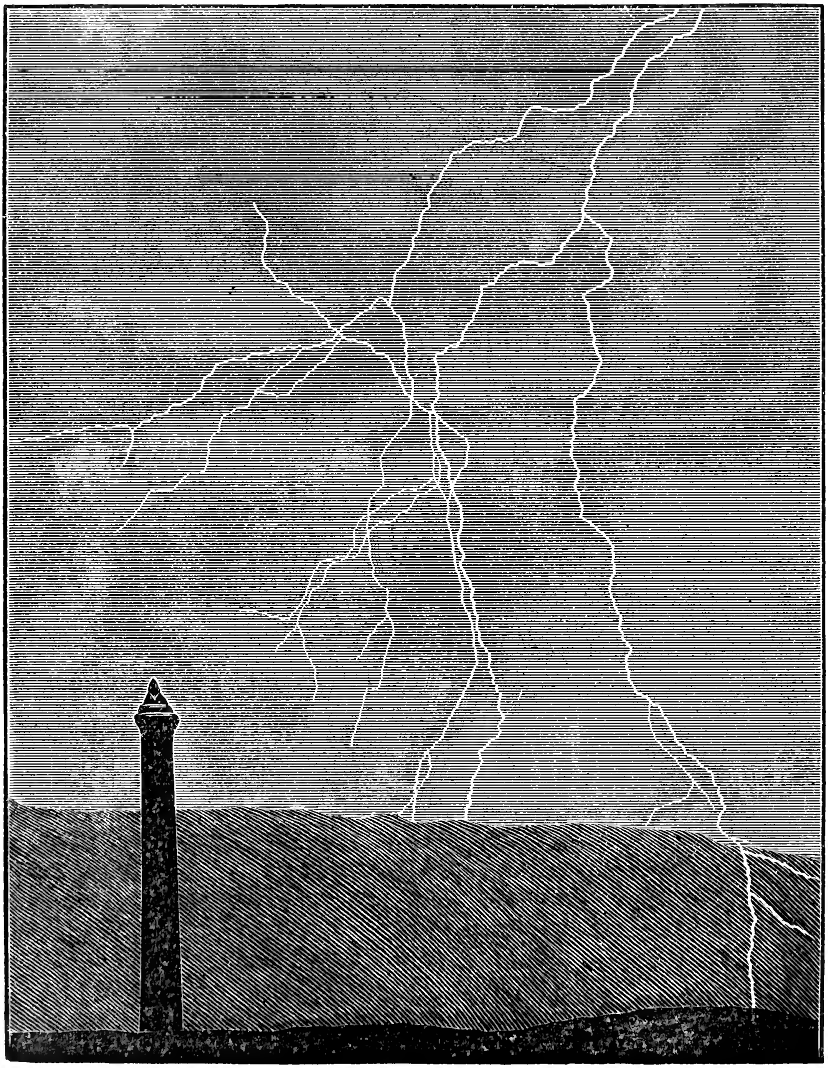

Fig. 1.

given for estimating the length of the luminous train, which, in one instance, is calculated to be seventeen hundred metres, or more than a mile.

Wheatstone demonstrated by direct experiments of great ingenuity that single flashes of lightning do not last more than a millionth of a second. We may judge from this of the wonderful sensibility of the new gelatine-bromide plates which permit the taking of correct views under these conditions.

M. Haensel has given a short account of the circumstances under which his photographs were taken and of the processes he employed. On the 6th of July, 1883, during a storm, when the sky was traversed

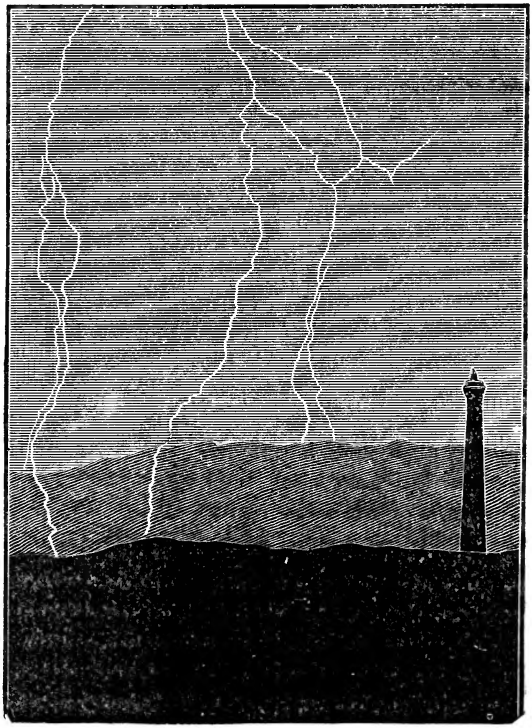

FIG. 2.

by frequent flashes of lightning, he turned his instrument at about ten o'clock in the evening toward that point whence the strongest flashes seemed to issue. The apparatus was furnished with the most sensitive gelatine-bromide plates, and the flash left its own impression upon them as it was formed. Out of ten plates that were exposed, he obtained only four photographs, of two of which we here give exact copies, taken from heliographic reproductions by M. Gillot, of Paris. The first figure represents two flashes. In the left one will be observed a double spark, which also appears triple in the middle. Simultaneously with this flash the sky was traversed by another, which also appears ramified in even a more complicated manner than its companion. The second figure represents in all its beauty a flash with many extensive and divergent ramifications.—*Translated for the Popular Science Monthly from La Nature.*

METHODS OF INSTRUCTION IN MINERALOGY.*

BY M. E. WADSWORTH, PH. D.,
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IN the present discussions concerning the relative merits of classical and scientific studies as factors in education, one point seems to be often lost sight of: the difference between instruction given for the purpose of disciplining the mind and that given for the purpose of imparting information. The former appears to be the chief function of our public schools, academies, seminaries, and colleges; the latter the principal object of technological and professional schools and graduate or university courses proper.

It would seem, then, that it is necessary for any one, seeking to replace any disciplinary study by something else, to show that the proposed new study will afford an equivalent amount in kind. In other words, if the scientist can not show that the studies he proposes to introduce into our colleges and high-schools possess, beyond the information given, a power of disciplining the mind, in certain valuable directions, equal to any other studies, his case had better be abandoned. Realizing this, it is proposed to show how instruction in mineralogy can be and has been given in such a way as to cultivate and develop faculties of the greatest value and use to any man, whatever may be his walk in life. Of necessity, personal experience must be referred to in this case, which is the excuse for the seeming egotism of this article.

It is intended, first, to show how this was accomplished in the elementary course in mineralogy in Harvard College, as given several years ago. This course extended throughout the college year, requiring of the students attendance upon three lectures a week, or their equivalents, and, in addition, at least six hours of laboratory work. Since it (like nearly all the courses in Harvard) was an elective, it was taken only by a limited number of students.

At the time of my acquaintance with it, as a pupil, the first two and a half months were devoted to crystallography, while determinative mineralogy occupied the rest of the year. The crystallography was taught by means of crystal models, with illustrations taken from natural crystals, and embraced certain of the mathematical princi-

* Abstract of a paper read before the Society of Naturalists of Eastern United States, New York, December 27, 1883.

ples; but the course was largely devoted to the drawing of figures of crystals. Nearly all of this instruction was of a kind that caused the pupil to do his work in a mechanical manner, following "thumb-rules" given by the instructor. The student evidently was not expected to understand the reasons for his work — the great object seemed to be to mechanically produce the most beautiful and perfect drawings; and on this part of the course itis not proposed to dwell.

The mineralogical instruction was given in the following manner: First, there had been chosen a set of the most important mineral species, amounting to over two hundred in all, with which it was thought best that the student should be familiar. A sufficient number of typical specimens of each species and its important varieties had been labeled and permanently arranged, according to Dana's "System of Mineralogy," in a set of drawers accessible to the student. The instructor, with the specimens before him and the students around him, proceeded to point out the essential characteristics of these minerals, calling attention mainly to those features which would distinguish each mineral from all others in the chosen set. It was not proposed to burden the pupil with long descriptions of each mineral, but rather to require him to know and understand that which separated each one from its fellows, and caused it to stand out distinct from them. To this end every means of determination that seemed essential was put in requisition, except quantitative analysis. If the crystalline form was sufficient, the student was not expected to go further. If the physical properties sufficed, that was all that was necessary; if not, then resort must be had to the blowpipe, and even to the wet tests. The student was taught to do that which the practical mineralogist does—to determine his minerals by the shortest method consistent with accuracy—the method to vary according to the specimen. The pupil was taught to observe the color, streak, hardness, etc., to weigh the evidence in each case, and to decide according to the weight of the evidence. No guess-work was permitted, but some decisive test was required which should prove that the specimen belonged to the species to which it had been assigned. After a certain group had been passed over by the instructor —as, for instance, the picked species of the native elements, sulphides, etc., and sulpharsenites, etc., of Dana's system—each student was assigned a drawer containing specimens of these minerals, unlabeled and mixed together. These specimens were selected so as to be fair representatives of the species and varieties, but yet sufficiently difficult and varied to bring into play the student's faculties which it was desired to cultivate. As aids, the student was allowed his lecture-notes, Dana's "System of Mineralogy," and the lecture-drawers of labeled minerals.

After sufficient time had been given for the laboratory-work, each student was expected to be questioned, during the lecture-hour, upon such specimens as the instructor chose from his drawer. The student was required not only to name the specimen, but also to give his proofs why this belonged to a certain species and not to any other.

After this laboratory work had been performed, the instructor passed on to the next group—the chlorides, etc., fluorides and oxides of Dana's system. Lectures with the succeeding laboratory work followed, but in the drawers for determination there were placed specimens not only of this group but also of the preceding group. This was followed throughout the year, so that the student was unable to lose sight of any species he had previously studied. Written examinations were occasionally interspersed, in which the student was required to determine a certain number of picked specimens that were placed before him, and write out the reasons for his determinations. This system of instruction, I believe, was devised by the teacher of the course at that time, Professor J. P. Cooke. After having endeavored to inform myself as to the methods of instruction in elementary mineralogy both in this country and in Europe, I have as yet failed to find one that, in my judgment, equals this, both for the mental discipline and the practical instruction it gives; and I take pleasure in acknowledging my great obligations and gratitude to Professor Cooke for the mineralogical instruction I received from him in that course.

When, in the process of time, this course passed under my charge, great modifications were made in it; the crystallography was reduced in amount and lithology added. By a different arrangement the crystallography was taught in six lectures. In these, by means of a few simple principles, the student was taught to recognize readily to which form the planes of any crystal belonged, no matter how many different forms might be represented. Further than this it did not seem practicable to go, without entering upon an extended course of instruction and practice in mathematical crystallography, which would have consumed the entire time of the course. However, it was found that the students were better trained for the practical application of crystallography to determinative mineralogy by this brief course than they had formerly been by the two and a half months' instruction previously given.

Another radical change was the substitution for the "general quiz" of all the students, at the lecture-hour, of an hour's oral examination for each student. Each one was required to arrange some hour in which he could meet the instructor alone in his room, with his (the student's) crystal models, or drawer of specimens, as the case might be. During that hour he was carefully questioned upon the material, and every effort was made to lead him to express his ideas clearly. He was cross-examined on every point, relating not only to general principles, but also to the particular specimens in hand. He was required to state what characters were upon the specimens, how he determined them, and what their relations were to others. If it was found that the student's methods were imperfect, his logic defective, or that he had misunderstood anything in the lectures, every effort was made to set him right. The examination was really made a pleasant conversation between two friends, in which one constantly endeavored to draw the other out, place him at his ease, and enable him to tell what he knew. Methods of thought and work were the great objects, far more than correctly naming the specimens. In such an examination as this the student was obliged to depend upon his merits. The teacher must have indeed been a poor one if he could not in that hour find out, to a far greater extent than the student dreamed or suspected, what he knew and what his methods of thought and work were. Every effort was made to render the student an independent thinker, to cultivate in him accuracy and quickness of observation and readiness of perception, to lead him to rely upon himself, to weigh evidence, to reason closely, to form an opinion, and give his reasons therefor—to see, to be accurate, to reason, to judge, to decide. The time was also improved as a means of getting hold of him and establishing cordial relations with him; as well as to turn him unconsciously in the right direction, and to come into that close personal contact which it is so difficult to bring about in a large university, but which is so precious and valuable. Since these hourly examinations were repeated with each pupil for each group, the chief drawback was the tax upon the instructor's time and strength, as any one can readily realize when he considers that this species of mental gymnastics was kept up from six to ten hours a day, and that there were seven groups requiring from twenty-six to thirty hours in each group. It is to be borne in mind that this work was entirely voluntary on the instructor's part, but it paid in the results to the students, and in many of them it has influenced powerfully their after-life.

The students attending the course comprised freshmen, sophomores, juniors, seniors, graduates, specials, and scientific school students—a perfectly natural result from the extended elective system of Harvard. I am free to confess that, for a course like the one above described, I much prefer freshmen and sophomores to juniors and seniors. The reason is not far to seek. The prime objects of such a course are to cultivate observation and accuracy, train the powers of reasoning and judgment, and above all to beget in the student independence and freedom of thought. The previous training of the upper-class men had usually been such as to cramp and weaken whatever faculties in these directions they might have originally possessed, and hence it was exceedingly difficult to stimulate them to right methods of work and thought. This was strikingly exemplified in the case of those students who were thoroughly conversant with the blow-pipe, from their previous study of chemistry. It was with the greatest difficulty that they could be prevented from taking some one of the numerous artificial blow-pipe keys for the determination of minerals, shutting their eyes to all the physical characters, transforming themselves into mere wind-machines, and mechanically grinding out their results.

One question will naturally arise in the minds of every one: Can similar methods be applied in giving instruction for a limited time when the means and appliances for determination are of themselves much circumscribed? In one case this has been practically answered by myself, in giving instruction in the rudiments of mineralogy and lithology in the Museum of Comparative Zoölogy. The problem was to take dust-covered minerals and rocks that had accumulated through many years—some good, but most of them mere rubbish, the odds and ends of various collections—and give a two and a half months' course. From the necessity of the case, no blow-pipes could be used in the building, there were no crystal models, and the whole apparatus for qualitative tests was a bottle of hydrochloric acid and a few test-tubes which could be used in the cold. Streakers, magnifying-glasses, magnets, and a knife or file, with some broken glass, completed the outfit. The miscellaneous collection of minerals and rocks was washed and sorted, and such specimens as could be used were labeled and placed in drawers accessible to the students. With this material it was impossible to arrange test-drawers as described in the previous course. The instructor then directed the attention of the students to those physical and chemical characters of the specimens that they could make use of. The same general system was pursued as before, so far as the different conditions would permit—the object being the same, to impart valuable instruction together with mental training. The students, under the direction of the instructor, worked over the labeled drawers, and determined for themselves why the specimens were labeled as they were. At the end of the course a series of minerals and rocks was placed before each student, and he was required to determine them, writing out his reasons therefor. The result far exceeded my expectations. Out of thirty-eight students examined, comprising freshmen, sophomores, juniors, seniors, graduates, special and engineering students, thirteen took over ninety per cent, three of whom had the maximum mark; twelve obtained over eighty per cent, five over seventy per cent, four between fifty and sixty per cent, and four between ten and fifty per cent.

That this course afforded an intellectual discipline of advantage to the student has been shown, among various ways, by the testimony of one of the sophomore students. His time later was largely devoted to philosophical studies, including language and history, and after graduation he pursued the same studies at Harvard and in the best European universities. After his return from Europe and his establishment as an instructor in his favorite branches, he informed me that this brief course had been of permanent advantage to him in his later studies, and that it was one of the very few of the courses taken in college upon which he could look back with any satisfaction and believe it had materially aided him both in mental discipline and in methods of study. I speak of this simply to fortify my claim that mineralogy when rightly taught affords in certain directions a most valuable means of intellectual training.

In most localities, especially in regions of crystalline rocks, the teacher, even with very limited means, can usually procure many specimens of at least a few species, which he can arrange for his students, and practice them upon in such a manner as to bring into play the required faculties. This method can even be pursued with large audiences, if specimens enough can be obtained.

Besides exercising the pupils on the selected collection, they should be encouraged to seek the specimens themselves in the field. Every means possible should be taken to develop in them methods of thought and work that will bear fruit in their future life. Far less should be thought of training mineralogists than of training men.

In giving advanced instruction, the secret seems to be to bring the student up to the level of the instructor; to see that he has a broad and thorough knowledge of the principles and necessary data of the science; to point out to him the untrodden fields; to strengthen and exercise him so that he may walk without the teacher's aid. The great aim should be to render the student independent in his thought and work, to free him from a slavish following after mere weight of authority, and to beget in him a desire to seek truth for its own sake. He should be so trained and strengthened that, when away from the instructor's aid, he can walk in the untried grounds with a firm and steady step.

The preceding has not been given as of necessity the most perfect way, but simply as a way for reaching certain results.

Far more, indeed, depends upon the teacher and his spirit than upon the method, however valuable the latter may be.

It may also not be amiss to call attention to certain requirements in the teacher. That an original investigator in any science may be a poor instructor in that science is too well known to be disputed, but I believe it to be equally true, that no man can teach any science in spirit and truth—can produce upon his pupils the effect that ought to be produced—unless he has the spirit and knowledge of an investigator himself. In truth, it is confidently believed that no man can be a teacher of the highest order who has not walked in the temple of mystery itself, and wrung from Mother Nature some of her closely-guarded secrets. As well ask one who has only *read* about disease to properly teach medical students the *practice* of medicine as to ask one who has only *read* about any science to give *proper* instruction to his students in it. Yet this is the thing which the majority of our colleges are doing, and they fill their chairs as if they thought a thorough training in any science disqualified a man for teaching it. And then we are told that science-teaching is a failure! Is not the failure more in the teachers *chosen* than in the subjects?

PHYSIOLOGICAL SIGNIFICANCE OF VITAL FORCE.

By WILLIAM G. STEVENSON, M. D.

MODERN science has so extended the horizon of our mental perspective, has achieved such brilliant triumphs in so many departments of thought, and, on the basis of verified fact, has erected such an imposing superstructure of useful knowledge in the domain of inorganic nature, that some, rejecting the vitalistic theories of the past, have accepted the belief that the deeper mysteries of vital phenomena will, in a final analysis, be demonstrated to be but resultants of physical forces acting under the complex conditions of organization.

To investigate and interpret the varied phenomena of nature is the unquestioned prerogative of the human intellect; but science, having to do only with "particular orders of phenomena which exist in relation to the percipient mind" and are susceptible of verification, does not hope to solve the profound mysteries involved in the ultimate realities of either matter, energy, or life. With restless energy the human mind presses on in its search for truth, and brings from varied sources new facts to add to the sum of knowledge, until the conclusion is reached that matter is indestructible and energy persistent, and in the formulated laws of the "correlation and conservation of energy" the widest generalizations are made. In thus classifying and uniting the manifestations of matter and of life, whether morphological or physiological, under one general cosmic law, their explanation is made complete within the limits of the known.

Phenomena are explained, but the absolute remains unrevealed. The questions still are asked: What is gravity? What are chemical, electrical, and vital forces? What is the essential nature of matter, energy, and life? There is no oracle to answer.

The study of vital phenomena is difficult because of their complex character, and, in the absence of exact analysis, speculative philosophy has for many ages ventured different theories in explanation of their nature. In seeking to give the present status of physiological science on this important question, it is of interest to take a general historical retrospect, in order that the steps of progress may be observed.

The atomic philosophy, as taught by Democritus and Epicurus, recognized but one kind of matter, whose elements, by virtue of their various forms, had the property of diversified and endless combinations. This play of atoms, independent of an overruling intelligence, produced the worlds of inorganic and of organized matter, which move on in endless cycles and are obedient only to physical forces.

Plato regarded the intelligent soul as of dual character: one part, located in the body, being mortal and presiding over the appetites and passions; the other part, located in the head, being immortal and the source of reason.

The nature of the function of the brain and of the nervous system was unknown to Aristotle, who thought the soul contained the body, having its mortal part located in the heart. He, as well as Plato, thought the "pneuma," or breath, was to cool the blood, and in some way act as an instrument of mind over bodily actions. The vital principle of all life-forms resides in a germ; "this principle, while it resembles heat, is not fire, but a spirit similar in nature to the sun and stars."

Hippocrates accepted the Pythagorean doctrine of the four elements, and from it developed his theory of four principal "humors" of the body. He taught the existence of an "intermediate nature," which, though distinct from the mortal soul or pneuma, was the source of vital activity.

The pneuma was deemed such an important factor in the explanation of vital phenomena, that a school called "Pneumatists" was founded in the first century of our era. It was not then known that the arteries contained blood, but they were regarded as the channels through which the pneuma passed throughout the body; and this pneuma was to Galen, A. D. 130, identical with the soul. For fourteen hundred years "pneumatism," under varied forms, was the accepted philosophic belief of the civilized world, and only in the latter part of the sixteenth century did anatomical study enable Sylvius, Fallopius, Fabricius, and Harvey, to modify the prevailing belief of bodily functions. Then it was that Paracelsus sought to explain vital phenomena through the agency of an "archæus" or demon, which, he affirmed, was located in the stomach, and presided over the processes of nutrition, separating the useful from the poisonous part of the food.

Van Helmont adopted the idea of an archæus, but thought it an immaterial though personal force or entity, which "presided over all bodily functions" and gave to each member of the body its own special "vital spirit." The consensus of all these vital spirits produced health, and their disagreement disease.

Van Helmont "discovered gaseous substances and identified the archæus itself with gas." He proclaimed the existence of a general bond of sympathy throughout the universe, because of the "vital spirits" which resided in all forms of matter.

Descartes regarded the body simply as a complex machine, acting under conditions of physical forces, and all the phenomena of life were but the products of their working. The soul, however, was a hihger and independent principle which, located in the pineal gland, made itself known by thought, and took its temporary abode in the body, simply as a spectator of vital functions.

Leibnitz, while admitting a harmony established by Divine power, denied to soul and body any reciprocal influence, saying: "The body goes on in its development mechanically, and the laws of mechanics are never transgressed in its natural motions. Everything takes place in souls as though there were no body, and in the body everything takes place as though there were no soul."

Lord Bacon accepted the doctrine of "vital spirits" as applied to both animate and inanimate bodies.

Glisson believed in "vital spirits intermediate between the soul and organs," and regarded "irritability as a force of which perception and appetite are factors."

Stahl, in the eighteenth century, enunciated the doctrine that chemical forces and vital force not only differ from each other, but are antagonistic. Chemical forces are destructive of the living body, and are held in abeyance, and their disintegrating power is neutralized by a vital force which resides in the body and ministers to its functions. "This vital force, struggling against physical force, acts intelligently, upon a definite plan, for the preservation of the organism"; its triumph secures life, while the rule of the physical forces alone brings death. The theories of "vitalism" and "animism" thus took their places among the philosophic ventures of the age.

Borden, Barthez, and Grimaud, "representing the school of Montpellier," accepted "vitalism" but rejected "animism." The principle of life was believed to be distinct from the soul, though it was thought to operate independently of mechanical or chemical laws.

Haller inaugurated the inductive method in physiological science, and, by experiments, located irritability in the muscular tissue and sensibility in the nervous tissue.

Buffon explained vital phenomena through the instrumentality of "organic molecules" which, differing in form and nature, were indestructible and endowed with the "properties of vitality." These molecules, when associated, not only gave specific character to each part of the organism, and provided for its physiological activity, but became the perennial source of life.

In order to explain how the organic molecules became arranged into the specific forms of life, and preserved individual and type identity in nutrition and reproduction, Buffon projected his theory of "interior molds," by which, in connection with the "organic molecules," he sought to account for all the phenomena of the organic world. It was not until 1827, when the ovule in the ovarian follicle of mammalians was discovered by De Baer, that the theory of "organic molecules" and "interior molds" was overthrown. A single demonstrated fact destroyed the speculations of an age.

Bonnet's theory of "included germs" was another example of reasoning from premises that had not been verified, and the result was disastrous to the subjective method. He taught that the germs of all life-forms not only pre-existed in their first-created representative, but actually contained within themselves, already formed, all the parts of the future organism.

Logical deduction and scientific research, according to the beliefs and methods of the age, permitted such doctrines to receive for a time the approval of popular assent. But the spirit of inquiry was abroad in the world, and the advance of embryological science soon gave the demonstration that the doctrine of "included germs" had no foundation in fact, and so it was numbered with the errors of the past.

Cuvier, who had with such ability compared the structure of animal organs, and classified the facts of animal life in their statical or anatomical relationship, was a "vitalist," and thought the vital properties of the body a kind of entity—independent of physical or chemical forces.

Bichat sought, by a study of the tissues which composed the organs, to learn the nature of their functions, or the dynamics of the living body. He found that all the various kinds of tissue of the body, though differing in function, were endowed with two common properties—extensibility and contractility.

While he made phenomena depend on the properties of matter, he nevertheless followed Stahl as a "vitalist," and claimed that vital and physical properties are not only distinct from but antagonistic to each other: "The vital properties preserve the living body by counteracting the physical properties that tend to destroy it." Each class of phenomena is under distinct laws, and the conflict between them is active and constant. As one or the other triumphs, life or death results, and "health and disease are but the vicissitudes of the strife."

Life is, by Bichat, defined as "the group of functions that resist death," and is under the direct supervision of a special principle called at different times "soul," "archæon," "psyche," or "vital force." The philosophic theory which postulated this undetermined factor was known by the generic term of "vitalism," which, under Stahl and Bichat, took accurate definition, and deeply impressed its tenets upon the physical, chemical, and physiological sciences of the age.

Entities of some kind presided over the functions of life and the manifestations of matter. A "vital principle" ruled the organic world, and the phenomena of inorganic nature depended upon the presence of some "principle" which existed independent of the matter through which it displayed itself. Material particles, darting from luminous bodies into the eye, produced the sensation of light. Heat and cold depended upon the presence or absence of a material substance called "caloric." Electricity was a subtile, material agent, existing in a "latent" state in all substances, and manifesting great power when liberated from its repose. And so throughout the domain of chemical, physical, and biological phenomena, material entities existed and were manifested in all forms of inorganic and organic bodies, and yet were independent of them.

This was not an age for synthetic work; indeed, not even accurate analytic work, except in simple things, could be performed. These are possible only when facts have been observed, and definite knowledge has been acquired in special directions. In the sixteenth century, alchemy, having failed to discover the philosopher's stone, sought to find chemical remedies for diseases. Crude theories were supported by a few facts wrongly interpreted.

Early in the seventeenth century Glauber states that salt is the origin of all things. Boyle argues against the theory that "salt, sulphur, and mercury are the principles of things," and makes heat a powerful factor in originating new bodies. Becher thought that metals consisted of earth, of which there were three kinds—fusible or stony, fatty or fluid, and a "something of which they became deprived on ignition." This "something" Stahl named "phlogiston," which is akin to "spirits" and "souls" of the alchemists.

The phlogistic theory of Stahl was without foundation in fact, and yet, based upon experimental data, it was a step upward in chemical research, and held the minds of all for over one hundred and fifty years, including such great names in the eighteenth century as Hales, Black, Scheele, Priestley, Cavendish, and Lavoisier. Then it was that the analytic method became more accurate. Black, with the balance, demonstrated that the ignition of the metals magnesium and calcium gave no evidence that a ponderable "caloric" entered into them, but, to the contrary, a peculiar "fixed air" was expelled from them, which rendered them lighter than before they were burned.

The foundation of quantitative chemistry was thus laid, and the existence of "imponderable" agents in nature questioned. The discovery of "dephlogisticated air" by Priestley, the investigation of gases by Cavendish, of heat and fire by Scheele, and of insoluble minerals by Bergman—by means of the blow-pipe—were important additions to chemical knowledge, and enabled Lavoisier to generalize the facts already discovered. He announced a new theory of combustion, and, by questioning the existence of phlogiston, and showing that "principles should not be assumed where they could not be detected," revolutionized chemistry and gave it a new impulse, which has been quickened by every discovery since made.

Analysis of inorganic bodies increased, new facts accumulated, and new interpretations of phenomena were given, until the atomic theory, first suggested by Dalton in 1804, was promulgated under the great generalization known as the law of Avogadro or Ampère, which makes "equal volumes of all substances, when in a state of gas, and under like conditions, contain the same number of molecules."

This was the birth of modern chemistry, and, though it received attention when first enunciated in 1811, its far-reaching principles of truth were neither fully understood nor accepted for half a century afterward.

Chemistry, free from the errors of the past, now seeks to discover in the organic world the relations of different substances, as it has sought to know their relations in inorganic nature, and already the evidence is prophetic of wonderful results.

In physical philosophy, "Stahlism" received its mortal wound at the close of the last century by the experiments of Rumford and Davy, which negated the theory of "caloric" and demonstrated heat to be a "mode of motion."

This new doctrine, though founded on a demonstrated fact, was not complete until 1850, when Joule, having determined the mechanical equivalent of heat and established the law of thermo-dynamics, made possible the classification of facts determined by Young, Melloni, Faraday, Liebig, Mayer, Grove, Helmholtz, Carpenter, Tyndall, Henry, and others, which enabled the deduction to be made of the universal laws of the "correlation and conservation of energy."

In inorganic nature, unity, under law, is an accepted fact, and analysis and synthesis harmonize as to causes and effects; but in the organic world there are yet many unknown quantities, and the progress in solving the mysteries of life-action is necessarily slow, because of their complex character.

To some, "vitalism" yet maintains its position in the philosophic realm of organization, and a "vital force," independent of and antagonistic to physical force, yet presides over the manifestations of organic bodies. This, if true, necessitates "two distinct sciences and two distinct orders in nature," which, though related, are not reciprocal. This view is not in harmony with either chemical, physical, or biological science of the present day, and stands in direct contradiction to the accepted doctrine of the correlation and conservation of energy.

Whatever may be the essential nature of the ultimate life-principle —with which science has nothing to do—it can not be denied that life-phenomena are presented to us only through forms of matter. Matter, or material organization, is, therefore, so far as human knowledge goes, an absolute condition upon which all life-manifestations depend, and to assert, as do the "vitalists," that this vital energy—an agency which can not be verified, though dependent upon a material condition for a display of its action—is not related to it, but is independent of it and under distinct and antagonistic laws, is an assumption at variance with scientific truth and reason.

Doubtless one common source of error in the minds of the disciples of "vitalism" is inaccurate definition, confounding, as they do, the scientific meaning of a term with its philosophical or metaphysical significance. Thus, the term "life," when applied to the higher animals, is, to the metaphysical philosopher, often related to, or made synonymous with, the "soul"; while to the physiologist it refers only to the sum of phenomena arising in organized bodies. If what "can not be explained by chemistry or physics" constitutes the vital functions, then, by simply eliminating the known or non-vital factors, we may easily learn the exact amount of the vital element.

Science has already "banished the vital force from the entire province of organic chemical compounds, proving them to be subject to the same physical and chemical forces which determine the composition of mineral matter," and it now remains to test by analysis and synthesis the problem of organization itself.

It may very properly be asked, If the vital force has been banished from the entire province of organic chemical compounds, as asserted and demonstrated, in what it now resides, where is it located and what are its functions?

Chemical science has already demonstrated that all "proximate principles" and tissues of an organized body are, in an ultimate analysis, reducible to some of the elementary substances; and as, in inorganic bodies, morphological differences result from the various combinations of the ultimate elements, so, too, is it with organized bodies. So far as form alone is concerned, it is no more difficult to understand why organic compounds, under conditions of vital relations, take on the special form of a single speck of bioplasm in one case, of a vegetable in another, or of an animal form in another case, than it is to understand why the same elements will produce substances either allotropic or isomeric.

The phenomena are classified and thus explained, but in neither example is the ultimate nature or condition which causes the morphological difference known. There is no known force in nature capable of lifting the elements to the plane of animal organisms, except through the intermediate planes of the mineral and the vegetable kingdoms. Chemism is sufficient to form the mineral kingdom from the simple elements, which are under physical force alone. As the elementary combinations necessary to form a mineral involve an expenditure of force, which is transformed from a lower to a higher expression, so, in resolving the mineral back again to its elementary state, the force conserved in a higher state represents the original larger but weaker force of lower grade. The same is true when chemical compounds, as represented in the mineral kingdom, are lifted to the plane of the vegetable kingdom, or when the members of this class are raised to the highest class of the animal kingdom. In all cases the higher conditions depend upon the conditions of the next lower plane; and the conserved forces of the higher plane, when liberated by decomposition, represent the special functions of the organization.

There is not a phenomenon in animal life, from the earliest stage of germ-growth to the final stage of human development, but is susceptible of classification. The monera—mere specks of bioplasm—organisms without organs, so far as can be determined in their power to move, to receive nourishment, to react on external impressions and to reproduce their kind—not only manifest the fundamental properties of life, but display them under conditions so simple, so free from all morphological complications, that the way seems prepared by nature herself for the inquirer to enter the portals which open into the mysteries of life. They are on the border-land of the living and the not-living, blending on the one side with colloidal matter and on the other with vegetable forms, all so intimately related with simple "matter" as to justify if not necessitate the conclusion of genetic correlation.

We see this simple hyaline particle of bioplasm expand and contract, accompanied with chemical composition and decomposition, and the conclusion is irresistible that these simplest forms of motion, expansion and contraction, follow in orderly sequence of cause and effect.

Motility, arising from chemical disintegration and reintegration, represents, therefore, a fundamental expression of living organized matter, and impresses us with the idea of energy transformed. Indeed, all the functions of the higher organisms testify to the truth of the proposition that every manifestation of energy of organized bodies has its mechanical equivalent, and follows an orderly sequence of events.

The nutrition of the body, through all the intricate processes of external and internal digestion under the action of the digestive ferments, involves only physical and chemical forces in the transformation of the various foods received. The entire animal body is composed of modified protoplasm, as represented in the three classes known as proteids, carbohydrates, and fats, with their respective derivatives.

The proteids are exceedingly complex in character, and are not as yet definitely classified among organic compounds. They unite with acids and alkalies, and yet "do not play the part of an acid toward the base," or conversely. They are not crystallizable, and, having no combining equivalent, do not possess an absolute ultimate constitution, and therefore their molecular reactions and changes in the body can not be expressed by exact chemical symbols.

Here, then, we see the formidable list of "proximate principles" that are known to belong to the animal body as nutrient elements, and which are necessary for tissue development. They are all organic compounds, from which science has "banished the vital force" by "proving them to be subject to the same physical and chemical forces which determine the composition of universal matter." Where, then, shall we seek this "indefinable something" which exists and acts in the organism independent of and antagonistic to the physical and chemical forces of nature, as affirmed by the doctrines of "vitalism" taught by Stahl and Bichat?

The position held by these distinguished men and their followers has been demonstrated to be untrue, because, whatever may be the essential nature of this vital force, certain it is that it is known only by and through its manifestations. These present themselves to the mind only through organizations which immediately depend on chemical and physical forces for those proximate constituents which go to nourish and build up the tissues and enable the organs of the body to perform their respective functions.

In nutrient action, by which lifeless material or pabulum is transformed into living tissues, evidence of this vital entity should be discovered, if anywhere, for here we have the primal seat of life, the very fountain of genetic power.

Analysis, however, finds room for it in nutrient action no more than in the mysteries which lie concealed in every expression of energy throughout nature's domain. Why will friction of glass produce a condition or property which will repel pith-balls, while friction of sealing-wax produces a condition which will attract them? Are these movements caused by some kind of life-principle developed in so simple a way? No; they come from positive and negative electricity evolved by friction, and, with this answer, science asserts that the explanation is complete. When asked, What is electricity, beyond a special display of energy? there is no answer.

If we question the various organic functions of the body, physical and chemical forces alone confront us. A muscle contracts according to mechanical laws, and its work is expressed in mechanical equivalents. Electric tension is lost, heat is evolved, carbon dioxide appears, and the muscular tissue, before neutral in reaction, is now acid. Whatever may be the nature of the vital force, if such there be, operating in muscular contraction, it at least is not independent of physical and chemical forces, and the evidence is cumulative that these will alone explain the phenomenon. Respiration is purely a chemical process, in harmony with the laws of gaseous diffusion. Circulation, with its pumps, pipes, and valves, is an hydraulic operation. Absorption is osmotic, and a similar selective affinity for special things is exhibited in inorganic material as well as in animal membranes.

There seems no good reason why we should hesitate to regard the vital force as correlated with the physical forces known to us as heat, light, electricity, and actinism. That some relation exists there can be no doubt, for the effect of physical forces upon organic life is marked, and their energy is made potential in the tissues of both vegetables and animals. This potential energy is, after a time, transformed into active energy, and new phenomena result.

Organic forms do not generate energy, they simply transform or evolve it from that which has been supplied from the outer world. Heat in the body results from combustion the same as in a furnace.

Contractility is a special function of muscular tissue, and is independent of nerve-force. This attribute exists in the tissue for a time after death, lasting longer in cold-blooded than in warm-blooded animals, because of the slowness of the process of the destructive assimilation of the tissues. Longet demonstrated that contractility is closely related to the supply of arterial blood in the capillary vessels, for, on diminishing the supply, contractility was lessened, and the temperature of the muscles reduced; while Matteucci proved that increased heat accompanies muscular contraction. The heat produced by muscular contraction is divided into two complementary portions, one part appearing as sensible heat, and the other part being converted into mechanical work.

It matters not whence comes the heat, whether from the chemical transformations which take place in the body, or from the sun-force which has for ages lain locked in the coal-strata of the earth, when liberated or made dynamic, it represents a definite amount of mechanical power.

Nerve-energy is transformed into motion, as evidenced in muscular action; it is also transformed into heat, but it is not known whether it is an immediate or a secondary result. There are some instances recorded which seem to show its transformation into light, and it is well known that in certain animals electricity is the direct result of its metamorphosis.

From these data the conclusion seems authorized that at least a partial correlation exists between the physical forces and the energy resulting from nerve-action. I say a partial correlation, because, while the evidence may permit the conclusion that nerve-force is transformed into motion, heat, light, and electricity, it does not yet authorize the assertion that these can be reconverted into nerve-force.

This correlation doubtless extends to the higher manifestations of nerve-energy, feeling, and thought, for their exercise causes disintegration of nerve-tissue, as shown by the excreted products of decomposition and increased muscular action, as evidenced in the increased circulation of the blood. Physical conditions, therefore, determine mental results. The higher nerve-tissue of the brain operates under physical and chemical conditions in its nutrition, the same as does the tissue of any other organ, and hence its transformed energy, as expressed in nervous or mental action, has its physiological representation and measurable force.

To extend this subject further in the line of analysis, though it might be interesting, is unnecessary for the object proposed, which is to show that chemical, physical, and biological sciences have overthrown the vitalistic doctrines of the past, and demonstrated by analysis a relationship between the forces which rule the inorganic world and the "vital force" which is manifested in living forms. At this point the question is properly asked, if chemical synthesis confirms the results and conclusions of chemical analysis.

If the morphology and physiology of organisms are the products simply of physical molecules under chemical and physical forces which are revealed by analysis, then the assumption seems justified that synthesis, by combining these same molecules and restoring these same forces, should be able to reproduce the forms and functions of life.

Synthesis requires exact knowledge of all the elements and forces involved in the object of its investigation, and looks to the inductive or analytic method to furnish these data. There must be no unknown quantities in the problem to be solved, for synthesis seeks not to build from the unknown but only to re-form the known. Hence it properly awaits to receive verified facts from chemical analysis, which has yet been able to compass but a fractional part of the organic compounds.

Chemical elements are the basis of chemical science; they are neither produced nor destroyed, but are the enduring and constant factors in the many series of changes in the properties of matter, which represent the desideratum of this science. And yet the knowledge of molecules is very meager; the weights of but a few are known, even among the commonest elements and compounds; and but little account has been taken of atomic motion, which furnishes the most perfect explanation of chemical reaction.

Of the highly complex series of albuminoid substances, which neither crystallize nor possess any combining equivalent, and therefore can not be expressed by exact symbols, analytic chemistry knows but little, and hence it would be in vain to attempt their reproduction by synthesis. Notwithstanding our ignorance of essential facts, the progress of synthetic chemistry has been great, and the prospect is favorable for more brilliant achievements in the future.

Wöhler, in 1828, first, by synthesis, formed urea from ammonia cyanate. It was claimed by the critics that urea, being a nitrogenous metabolite, a product of animal decomposition, was a mineral, rather than an element of the animal tissues; but when Fownes, in 1841, prepared cyanogen itself direct from its elements, and, from this salt, urea, the fact was recognized and accepted, although it was affirmed that a "vital force" was necessary to account for the more complicated organic compounds, of which series urea was a member having only simple combinations. This was disproved by Berthelot in 1856, when he obtained the potassium salt of formic acid. Then followed the production of acetylene, marsh-gas, ethylene, and other hydrocarbons, from inorganic materials. Marsh-gas was converted into methyl alcohol, and ethylene into ethyl alcohol, and from these alcohols formic and acetic acids were made.

Startling as these results were, the substances formed were, relatively, simple in nature, and the "vital force" still ruled in the more complicated bodies of organic origin.

Synthetic work continued to achieve brilliant results and added to its list of vegetable compounds oxalic, valeric, malic, citric, tartaric, and salicylic acids, the oils of garlic, mustard, and wintergreen, also conine, alizarine, and indigo.

Of animal compounds, leucin, creatin, sarcosin, and taurin are added to the large and growing list of substances from which analysis and synthesis have banished the vital force, and harmonized the facts of their existence with the physical and chemical forces of the inorganic world.

Over one thousand organic compounds, which but a few years since were supposed to be formed within the vegetable or animal body only by the action of a "vital force," are now produced synthetically from the elements which constitute them, and "there is every reason to expect," says the conservative but able author of "The New Chemistry," Professor Cooke, "that in the no distant future the chemist will be able to prepare, in his laboratory, both the material of which the cell is fashioned and the various products with which it becomes filled during life."

It is true that the knowledge of man has not yet enabled him to make a vegetable or an animal cell, but this is no evidence in favor of a "vital force" *per se*, but an indication of ignorance relative to the ultimate constitution of the cell. Indeed, pseudo-organic forms, which resemble living cells, having heterogeneous contents, and true inclosing membranes possessing dialyzing power, have already been reported as produced by Monnier and Vogt.

It is well, however, to remind ourselves of the fact that the "cell," as commonly understood, embracing a cell-wall and an internal nucleus, represents in itself an advanced condition of organization, and not, as is so often inferred, the most primitive and simplest of life-forms. "Cell," in biology, "is a technical term used to denote a unit of living tissue," and the fact that the chemist can not make it is not proof that an independent life-principle resides in it, but is proof of ignorance of its organic formation.

If the fact of a "vital force," distinct from physical and chemical forces, is to be established because of inability to make by synthesis a living cell, then, in logical fairness, should this force, or some other equally independent of physical and chemical laws, be declared to preside over the genesis and potencies of those inorganic elements and bodies which thus far have defied, not synthesis only, but analysis also.

In germinal matter is found the apparent seat of life, for this it is that transforms pabulum to build the tissues at first, and in it lies the potency of restoring to physical completeness portions of the body that may be injured or diseased. The repair of living tissues after mutilation is not, however, positive evidence of the existence of a special principle, for the same action occurs in inorganic materials.

Pasteur records the fact that "when a crystal is broken on any one of its faces, and replaced in the fluid of crystallization, we remark that while the crystal increases in all directions by the deposit of crystalline particles, a very decided simultaneous action takes place at the broken or injured part, and this action suffices in a few hours, not merely for the general, regular formation of increase over all parts of the crystal, but also for the restoration of regularity in the injured part." Shall we ascribe a "vital principle" to the unorganized crystal as well as to the organized vegetable or animal tissue?

The mysteries of nature are not all confined to life-expressions. Who shall explain the ultimate nature of crystallization, which, under the laws of fixed axial ratios, gives to each variety such definite and invariable form? Who shall explain the flower's perfume? Where is the "vital force" in the seed which lies for ages in the tomb of some Pharaoh? Does "vital force," as an independent entity, which works contrary to physical and chemical laws, thus imprison itself and voluntarily submit to what must be, to it, a death? If it acts independently of the physical forces of nature, why has it not furnished evidence thereof in some way or at some time? How is life made active in this seed so long dried and practically dead? Not by any occult influence at discord with organic growth, but simply by environing the seed with conditions favorable to physical well-being. Heat, light, and moisture—all physical and chemical agents—soon revivify this seed, and evidence is added to sustain the proposition that, while "the present state of knowledge furnishes us with no link between the living and the not-living," yet are both actuated by forces of the same kind. "Vital force," therefore, is, in reality, only another term for the properties of matter; it denotes simply the causes of certain great groups of natural operations, as we employ the terms "electricity" and "electrical force" to denote others. But to use the term "vitality" or "vital force" in the sense of an entity, which acts as an efficient cause of vital phenomena, is an assumption as absurd as to assume that "'electric,' 'attractive,' and 'chemical' forces are entities which determine the phenomena of electricity, chemism, and gravitation."

"If we knew all the laws of the composition of matter, and all the changes of which it is capable, every phenomenon which any given substance presents must be caused either by something taking place in the substance or by something taking place out of it, but acting upon it. Those mysterious forces, whether they be emanations from matter or whether they be merely properties of matter, must, in an ultimate analysis, depend either on the internal arrangement or on the external locality of their physical antecedents. However convenient, therefore, it may be, in the present state of our knowledge, to speak of vital principles, imponderable fluids, and elastic ethers, such terms can only be provisional, and are to be considered as mere names for that residue of unexplained facts which it will be the business of future ages to bring under generalizations wide enough to cover and include the whole."

As mechanical energy manifests different powers and results as it operates through differently constructed mechanisms, so vital energy becomes more complex in its manifestations as the organism through which its work is displayed is more complicated in structure.

Jevons has well defined the physiological significance of "vital force" thus: "We are at freedom to imagine the existence of a new agent, and to give it an appropriate name, provided there are phenomena incapable of explanation from known causes. We may speak of vital force as occasioning life, provided that we do not take it to be more than a name for an undefined something giving rise to inexplicable facts, just as the French chemists called iodine the substance *x*, so long as they were unaware of its real character and place in chemistry. Encke was quite justified in speaking of the resisting medium in space so long as the retardation of his comet could not be otherwise accounted for.

"But such hypotheses will do much harm whenever they divert us from attempts to reconcile the facts with known laws, or when they lead us to mix up discrete things.

"Because we speak of vital force we must not assume that it is a really existing physical force like electricity. We do not know what it is; we have no right to confuse Encke's supposed resisting medium with the bases of light without distinct evidence of identity. The name protoplasm, now so familiarly used by physiologists, is doubtless legitimate so long as we do not mix up different substances under it, or imagine that the name gives us any knowledge of the obscure origin of life. To name a substance protoplasm no more explains the infinite variety of forms of life which spring out of the substance than does the vital force which may be supposed to reside in the protoplasm. Both expressions are mere names for an inexplicable series of causes which, out of apparently similar conditions, produce the most diverse results."

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XXVI.

THERE is one more constituent of animal food that demands attention before leaving this part of the subject. This is the fat. We all know that there is a considerable difference between raw fat and cooked fat; but what is the *rationale* of this difference? Is it anything beyond the obvious fusion or semi-fusion of the solid?

These are very natural and simple questions, but in no work on chemistry or technology can I find any answer to them, or even any attempt at an answer. I will therefore do the best I can toward solving the problem in my own way.

All the cookable and eatable fats fall into the class of "fixed oils," so named by chemists to distinguish them from the "volatile oils," otherwise described as "essential oils." The distinction between these two classes is simple enough. The volatile oils (mostly of vegetable origin) may be distilled or simply evaporated away like water or alcohol, and leave no residue. The fixed oils similarly treated are dissociated more or less completely.

Otherwise expressed, the boiling-point of the volatile oils is below their dissociation-point. The fixed oils are those which are dissociated at a temperature below their boiling-point.

My object in thus expressing this difference will be understood upon a little reflection. These volatile oils, when heated, being distilled without change are uncookable; while the fixed oils if similarly heated suffer various degrees of change as their temperature is raised, and may be completely decomposed by steady application of heat in a closed vessel without the aid of any other chemical agent than the heat itself. This "destructive distillation" converts them into solid carbon and hydrocarbon gases, similar to those we obtain by the destructive distillation of coal.

If we watch the changes occurring as the heat advances to this complete dissociation-point, we may observe a gradation of minor or partial dissociation proceeding gradually onward, resembling that which I have already described as occurring when sugar is similarly treated (see No. XIII of this series).

But in ordinary cooking we do not go so far as to carbonize the fat itself, though we do brown or partially carbonize the membrane which envelops the fat. What, then, is the nature of this minor dissociation, if such occurs?

Before giving my answer to this question, I must explain the chemical constitution of fat. It is a compound of a very weak base with very weak acids. The basic substance is glycerine, the acids (not sour at all, but so named because they combine with bases as the actually sour acids do) are stearic acid, palmitic acid, oleic acid, etc., and bear the general name of fatty acids. They are solid or liquid, according to temperature. When solid, they are pearly, crystalline substances; when fused, they are oily liquids.

To simplify, I will take one of these as a type, and that the one which is the chief constituent of animal fats, viz., stearic acid. I have a lump of it before me. Newly broken through, it might at a distance be mistaken for a piece of Carrara marble. It is granular like the marble, but not so hard, and, when rubbed with the hand, differs from the marble in betraying its origin by a small degree of unctuousness, but can scarcely be described as greasy.

I find by experiment that this may be mixed with glycerine without combination taking place; that when heated with glycerine just to its fusing-point, and the two are agitated together, the combination is by no means complete. Instead of obtaining a soft, smooth fat, I obtain a granular fat, small stearic crystals with glycerine among them. It is a *mixture* of stearic acid and glycerine, not a chemical compound; it is stearic acid and glycerine, but not a stearate of glycerine.

A similar separation is what I suppose to occur in the cooking of animal fat. I find that mutton-fat, beef-fat, or other fat when raw, is perfectly smooth, as tested by rubbing a small quantity, free from membrane, between the finger and thumb, or by a still more delicate test of rubbing it between the tip of the tongue and the palate. But dripping, whether of beef, or mutton, or poultry, is granular, as anybody who has ever eaten bread and dripping knows well enough, and the manufacturers of "butterine," or "bosch," know too well, as the destruction or prevention of this granulation is one of the difficulties of their art.

My theory of the cookery of fat is simply that heat, when continued long enough, or raised sufficiently high, effects an incipient dissociation of the fatty acids from the glycerine, and thus assists the digestive organs by presenting the base and the acids in a condition better fitted (or advanced by one stage) for the new combinations demanded by assimilation. Some physiologists have lately asserted that the fat of our food is not assimilated at all—not laid down again as fat, but is used directly as fuel for the maintenance of animal heat. If this is correct, the advantage of the preliminary dissociation is more decided, for the combustible portion of the fat is its fatty acids; the glycerine is an impediment to combustion, so much so that the modern candle-maker removes it, and thereby greatly improves the combustibility of his candles.

It may be that the glycerine of the fat we eat is assimilated like sugar, while the fatty acids act directly as fuel. This view may reconcile some of the conflicting facts (such as the existence of fat in the carnivora) that stand in the way of the theory of the uses of fat food above referred to, according to which fat is not fattening, and those who would "Bant" should eat fat freely to maintain animal heat, while very abstemious in the consumption of sugar and farinaceous food.

The difference between tallow and dripping is instructive. Their origin is the same; both are melted fats—beef or mutton fats—and both contain the same fatty acids and glycerine, but there is a visible and tangible difference in their molecular condition. Tallow is smooth and homogeneous, dripping decidedly granular.

I attribute this difference to the fact that, in rendering tallow, the heat is maintained no longer than is necessary to effect the fusion; while, in the ordinary production of dripping, the fat is exposed in the dripping-pan to a long continuance of heat, besides being highly heated when used in basting. Therefore the dissociation is carried further in the case of the dripping, and the result becomes sensible. I have observed that home-rendered lard, that obtained in English farm-houses, where the "scratchings" (i. e., the membranous parts) are frizzled, is more granular than the lard we now obtain in such abundance from Chicago and other wholesale hog-regions. I have not witnessed the lard-rendering at Chicago, but have little doubt that economy of fuel is practiced in conducting it, and therefore less dissociation would be effected than in the domestic retail process.

Some of the early manufacturers of "bosch" purified their fat by the process recommended and practiced by the French Academicians MM. Dubrunfaut and Fua (see "Comptes Rendus," vol. lxxi) during the siege of Paris, when they and others read papers on the manufacture of "siege-butter" without the aid of the dairy. This consisted in frying the refuse fat from slaughter-houses until the membranous matter and other impurities were carbonized, and thus could be strained away. I wrote about it in 1871, and consequently received some samples of artificial butter thus made in the midlands. It was pure fat, perfectly wholesome, but, although colored to imitate butter, had the granular character of dripping. Since that time great progress has been made in this branch of industry. I have lately tasted samples of pure "bosch" or "oleomargarine" undistinguishable from churned cream or good butter, though offered for sale at 8½*d.* per pound in wholesale packages. In the preparation of this I understand high temperatures are carefully avoided, and by this means the smoothness of pure butter is obtained. I mention this now merely in confirmation of my theory of the *rationale* of fat-cookery, but shall return to this subject of "bosch" or "butterine" again, as it has considerable intrinsic interest in reference to our food-supplies, and should be better understood than it is.

XXVII.

The cookery of milk is very simple, but by no means unimportant. That there is an appreciable difference between raw and boiled milk may be proved by taking equal quantities of each (the boiled sample having been allowed to cool down), adding them to equal quantities of the same infusion of coffee, then critically tasting the mixtures. The difference is sufficient to have long since established the practice among all skillful cooks of scrupulously using boiled milk for making *café au lait.* I have tried a similar experiment on tea, and find that in this case the cold milk is preferable. Why this should be, why boiled milk should be better for coffee and raw milk for tea, I can not tell. If any of my readers have not done so already, let them try similar experiments with condensed milk, and I have no doubt that the verdict of the majority will be that it is passable with coffee, but very objectionable in tea. This is milk that has been very much cooked.

The chief definable alteration effected by the boiling of milk is the coagulation of the small quantity of albumen which it contains. This rises as it becomes solidified, and forms a skin-like scum on the surface, which may be lifted with a spoon and eaten, as it is perfectly wholesome and very nutritious.

If all the milk that is poured into London every morning were to flow down a single channel, it would form a respectable little rivulet. An interesting example of the self-adjusting operation of demand and supply is presented by the fact that, without any special legislation or any dictating official, the quantity required should thus flow with so little excess that, in spite of its perishable qualities, little or none is spoiled by souring, and yet at any moment anybody may buy a pennyworth within two or three hundred yards of any part of the great metropolis. There is no record of any single day on which the supply has failed, or even been sensibly deficient.

This is effected by drawing the supplies from a great number of independent sources, which are not likely to be simultaneously disturbed in the same direction. Coupled with this advantage is a serious danger. It has been unmistakably demonstrated that certain microbia (minute living abominations) which disseminate malignant diseases may live in milk, feed upon it, increase and multiply therein, and by it be transmitted to human beings with very serious and even fatal results.

I speak the more feelingly on this subject, having very recently had painful experience of it. One of my sons went for a holiday to a farm-house in Shropshire, where many happy and health-giving holidays have been spent by all the members of my family. At the end of two or three weeks he was attacked by scarlet fever, and suffered severely. He afterward learned that the cow-boy had been ill, and further inquiry proved that his illness was scarlet fever, though not acknowledged to be such ; that he had milked before the scaling of the skin that follows the eruption could have been completed, and it was therefore, most probable, that some of the scales from his hands fell into the milk. My son drank freely of uncooked milk, the other inmates of the farm drinking home-brewed beer, and only taking milk in tea or coffee hot enough to destroy the vitality of fever-germs. He alone suffered. This infection was the more remarkable, inasmuch as a few months previously he had been assisting a medical man in a crowded part of London where scarlet fever was prevalent, and had come in frequent contact with patients in different stages of the disease.

Had the milk from this farm been sent to London in the usual manner in cans, and the contents of these particular cans mixed with those of the rest received by the vender, the whole of his stock would have been infected. As some thousands of farms contribute to the supplying of London with milk, the risk of such contact with infected hands occurring occasionally in one or another of them is very great, and fully justifies me in urgently recommending the manager of every household to strictly enforce the boiling of every drop of milk that enters the house. At the temperature of 212° the vitality of all dangerous germs is destroyed, and the boiling-point of milk is a little above 212°. The temperature of tea or coffee, as ordinarily used, may do it, but is not to be relied upon. I need only to refer generally to the cases of wholesale infection that have recently been traced to the milk of particular dairies, as the particulars are familiar to all who read the newspapers.

It is an open question whether butter may or may not act as a dangerous carrier of such germs; whether they rise with the cream, survive the churning, and flourish among the fat. The subject is of vital importance, and yet, in spite of the research-fund of the Royal Society, the British Association, etc., we have no data upon which to base even an approximately sound conclusion.

We may theorize, of course; we may suppose that the bacteria, bacilli, etc., which we see under the microscope to be continually wriggling about or driving along, are doing so in order to obtain fresh food from the surrounding liquid, and therefore that, if imprisoned in butter, they would languish and die. We may point to the analogies of ferment-germs which demand nitrogenous matter, and therefore suppose that the pestiferous wanderers can not live upon a mere hydrocarbon like butter. On the other hand, we know that the germs of such things can remain dormant under conditions that are fatal to their parents, and develop forthwith when released and brought into new surroundings. These speculations are interesting enough, but in such a matter of life and death to ourselves and our children we require positive facts, direct microscopic evidence.

In the mean time the doubt is highly favorable to *bosch*. To illustrate this, let us suppose the case of a cow grazing on a sewage-farm manured from a district on which enteric fever has existed. The cow lies down and its teats are soiled with liquid containing the germs which are so fearfully malignant when taken internally. In the course of milking, a thousandth part of a grain of the infected matter containing a few hundred germs enters the milk, and these germs increase and multiply. The cream that rises carries some of them with it, and they are thus in the butter, either dead or alive, we know not which, but have to accept the risk.

Now, take the case of bosch. The cow is slaughtered. The waste fat, that before the days of palm-oil and vaseline was sold for lubricating machinery, is skillfully prepared, made up into two-pound rolls, delicately wrapped in special muslin or prettily molded and fitted into "Normandy" baskets. What is the risk in eating this?

None at all, provided always the bosch is not adulterated with cream-butter. The special disease-germs do not survive the chemistry of digestion, do not pass through the glandular tissues of the follicles that secrete the living fat, and therefore, even though the cow should have fed on sewage-grass, moistened with infected sewage-water, its fat would not be poisoned.

What we require in connection with this is commercial honesty, that the thousands of tons of bosch now annually made be sold as bosch, or, if preferred, as "oleomargarine," or "butterine," or any other name that shall tell the truth. In order to render such commercial honesty possible to shopkeepers, more intelligence is demanded among their customers. A dealer, on whom I can rely, told me lately that if he offered the bosch or butterine to his other customers as he was then offering it to me at 8½*d.* per pound in twenty-four-pound box, or 9*d.* retail, he could not possibly sell it, and his reputation would be injured by admitting that he kept it ; but that the same people who would be disgusted with it at 9*d.* will buy it freely at double the price as prime Devonshire fresh butter ; and he added, significantly, "I can not afford to lose my business and be ruined because my customers are fools." To pastry-cooks and others in business, it is sold honestly enough for what it is, and used instead of butter.

Before leaving the subject of animal food I may say a few words on the latest and perhaps the greatest triumph of science in reference to food-supply—i. e., the successful solution of the great problem of preserving fresh meat for an almost indefinite length of time. It has long been known that meat which is frozen remains fresh. The Aberdeen whalers were in the habit of feasting their friends on returning home on joints that were taken out fresh from Aberdeen and kept frozen during a long Arctic voyage. In Norway, game is shot at the end of autumn, and kept in a frozen state for consumption during the whole winter and far into the spring.

The early attempts to apply the freezing process for the carriage of fresh meat from South America and Australia by using ice, or freezing mixtures of ice and salt, failed, but now all the difficulties are overcome by a simple application of the great principle of the conservation of energy, whereby the burning of coal may be made to produce a degree of cold proportionate to the amount of heat it gives out in burning.

Carcasses of sheep are thereby frozen to stony hardness immediately they are slaughtered in New Zealand and Australia, and then packed in close refrigerated cars, carried to the ship, and there stowed in chambers refrigerated by the same means, and thus brought to England in the same state of stony hardness as that originally produced. I dined to-day on one of the legs of a sheep that I bought a week ago and which was grazing at the antipodes three months before. I prefer it to any English mutton ordinarily obtainable.

The grounds of this preference will be understood when I explain that English farmers who manufacture mutton as a primary product kill their sheep as soon as they are full grown, when a year old or less. They can not afford to feed a sheep for two years longer merely to improve its flavor without adding to its weight. Country gentlemen who do not care for expense occasionally regale their friends on a haunch or saddle of three-year-old mutton, as a rare and costly luxury.

The antipodean graziers are wool-growers. Until lately, mutton was merely used as manure, and even now it is but a secondary product. The wool-crop improves year by year until the sheep is three or four years old; therefore, it is not slaughtered until this age is attained, and thus the sheep sent to England are similar to those of the country squire, and such as the English farmer could not send to market under eighteen pence per pound.

There is, however, one drawback; but I have tested it thoroughly, having supplied my own table during the last six months with no other mutton than that from New Zealand, and find it so trifling as to be imperceptible unless critically looked for. It is simply that, in thawing, a small quantity of the juice of the meat oozes out. This is more than compensated by the superior richness and fullness of flavor of the meat itself, which is much darker in color than young mutton. —*Knowledge.*

A DEFENSE OF MODERN THOUGHT.*

By WILLIAM D. LE SUEUR, B. A.

FROM the point of view of the present writer, there are good reasons for believing that a general readjustment of thought is now in progress, and that it is destined to go on until old forms of belief, inconsistent with a rational interpretation of the world, have been completely overthrown. This progressive readjustment is not a thing of yesterday; it is simply that gradual abandonment of the theological stand-point which has been taking place throughout the ages. As a modern philosopher has remarked, the very conception of *miracle* marks the beginnings of rationalism, seeing that it recognizes an established order of things, a certain "reign of law," with which only supernatural power can interfere. The progress beyond this point consists in an increasing perception of the universality of law, and an increasing disposition to be exacting as to the evidences of miracle. No candid person can read the history of modern times without arriving at the conclusion that the whole march of civilization illustrates, above everything else, this gradual change of intellectual stand-point. Man's power keeps pace ever with his knowledge of natural law and his recognition of the uniformity of its operations. What we see to-day is simply the anticipation by thousands of the conclusion to which all past discoveries and observations have been pointing, that the reign of law is and always has been absolute. This is really what "agnosticism," so called, means. It means that thinking men are tired of the inconsistencies of the old system of belief, and that they de-

* From a pamphlet reply to a lecture on "Agnosticism," delivered by the Lord Bishop of Ontario.

sire to rest in an order of conceptions not liable to disturbance. The great Faraday, who had not brought himself to this point, used to say that when he had to deal with questions of faith he left all scientific and other human reasonings at the door, and that when he had to deal with questions of science he discarded in like manner all theological modes of thought. The region of science was one region, that of faith was another ; and between these he placed a wall so high that once on either side he could see nothing that lay on the other. He did not attempt to reconcile faith with science, as some do ; he separated them utterly, feeling them apparently to be irreconcilable. Thus he virtually lived in two worlds—one in which no miracles took place, but in which everything flowed in an orderly manner from recognized antecedents, and another in which the chain of causation might be broken at any moment by supernatural power. Since Faraday's time, however, men of science have grown bolder. They have renounced the attempt to live a divided life. They do not believe in insuperable barriers between one field of thought and another. They believe in the unity of the human mind and in the unity of truth. They have made their choice—those of them at least whom the Bishop of Ontario designates as agnostics—in favor of a world in which cause and effect maintain constant relations. In doing so they do not act willfully, but simply yield to the irresistible weight of evidence. Miracle is a matter of more or less uncertain testimony, while the unchangeableness of natural law is a matter of daily observation. Miracles never happen in the laboratory. Supernatural apparitions do not haunt the museum. Distant ages and countries or lonely road-sides reap all the glory of these manifestations. What wonder, then, that the man of science prefers to trust in what his eyes daily see and his hands handle, rather than in narratives of perfervid devotees, or in traditions handed down from centuries whose leading characteristic was an omnivorous credulity ? There is nothing negative in this attitude of mind. On the contrary, it is positive in the highest degree. The true man of science wants to know and believe as much as possible. He desires to know what *is* and to adapt his thoughts to that ; and the universe is to him simply an inexhaustible treasure-house of truths, all of more or less practical import.

It is right, however, before proceeding further, to examine this word "agnosticism" a little, to see whether it is one that is really serviceable in the present controversy. That some have been willing to apply the term to themselves and to regard it as rather *ben trovato,* I am quite aware ; but I think there are good reasons why serious thinkers should decline to call themselves by such a name, and should object to its application to them by others.

A question proposed for discussion either can or can not be settled ; it either lies within or beyond the region in which verification is possible. If it lies within that region, no man should call himself an agnostic in regard to it. He may withhold his judgment until the evidence is complete, but suspension of judgment is not agnosticism, which, if it means anything, means a profession of hopeless and, so to speak, invincible ignorance in regard to certain matters. But if it would be absurd for a man to profess himself an agnostic in regard to problems admitting or believed to admit of solution, is it not idle for any one to accept that designation because he believes that there are other problems or propositions which do not admit of solution? All one has to do in relation to the latter class of problems is to recognize their unreal or purely verbal character. It is the nature of the problem that requires to be characterized, not our mental relation thereto. The latter follows as a matter of course from the former. Moreover, why should any one wish or consent to be designated by a term purely negative in its meaning? It is what we know, not what we do not know, that should furnish us with a name, if it is necessary to have one. The little that a man knows is of vastly more consequence to him than all the untrodden continents of his ignorance. The chemist calls himself so because he professes to have a knowledge of chemistry: he does not invent for himself a name signifying his ignorance of political economy or metaphysics. Why, then, should any man adopt a name which defines his relation not to things that he knows or to questions to which he attributes a character of reality, but to things that he does not know and to questions which, so far as he can see, have no character of reality? Let others give him such a name if they will, but let no man voluntarily tie himself to a negation.

There are some, as I believe, who have adopted the appellation of agnostic thoughtlessly: some through indolence, as appearing to exempt them from the necessity of a decision in regard to certain difficult and, in a social sense, critical questions; and some possibly for the reason hinted at by the Bishop of Ontario, namely, lack of the courage necessary to take up a more decided position. Whatever the motive may be, however, I am persuaded that the term is a poor one for purposes of definition; and I should advise all earnest men, who think more of their beliefs than of their disbeliefs, to disown it so far as they themselves are concerned. If it be asked by what appellation those who do not believe in "revealed religion" are to be known, I should answer that it is not their duty to coin for themselves any sectarian title. They are in no sense a sect. They believe themselves to be on the high-road of natural truth. It is they who have cast aside all limited and partial views, and who are opening their minds to the full teaching of the universe. Let their opponents coin names if they will: they whom the truth has made free feel that their creed is too wide for limitation.

The Bishop of Ontario stands forth in the pamphlet before us simply as the champion of the two great doctrines of God and immortality. In reality, however, he is the champion of much more, for he does not profess that these doctrines can stand by themselves apart from a belief in revelation. The issue between the bishop and those whom he styles agnostics is not really as to these two abstract doctrines, but as to the validity of the whole miraculous system of which his lordship is a responsible exponent. If we can imagine a person simply holding, as the result of his own individual reasonings or other mental experiences, a belief in God as a spiritual existence animating and presiding over the works of Nature, and a further belief in a future existence for the human soul, I do not see that there would necessarily be any conflict between him and the most advanced representatives of modern thought. No, the trouble does not begin here. The trouble arises when these beliefs are presented as part and parcel of a supernatural system miraculously revealed to mankind, and embracing details which bring it plainly into conflict with the known facts and laws of Nature. To detach these two doctrines, therefore, from the system to which they belong, and put them forward as if the whole stress of modern philosophical criticism was directed against them in particular, is a controversial artifice of a rather unfair kind.

We are reminded by the right reverend author that no chain is stronger than its weakest link, and we are asked to apply the principle to the doctrine of evolution, some of the links of which his lordship has tested and found unable to bear the proper strain. The principle is undoubtedly a sound one; but has it occurred to his lordship that it is no less applicable to the net-work of doctrine in which he believes than to the doctrine of evolution? Some links of that net-work are snapping every day under no greater strain than the simple exercise of common sense by ordinary men. It is a beautiful and well-chosen position that his lordship takes up as champion of the doctrines of God and immortality against "agnostic" science; but it would have argued greater courage had the banner been planted on the miraculous narratives of the Old and New Testament. A gallant defense of the scriptural account of the taking of Jericho, of the arresting for a somewhat sanguinary purpose of the earth's rotation, of the swallowing of Jonah by a whale, and his restoration to light and liberty after three days and nights of close and very disagreeable confinement, of the comfortable time enjoyed by Shadrach, Meshach, and Abednego in the fiery furnace, of the feeding of five thousand men with five loaves and two fishes and the gathering up of twelve basketfuls of the fragments—a gallant defense, I say, of these things would be very much more in order; for *these* are the links that criticism has attacked and which the common judgment of the nineteenth century is daily invalidating. Modern philosophy in its negative aspect is simply a revolt against the attempt to force such narratives as these upon the adult intelligence of mankind—against the absurdity of assigning to Hebrew legends of the most monstrous kind a character of credibility which would be scornfully refused to similar productions of the imagination of any other race. Let there, then, be no misunderstanding : science is not concerned to prove that there is no God, nor even that a future life is an impossibility ; it simply obeys an instinct of self-preservation in seeking to repel modes of thought and belief which, in their ultimate issues, are destructive of all science.

One has only to reflect for a moment, in order to see how much theological baggage the orthodox disputant throws away, when he confines his arguments to the two points of God and a future life. Were it thrown away in sincerity, argument might cease ; but no, the manœuvre is first to make a formidable demonstration as champion of two cardinal doctrines which in themselves arouse little opposition, even where they do not commend assent, and then to apply the results of the proceeding to the benefit of those parts of the system which had been kept in the background. It is not in the interest of a simple theistic belief, unconnected with any scheme of theology, that the Bishop of Ontario writes : what he has at heart, I venture to say, is that men may believe as he does. The theism of Francis Newman, or of Victor Hugo, or Mazzini—all convinced theists—would be very unsatisfactory in his eyes, and it may be doubted whether he would take up his pen for the purpose of promoting theism of this type. It should, therefore, be thoroughly understood that, while his lordship is professedly combating agnosticism, he is really waging war on behalf of that elaborate theological system of which he is an exponent—that system which bids us look to the Bible for an account of the creation of the world and of man ; and which requires us to believe that the Creator found it necessary in former times, for the right government of the world, to be continually breaking through the laws of physical succession which he himself had established. In arguing against the doctrine of evolution, he labors to establish the opposite doctrine of the creation and government of the world *by miracle.*

The question therefore is, Can science be free and yet accommodate itself to the whole elaborate scheme of Christian orthodoxy? The great majority of those who are most entitled to speak on behalf of science say No ; and it is this negative which his lordship of Ontario converts into a denial of the two doctrines above-mentioned. But let those who are at all familiar with the course of modern thought ask themselves if they recall in the writings of any leading philosopher of the day arguments specially directed against the hypothesis of God, or even against that of a possible future state of existence for humanity. What every one can at once remember is, that the writers who are called "agnostics," the Spencers, Huxleys, Tyndalls, and Darwins, plead for the universality of Nature's laws and the abiding uniformity of her processes. That is what they are concerned to maintain, because it is upon that that all science depends. Scientific men in general are but little disposed to disturb any one's faith in God or immortality, so long as these doctrines are not associated with or put forward as involving others which really invade the domain of science and tend to cast uncertainty upon its methods and results.

In seeking to account for "the modern spread of agnosticism," the bishop finds that it is to "the widely-spread popularity of the theory of evolution, leading as it does to materialism," that the phenomenon is to be attributed. Consequently the theory of evolution must be destroyed. The Episcopal edict has gone forth, and the Episcopal batteries are raised against this later Carthage of infidelity. But, alas! it does not sufficiently appear that the right reverend director of the siege understands either the nature of the task he has undertaken or the significance which would attach to success could he achieve it. To take the latter point first: science was making very rapid progress before the evolution theory had acquired any wide popularity, before in fact anything was known of it outside of one or two speculative treatises; and already the opposition of science to a scheme which makes this earth the theatre of miracle-working power was well marked. Twenty-two years ago, when "The Origin of Species" was but two years old, and had still a great deal of opposition to encounter even from men of science, before even the term evolution had any currency in the special sense it now bears, a leading prelate of the Church of England, Bishop Wilberforce, discerned a skeptical movement "too wide-spread and connecting itself with far too general conditions" to be explained otherwise than as "the first stealing over the sky of the lurid lights which shall be shed profusely around the great Antichrist." * To charge the present intellectual state of the world, therefore, on the doctrine of evolution is to ignore that general movement of thought which, before the idea of evolution was a factor of any importance in modern speculation, had already, as the Bishop of Oxford testified, carried thousands away from their old theological habitations, and which, with or without the theory of evolution, was quite adapted to produce the state of things which we see to-day in the intellectual world.

The doctrine of evolution is simply the form in which the dominant scientific thought of the day is cast. As a working hypothesis it presents very great advantages; and the thinkers of to-day would find it hard to dispense with the aid it affords. But supposing it could be shown that the doctrine, as at present conceived, was untenable—what then? Would men of science at once abandon their belief in the invariability of natural law and fly back to mediæval superstitions? By no means. If there is any class of men who have learned the lesson that the spider taught to Bruce, it is the class of scientific workers. Destroy one of their constructions and they set to work again, with unconquerable industry, to build another. In fact, they are always testing and trying their own constructions; and we may be sure that if the evolution theory is ever to be swept away it will

* *Vide* preface to "Replies to Essays and Reviews."

be by scientific not theological hands. It holds its ground now, because it is a help to thought and investigation; if it should ever become so beset with difficulties as to be no longer serviceable, it will be withdrawn from use, as many a theory has been before it, and as many a one will be in the days to come. Among contemporary men of science there is probably none who believes more strongly in the doctrine in question than the editor of "The Popular Science Monthly"; yet in a recent number of his magazine he has marked his attitude toward it in a manner which for our present purpose is very instructive. "It is undeniable," he writes, "that the difficulties in the way of the doctrine of evolution are many and formidable, and it will no doubt take a long time to clear them up; while the solution of still unresolved problems will very possibly result in important modifications of the theory as now entertained. But the establishment of the doctrine of evolution, as a comprehensive law of nature, is no longer dependent upon its freedom from embarrassments, or that absoluteness of proof which will only become possible with the future extension of knowledge. Notwithstanding these drawbacks, the evidence for it is so varied, so consistent, and so irresistible, as to compel its broad acceptance by men of science, who, while disagreeing upon many of its questions, find it indispensable as a guide to the most multifarious investigations."

We now come to the further question of the validity of the criticisms directed in the pamphlet before us against the doctrine of evolution, in discussing which the competency of the critic for his self-imposed task will necessarily come more or less under consideration. Let us first notice the quotations which his lordship brings forward, remembering that the doctrine of evolution in its present shape may be said to be the work of the last twenty years. Well, his lordship quotes three leading scientific authors—Owen, Agassiz, and Lyell; but it is noticeable that in no case does he give the date of his quotation, and in the case of the first two does not even mention the work in which the passage he refers to is to be found. The quotations are intended to show that these eminent authors rejected the doctrine of the "origin of species by natural selection." As regards Agassiz, who died ten years ago, every one knows that this was the case; and most are also aware that the great Swiss naturalist left behind him a son, a naturalist almost equally great, who supports the Darwinian theory as strongly as his father opposed it. Owen, though not a Darwinian in the full sense, held views which were clearly in the direction of natural selection. It is, however, when we come to Lyell that we have cause for astonishment. Here we have the most eminent of English geologists, whose adhesion to the Darwinian theory, announced for the first time in 1863—the date of the publication of the first edition of his "Antiquity of Man"—created such a sensation in the scientific world, quoted, at this time of day, as an anti-Darwinian! What are we to think of this? I can not and do not believe, nor would I wish to suggest, that the Right Reverend the Bishop of Ontario was carried so far in his zeal against evolution as deliberately to misrepresent Sir Charles Lyell's attitude toward that doctrine. The only other hypothesis, however, is that of extreme ignorance. Of this his lordship must stand, not only accused, but convicted. The fact of Sir Charles Lyell's conversion to the views of Darwin on the origin of species was one of which the whole reading world took note at the time, and which has been known to every tyro in general science from that day to this. His lordship, quoting from the "Principles of Geology," but without any mention of edition, represents Sir Charles as holding "that species have a real existence in nature, and that each was endowed at the time of its creation with the attributes and organization by which it is now distinguished." That these *were* Sir Charles Lyell's views when the earlier editions of his "Principles" were published every one is aware; but it is a most extraordinary thing that any one should have quoted them as his full twenty years after he had distinctly abandoned them. The preface to the fourth edition of the "Antiquity of Man" opens as follows: "The first edition of the 'Antiquity of Man' was published in 1863, and was the first work in which I expressed my opinion of the prehistoric age of man, and also my belief in Mr. Darwin's theory of the 'Origin of Species' as the best explanation yet offered of the connection between man and those animals which have flourished successively on the earth." In the tenth edition of his "Principles," published in 1868, he says (page 492) that "Mr. Darwin, without absolutely proving this (theory), has made it appear in the highest degree probable, by an appeal to many distinct and independent classes of phenomena in natural history and geology." Darwin himself would not have claimed more for his theory than this. Professor Huxley would not claim more for it to-day. Enough for either of them the admission that, by arguments drawn from many quarters, it had been rendered "in the highest degree probable." In his "Antiquity of Man,"* Sir Charles Lyell expressly acknowledges the inconclusiveness of the arguments he had used at an earlier date to prove that "species were primordial creations and not derivative." His reasonings, he frankly confesses, could not hold their ground "in the light of the facts and arguments adduced by Darwin and Hooker." As regards the "descent of man," after quoting a passage from Darwin to the effect that "man is the co-descendant with other mammals of a common progenitor," he observes that "we certainly can not escape from such a conclusion without abandoning many of the weightiest arguments which have been urged in support of variation and natural selection considered as the subordinate causes by which new types have been gradually introduced into the world." On every point, therefore, the real views of Sir Charles Lyell, as formed in the

* See fourth edition, p. 469.

light of the facts adduced by Darwin and of his own maturer reasonings, were totally opposed to those quoted in the bishop's pamphlet. Is it not remarkable, such being the case, that not one member of the reverend and learned clergy of the diocese of Kingston, by whose special request this document was given to the world, should have suggested a correction on this point? Was there not a lay delegate who could have done it; or were they all—bishop, clergy, and laymen—equally in the dark? It would really seem so. Who can wonder that the doctrine of evolution does not make much progress in certain quarters?

Sir Charles Lyell unfortunately is not the only author misrepresented. Huxley is said to "discredit" the origin of life from non-living matter. Huxley does nothing of the kind; he simply says that the experiments heretofore made to show that life can be so developed have not been successful. On the page of the pamphlet immediately preceding that on which this statement is made in regard to Huxley, we are informed, correctly, that the same great naturalist professes "a philosophic faith in the probability of spontaneous generation." Surely his lordship could not have understood the force of these words, or he would not have said, almost immediately after, that "the origin of life on earth . . . is not only discredited * by Huxley but by many other great scientists." A writer who finds such comparatively simple language beyond his comprehension is not, one would judge, very well fitted to enter the lists against the leading thinkers of the day, except perhaps for strictly diocesan purposes.

That his lordship is really hopelessly at sea in discussing this question is evident by many signs. Such sentences as the following speak volumes for the mental confusion of their author: "Agnosticism takes refuge in evolution in order to get rid of the idea of God as unthinkable and unknowable." Here, again, inaccuracies of language. An idea may be unthinkable in the sense of not admitting of being *thought out*, but can an idea be said to be "unknowable"? What is an unknowable idea? An idea must be known in order to be an idea at all. But this mere verbal inaccuracy is not the worst. We had been told that agnosticism was a form of opinion according to which nothing could be known of God. Now, it seems that agnosticism has to fall back on evolution, "in order to get rid of the idea of God as unthinkable and unknowable." Now, the so-called agnosticism could not have been agnosticism in reality, otherwise it would not have required the help of evolution in such a matter. If we ask how evolution helps agnosticism to regard "the idea of God as unthinkable and unknowable," we shall only find the confusion growing worse confounded.

* His lordship means "discredited not only by Huxley, but by etc." The inaccuracy of expression observable here is paralleled in many other passages of the pamphlet. For example, his lordship says, page 5, "They are not content to speak for themselves, but for all the world besides." A bishop should write better English than this.

Evolution has nothing to do with such questions : it is a simple theory as to the mode of generation and order of succession of different forms of existences.

It is, however, when his lordship comes to discuss the doctrine of the survival of the fittest that his sad want of acquaintance with the whole subject shows itself most conspicuously. Let me quote : "By some means or other 'the survival of the fittest in the struggle for existence' is assumed to be a law of Nature, and if it be so our faith is severely taxed. Survival of the fittest—fittest for what? If the answer be, fittest for surviving, we argue in a circle, and get no information whatever. The only rational answer must be, they survive who are fittest for their environments in size, strength, and vigor." Let me here ask what sense the learned author can possibly attach to these last words execpt the very one he had just discarded as meaningless—"fitness to survive"? How is fitness to environment proved except by the actual fact of survival? Do environments always require "size" as an element of fitness? By no means, they sometimes require smallness. When a mouse escapes into a hole, where the cat can not follow, it survives not by reason of its size, but by reason of its smallness. Strength, again, is one element of adaptation to environment, but only one ; and it may fall far below some other element, swiftness, for example, or cunning, in practical importance. The fact, however, that the learned author sees no meaning in the answer "fitness to survive," tells the whole story of his own unfitness for the special environment in which he has placed himself in attempting to discuss the doctrine of evolution, and rather tends to create doubt as to the survival of the work he has given to the world. This is a matter in which no aptitude in quoting Horace is of any avail. The road to an understanding of the terms and conceptions of modern science lies in a careful study at first hand of the works in which these terms and conceptions are expounded. His lordship assumes that, if we say that those survive who are fit to survive, we utter a barren truism. It is a truism we may grant, but not a barren one, any more than the axioms of geometry are barren. The simple word "fitness" implies a definite external something, adaptation to which is the price of existence. The definiteness of the mold involves the definiteness of that which is molded ; and all the miracles of life and organization we see around us are in the last resort merely examples of adaptation to fixed conditions of existence. "Born into life we are," says Matthew Arnold, "and life must be our mold." By "life" understand the universe, and we have a poetical version of the doctrine of the survival of the fittest. It so happens, and this is a further truth which it would not be well to pass over, that adaptation does more or less imply excellence even from the human stand-point. All those adaptations that favor human life and happiness we of course call excellent, even though they may not be favorable to the life and happiness of other living creatures. And as man has thriven mightily and prevailed, adaptation *in general* presents itself to him in a favorable light. Occasionally, when his crops are destroyed by some insect-pest wonderfully adapted for its work, or when his cattle are infested with deadly parasites, or when some germ of disease is multiplying a million-fold in his own frame, he sees that *all* adaptations are not yoked to his especial service.

His lordship seems to suppose that the believers in the doctrine of the survival of the fittest are bound to show that there has been a steady improvement of type from the first dawn of life. To show how gross and inexcusable a misunderstanding this is, I need only quote two sentences from Sir Charles Lyell's "Antiquity of Man": "One of the principal claims," observes the great geologist, "of Mr. Darwin's theory to acceptance is that *it enables us to dispense with a law of progression* as a necessary accompaniment of variation. It will account equally well for what is called degradation or a retrograde movement toward a simpler structure, and does not require Lamarck's continual creation of monads; for this was a necessary part of his system in order to explain how, after the progressive power had been at work for myriads of ages, there were as many beings of the simplest structure in existence as ever." *

Writing thus in ignorance of what the law of the survival of the fittest, as formulated by Darwin, and accepted by modern men of science, really means, his lordship is able to ask such pointless questions as whether the law is illustrated in the slaughtering of the flower of a nation in war, and whether it is the fittest who survive famines, pestilences, shipwrecks, etc. His lordship evidently does not himself believe there is any provision for the survival of the fittest in the providential government of the world; yet, strange to say, he taunts evolutionists with this lack in the general scheme of things. If it be an embarrassment to their theory, how much more should it be to the bishop's theology! The evolutionist might, however, turn round and instruct the divine out of his own pocket Bible, where it is expressly stated that the wicked shall not live out half his days; and then out of the newspapers which continually show us what happens to the violent and bloody man, to the intemperate, and to various other classes of evil-doers. The evolution philosophy does not guarantee, as has been already shown, continuous progress in what, from the human stand-point, may seem the best directions; but evolutionists are able to note, and do note with satisfaction, that the qualities which the moral sense of mankind most approves do in point of fact tend to the survival of their possessors. War itself illustrates the principle; seeing that the most important element of strength abroad is cohesion at home, a condition which must depend on a relatively high development of social justice. To take an example from our own history: English arms would not have been so successful as they have been

* Fourth edition, p. 459.

abroad, had there not been a united country behind them. It was the virtues, not the vices, of the Roman people that enabled them to conquer the world. It was their vices, not their virtues, that led to their fall. Fitness to survive is a quality the import of which varies according to circumstances. In shipwrecks (to pursue his lordship's illustrations) the fit to survive are those who can swim, or who have readiness of resource or strength of constitution. In famines and pestilences the physically stronger will as a rule survive; though here prudence and self-control become also most important elements of safety. Let it always be remembered that the problem with which evolutionary philosophy has to grapple is not how to account for a perfect world, or a perfect state of society, but how to account for just such a mingling of good and evil (accompanied by general tendencies toward good) as we actually witness. This once settled, most of the objections of the theologians would be seen to fall wide of the mark.

To persons unfamiliar, or but slightly familiar, with the present subject, it is possible that the Bishop of Ontario may appear to have touched a weak point in the doctrine under discussion where he says: "Laws of nature should be obeyed and co-operated with, not fought against and thwarted; and, if the survival of the fittest be one of those laws, we ought to abolish all hospitals and asylums for the blind, the deaf, the drunkard, the idiot, and the lunatic, and we ought to expose to death all sickly, puny, and superfluous infants." A word, therefore, in regard to this objection may not be thrown away. The first observation to make is, that there is nothing whatever in the law of the survival of the fittest, as understood by men of science to-day, which could possibly be converted into a rule of conduct. The scientific world is not aware that Nature has any ends in view, or is capable of having any ends in view, which she needs the help of man to enable her to realize. Science does not attribute purpose to Nature. Science has simply obtained a glimmering of how, in point of fact, Nature works. It sees that survival is a question of fitness, in other words a question of the fulfillment of the conditions on which continued existence depends. In some cases, as is well known, superiority of type becomes an impediment, not a help, to the preservation of life; and in a vast number of cases the differentiations on which survival depends imply neither progress nor retrogression.* What moral guidance, therefore, can possibly be found in a simple perception of the fact that in the realm of Nature there are conditions attached to survival? We may ask, in the next place, whether there is any single law of Nature which men "obey," or ever have obeyed, in the sense in which his lordship bids us obey the law of the survival of the fittest.

* *Vide* Spencer, "Principles of Sociology," vol. i, pp. 106, 107; and Haeckel, "History of Creation," vol. i, p. 285.

When a conflagration rages, do we "obey" and "co-operate" with Nature by adding fuel to the flames? When pestilence is abroad, do we try to increase its deadly activity? When we stumble, do we make a point of yielding to the law of gravitation and throwing ourselves headlong? When the winter winds are howling, do we throw open doors and windows that we may feel all the force and bitterness of the blast? Or do we, in these and all other cases, seek to modify the action of one law by that of another—a process his lordship calls "thwarting"—in order that their combined or balanced action may yield us, as nearly as possible, the results we desire? We throw water on the fire. We use disinfectants and prophylactics against the plague. We set muscular force against that of gravitation. We oppose warmth to cold. In none of these cases do we ask what Nature wants; we are content to know what *we* want. We don't really believe that Nature wants anything; so we have no hesitation or compunction in letting our wants rule. In the matter of the weak and sickly, they might perish if unconscious forces alone were at work, or even in certain conditions of human society; but it does not suit *our* interests, for very obvious reasons, to let them perish. To do so would strike at all human affections, and would so far weaken the bonds of society and render the whole social fabric less secure. Moreover, a sick man is very different from a sick animal. The latter is inevitably inferior as an animal, whereas the former may not only not be inferior, but may be superior as a *man*, and capable of rendering much service to society. Two instances occur to me as I write—that of the late Professor Cairnes, in England, and of the late Professor Ernest Bersot, in France, both smitten with cruel and hopeless maladies, but both fulfilling, in an eminent degree, the highest intellectual and moral offices of *men*. What the well do for the sick is of course obvious, and attracts sufficient attention; but what the sick do for the well, not being so obvious, attracts less attention than it deserves. Yet how many lessons of patience, fortitude, and resignation—lessons that all require—come to us from the sick-bed, or at least from those whom weakness of constitution or perhaps some unhappy accident has robbed of a normal activity and health! At times we see superiority of intellectual and moral endowment triumphing over the most serious physical disabilities; as in the case of the present Postmaster-General of England, who accidentally lost his sight when quite a youth. The late M. Louis Blanc, a man of splendid talents, never advanced beyond the stature of a child. The ancient Spartans might have exposed one of so feeble a frame on Taygetus; for with them every man had to be a soldier; but, in modern life, with its greatly diversified interests, many a man too weak to be a soldier can yet render splendid service to the community. It will, therefore, I trust, be sufficiently obvious, first, that Nature has no commands to give us in this matter; and, secondly, that there are excellent reasons why we should not treat the sick and weakly, as the lower animals commonly, but not universally, treat the sick and weakly of their own kind.*

There is, however, another view of this question which should not be overlooked. While human beings in civilized countries manifest, and always have manifested, more or less sympathy with the physically afflicted, their steadfast aim has been to get rid of physical evil in all its forms. No care that is taken of the sick has for its object the perpetuation of sickness, but rather its extirpation. We do not put idiots to death; but when an idiot dies there is a general feeling of relief that so imperfect an existence has come to an end. Were idiots permitted to marry, the sense of decency of the whole community would be outraged. Public opinion blames those who marry knowing that there is some serious taint in their blood; and commends, on the other hand, those who abstain from, or defer, marriage on that account. There is probably room for a further development of sentiment in this direction. We need to feel more strongly that all maladies and ailments are in their nature preventable, inasmuch as they all flow from definite physical antecedents. As long as our views on this subject are tinged in the smallest degree with supernaturalism, so long will our efforts to track disease to its lair and breeding-grounds be but half-hearted. How can we venture to check abruptly, or at all, the course of a sickness sent expressly for our chastisement? Is it for us to say when the rod has been sufficiently applied? How do we dare to fortify ourselves in advance against disease, as if to prevent the Almighty from dealing with us according to our deserts? We vaccinate for small-pox, we drain for malaria, we cleanse and purify for cholera, we ventilate and disinfect, we diet and we exercise—and all for what? Precisely to avoid the paternal chastenings which we have been taught are so good for us, and the origin of which has always been attributed by faith to the Divine pleasure. Evidently our views are undergoing a change. We all wish to be fit to survive, and all more or less believe that it is in our power to be so and to help others to be so. We believe in sanitary science, and, if we attribute any purpose in the matter to the Divine mind, it is that all men should come to the knowledge of the truth, as revealed by a study of Nature, and live.

THE FACULTY OF SPEECH.†

By E. F. BRUSH, M.D.

UNTIL the beginning of this nineteenth century, the mind was considered as a unit. Early in the century, Gall, a distinguished German physician, noted the fact that those students whose super-

* See Romanes, "Animal Intelligence," pp. 471, 475, as to the sympathy exhibited by the monkey tribe toward their sick.

† Read at a meeting of the Mount Vernon Athenæum, January 24, 1883.

orbital plates were depressed sufficiently to produce protruding eyes and baggy under-lids excelled in memory, oratory, philology, and the ability to acquire languages. This observation may be called the foundation of phrenology, for it led Gall to divide the mind into faculties, and to locate the faculty of speech in the anterior lobes of the cerebral hemisphere. This was the basis of his system. But the enthusiasm with which he constructed this system, and the sweeping deductions which he and his follower, Spurzheim, drew from this one prominent fact, failed to interest the scientific mind. Soon after this, without paying any regard to the conclusions of Gall and Spurzheim, the pathologists discovered how frequently the loss of speech co-existed with diseases or injuries of the anterior lobes of the brain, and that sometimes the only symptom of cerebral lesions was a loss of the power of articulate language. These observations led Bouillaud, in 1825, to divide the faculty of speech into two phenomena, internal speech—the faculty to create and to represent ideas—and external speech, or the co-ordinating power necessary to articulate the words created. In medical literature, the loss of the faculty of speech is termed *aphasia*, and when it affects the internal speech it is designated as *amnesic* aphasia, and when external speech is affected the term *ataxic* aphasia expresses it.

But without going into detail respecting the weighty *pros* and *cons* in the discussion of this subject during the last fifty years up to the present time, it is safe to state that the power of speech is *twofold*, namely, *mental* and *motor*. Now, as a mental fact, the faculty of articulate language implies perception, intellectual distribution of perception, excitation of emotion, will to enunciate. As an illustration: we see a man across the street; we recognize him as John Jones, from Johnsonville; we experience pleasure, and say, "My dear friend, I am glad to see you." Thus it will be seen that the mind as regards speech can be divided into perception, intellect, emotion, and will. These are the mental attributes, and the impairment of any one of them will interfere with the culminating act of speech. The perception may be impaired, then the friend across the street would not start the mental train. Furthermore, if perception was perfect and the intellect impaired, we would see the man, perceive the color of his hair and eyes, the style of his clothing, and so forth, but not be conscious that we had met him before, and that he was a friend. Still further, if the emotion was impaired and the two other faculties normal, we would see the man, know he was a friend, but not be stimulated to further action. Again, if the three above faculties were normal and will-power wanting, we would see, recognize, and wish to speak to him, but be powerless to do so. All the best evidence of recent times indicates that these faculties reside in the gray matter which is spread over the surface of the cerebral hemispheres, with their manifold sulci and convolutions, and the depth of which is an index of the intellectual power, rather than the mere mass of the brain, as was previously supposed. Now, this gray matter may be intact and, consequently, all the functions above enumerated may be perfect, and still the ability to articulate may be wanting, because the motor power which is supposed to reside in the white matter, and to preside over the co-ordinating power, controlling the nerves and muscles of articulation, may be impaired, and then, although our ideas may be correct, the ability to express them would be wanting. Medical literature abounds with cases which illustrate this condition. I select the following instance as a perfect illustration of this state: An intelligent man, sixty years old, suddenly became incoherent and quite unintelligible to those around him. He had forgotten the names of every object in nature; his recollection of things seemed to be unimpaired, but the words by which men and things were designated were entirely obliterated from his mind, or rather he had lost the faculty by which they were called up at the control of will. He was, however, by no means inattentive to what was going on, and he recognized friends and acquaintances quickly, but their names, or even his own, or his wife's name, or the names of any of his domestics appeared to have no place in his recollection. One morning, much against the wishes of his family, he went to his workshop, and, when visited by his physician, gave him to understand by a variety of signs that he was perfectly well in every respect, with the exception of some slight sensations referable to the eyes and eyebrows. He was so well in bodily health that he could not be confined to the house, and his judgment, so far as an estimate could be formed of it, was unimpaired, but his memory of words was so much a blank that the monosyllables of affirmation and negation were the only two words of the language the use and signification of which he never entirely forgot. He comprehended perfectly every word that was spoken or addressed to him, and, although he had ideas adequate to form a full reply, the words by which these ideas are expressed seemed entirely obliterated from his mind. By way of experiment, the name of a person or thing was mentioned to him, his own name for example, or that of one of his domestics; he would repeat it once or twice distinctly, but generally before he could do so a third time the word was gone from him as completely as though he had never heard it pronounced. When any one read to him from a book he had no difficulty in perceiving the meaning of the passage, but he could not himself then read. He had forgotten the elements of written language. He became very expert in the use of signs, and his convalescence was marked by his imperceptibly acquiring some general terms which were with him at first of very extensive and varied application. All future events and objects before him were, as he expressed it, "next time"; but past events and objects behind him were designated "last time." One day being asked his age, he pointed to his wife and uttered the words "Many times" repeatedly, as if he meant that he had often told her his age. When she said "Sixty," he answered in the affirmative. Some months afterward he suddenly became paralyzed on the right side, and a few months later died from an attack of apoplexy. His brain was found extensively diseased in the white portion of the anterior lobe of the left hemisphere.

This case was purely and simply an impairment of external speech. On looking over the medical literature on the subject I have been unable to find as striking a case of impairment of internal speech, and this fact can be readily understood when we consider that a lesion necessary to produce this condition would be a destruction of the gray or cortical matter of the brain, and when this is injured the whole intellect becomes disjointed, as we see in the maniac, where the simple mechanical power of speech is perfect, but the incoherency and the wrong interpretation of external impressions are evident. I have said that these cases of the derangement of the faculties of internal speech are chiefly found in lunatic asylums. But, when I think, I remember to have met many mild cases outside of asylums, cases which can be best described by our Americanism of "talking too much with their mouth."

I have said the faculty of speech resides in the anterior lobes of the brain. But the evidence gleaned from pathology is convincing that the faculty is confined to a comparatively limited portion of the frontal lobe of the left cerebral hemisphere. This localization of a function to a single side of the brain is a curiously interesting fact. But when it is known that the left side of the brain presides over the motions and sensations of the right side of the body, it may be conceived that because we are right-handed we are left-minded. Why we are right-handed involves a discussion which would be beyond the limits of the present essay. But that the left side of the brain is almost always larger than the right is a well-known fact, and this asymmetry of the encephalon was prominently brought before the public during the Guiteau trial, with its prominent, ghastly rhombo-cephalic.

A curiously complicated and wonderful adaptation is this faculty of speech, sometimes bearing weighty loads of truth, at other times the veriest dregs of gorged society—words, windy words. The highest and best result of education is to form our ideas into words, to crystallize them into speech. We all feel that here we fail. Our thoughts well up and almost burst their limits, but faulty speech will not give the color and glow which the soul infuses into the thoughts. We can all say with the poet:

"Our whitest pearls we never find,
Our ripest fruit we never reach;
The flowering moments of the mind
Drop half their petals in our speech."

BIBLICAL AND MODERN LEPROSY.

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THE diseases which prevailed among the children of Israel were doubtless as numerous and as varied as those which now exist, and to a great extent they were probably identical with those affecting humanity at the present time. The most notable one spoken of in the Old Testament is called *leprosy*. As there exists at the present day a disease called by the same name, a consideration and comparison of the two may prove of interest.

The leprosy of the present day is found not only in distant parts of the world, but also in our own country. In Egypt, where it doubtless originated, and has prevailed for several thousand years, it still occurs. In Syria, India, China, and Japan, it is quite common. In Europe it is endemic chiefly along the shores of the Mediterranean and in Norway, although occasional cases are met with from time to time in many of the larger cities. In the West Indies and portions of South America it is also common, and in the Sandwich Islands it has increased rapidly in recent years, and now afflicts a large proportion of the native population. Coming nearer home, we find the disease existing among the Chinese in California, among the Norwegians in Minnesota, among the French and negroes in Louisiana, and among certain French Canadians in New Brunswick and Nova Scotia. During the past ten or fifteen years there have constantly been from one to a half-dozen or more cases in the hospitals of New York city. while other cases have been reported from Boston, Philadelphia, Baltimore, and other cities. Most of these cases have occurred among sailors or others, who have spent considerable time in the tropics or in regions where leprosy is common, and there contracted the disease. In New York there has occurred but one case in a person who had not been outside of the State, and in this case the origin of the disease could not be explained. It is an extremely difficult matter to determine beyond all doubt whether leprosy spreads only through hereditary transmission, or only through direct contagion, or in both ways. The disease is considered, by many who have had the best opportunities for studying it, to be hereditary in some cases, and at the same time capable of being propagated through inoculation. When leprosy once becomes prevalent in a community where vice, ignorance, and filth abound, it usually tends to increase, but it is far from being a highly contagious disease, as is commonly imagined. Physicians and hospital nurses have no hesitancy in caring for leprous patients, and the fear of the disease spreading through an intelligent community is based mainly upon sensational reports which have appeared from time to time in the newspapers.

I will not enter upon a detailed description of this dread malady. It is one which profoundly affects the constitution of its victim, and usually terminates fatally in from five to fifteen years. It can not be said to be an absolutely incurable disease, although the most that medical skill has succeeded in accomplishing, save in a few exceptional instances, has been to cause a temporary disappearance of the symptoms at the outset, or to mitigate the suffering of the patient in the later stages. In some cases, the disease appears in the form of dull, brownish spots upon the skin, with loss of its natural sensibility. This is the *macular* form of leprosy. In other cases the disease is characterized by the formation of dark, reddish-brown lumps upon the face and other parts of the body, which give the leper a peculiarly unsightly expression. This constitutes the more severe or *tubercular* form of the disease. In all cases the nerve-trunks are more or less affected, and the sense of touch in the extremities is greatly impaired. The hands shrivel, the fingers become bent like claws, ulceration takes place in some cases, and the joints drop off one by one. The leper now becomes an utterly helpless and pitiable object.

Such is leprosy as met with at the present day, and at once the interesting question arises, "Is this the leprosy of olden time—the *tsaraath* of the Old Testament?" Without doubt the disease of which I have been speaking existed among the Egyptians and the Israelites in Moses's day, and from Egypt gradually made its way along the coasts of the Mediterranean to Greece and later to Italy. There is doubt, however, as to whether Moses was perfectly familiar with the leprosy which we now recognize, and distinguished it from other affections of a severe and contagious character. Certainly there are no scriptural references to any disease which is unmistakably the leprosy of the present day. We read that when Moses put his hand into his bosom and took it out again at the command of the Lord, "Behold his hand was leprous as snow." When the anger of the Lord was kindled against the sister of Moses, "Behold, Miriam became leprous, white as snow." Again, Gehazi, the servant of Elisha, was told by the prophet: "The leprosy, therefore, of Naaman shall cleave unto thee and unto thy seed forever. And he went out from his presence a leper as white as snow." Now, there are certain affections of the skin, met with at the present day, to which the expression "white as snow" would be applicable, but leprosy is not one of them. Indeed, in this disease, the skin usually becomes dark rather than light in color, and in none of the few score of cases which I have had the opportunity of observing would the phrase "white as snow" be other than highly inappropriate.

The somewhat detailed description of leprosy which is found in the thirteenth chapter of Leviticus is almost unintelligible in the light of our present knowledge, and, after making due allowance for the necessarily imperfect translation of the Hebrew scriptures, we are forced to believe that Moses associated leprosy with other diseases, as many distinguished medical writers have done in later years. Indeed, it is only during the past few decades that the disease has been carefully studied in various parts of the world and its identity thoroughly established.

In studying the Mosaic laws respecting leprosy, we find statements made and directions given for its recognition by the priests who could not have referred to the disease which we now call leprosy. For instance, it is stated that if the leprosy cover the whole skin of him that hath the plague, the priest shall pronounce him clean. This would hardly apply to modern leprosy, which never involves the whole skin, as far as my observation goes. But there are other cutaneous affections which frequently do cover the afflicted subject "from his head even to his foot." Why the leper should have been pronounced unclean while the disease was spreading, and clean when it had reached that point where further spreading was impossible, I will leave for others to determine, merely remarking that a law which permitted only such lepers within the camp as were covered by the disease from head to foot could certainly not have had a sanitary origin. Furthermore, the rule that the leper should be shut up for seven days, and then examined by the priest, with a view to noting the change that had taken place in the mean time, would seem to indicate some other disease than modern leprosy, for the latter is extremely chronic in its course, and never presents any noticeable change in so short a time even under the most active treatment. What was meant by the reference to leprosy of clothing and of houses is now difficult to understand. There are infectious diseases at the present day, the germs of which may dwell for a time in clothing and the walls of houses, but there is nothing in connection with the modern leprosy which would justify us in believing that it ever infects an inanimate object.

On the other hand, if we assume that the leprosy of ancient times was identical with that of the present day, it seems strange that Moses failed to mention the loss of sensation, the deformity of the hands, and other features which are the most striking characteristics of the disease. That the leprosy which I have described has not changed its type in the course of centuries, as other diseases have done in a comparatively short time, is shown by the fact that some of the earliest medical descriptions are so correct that they might answer their purpose in a modern text-book, and we are therefore led to the conclusion that Moses, though possessing all the learning of the Egyptian priests, including the highest medical knowledge of his age, did not note the distinctive characteristics of leprosy, but classed it under one name with other prevalent diseases.

In this connection, it may be of interest to consider very briefly the character of the disease mentioned as leprosy in the New Testament. However uncertain we may be as to the precise nature of the Mosaic disease, it appears to me to be almost certain that the leprosy cured by our Saviour, after his sermon on the mount, was not the leprosy of the present day, but a far more common disease which is now known as *psoriasis*. The earliest Greek writers on medicine were unacquainted with Egyptian leprosy, except by hearsay. Hippocrates, writing over four hundred years before Christ, speaks of it as "the Phœnician disease," and even at the time of the Septuagint translation of the Pentateuch this leprosy was practically unknown to the Greeks. The Hebrew word *tsaraath* was translated by the Greek word *lepra*, which was the name of a disease characterized by white scaly patches upon the skin. This differed totally in its nature from the disease which is now called leprosy, and which prevailed at that time in Egypt and Palestine. This disease, being subsequently introduced into Greece, was designated by a different name, *elephantiasis*. At the time when the Gospels were written, the Greek medical writers recognized two distinct diseases under these names, *lepra* and *elephantiasis*. The former was the psoriasis, or white, scaly disease of the present day; the latter was the modern leprosy. The description of each of these diseases by Greek writers is explicit and readily recognizable, and the Gospels of Matthew and Mark agree in the statement that it was lepra and not elephantiasis which was cured by our Saviour. In other words, it was psoriasis, and not the modern leprosy.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

MISCELLANEOUS REMEDIES.

ANÆSTHETICS.—The inductive study of Nature has often proved the shortest way to discoveries which other methods can reach only by a circuitous route. The ancient Greeks, recognizing the significance of the fact that malarial complaints vanish at the approach of winter, cured their fever-patients by refrigeration, and this century of research will perhaps close before some experimenting Pasteur stumbles upon the fact that the proximate cause of ague and yellow fever can be traced to the agency of microscopic parasites whose development may be arrested by the influence of a low temperature. More than two thousand years ago the movement-cure, the fasting-cure, and other reactions against the baneful tendencies of the drug-delusion, were anticipated by the school of the natural philosopher Asclepiades.

The principle of the best *natural anæsthetic*, too, was practically applied, if not theoretically understood, by our rude ancestors. No one who has watched the contest of a pair of rough-and-tumble fighters—

biped or quadruped—or participated in a scuffle of that sort, can doubt that the excitement of the fight temporarily blunts the feeling of pain. Count Ranzau, the "Streit-Hans"—"Rowdy Jack," as his comrades used to call him—once received three dagger-stabs before he knew that he was wounded at all. Soldiers, storming a battery, have often suddenly broken down from the effects of wounds which they had either not felt, or suspected only from a growing feeling of exhaustion. Olaf Rygh, the Norwegian Herodotus, tells us that, when the old Baresarks felt the approach of their end, they robbed death of its sting by drifting out to sea in a scuttled or burning boat, and thus expired, "screaming the wild battle-songs of their tribe." The Roman gladiators shouted and laughed aloud while their wounds were being dressed. A scalded child sobs and gasps for a therapeutical purpose: instinct teaches it the readiest way to benumb the feeling of pain. The physiological *rationale* of all this is that *rapid breathing is an anæsthetic.* In a paper read before the Philadelphia Medical Society, May 12, 1880, Dr. W. A. Bonwill ascribes that effect to the influence of the surplus of oxygen which is thus forced upon the lungs, just as by the inhalation of nitrous-oxide gas (which is composed of the same elements as common air, but with a larger proportion of oxygen), and mentions a large variety of cases in his own practice where rapid breathing produced all the essential effects of a chemical pain-obtunder, without appreciably diminishing the *consciousness* of the patient. Persons who object to the use of chloroform (perhaps from an instinctive dread that in their case the ether-slumber might prove a sleep that knows no waking), can benumb their nerves during the progress of a surgical operation by *gasping as deeply and as rapidly as possible.* "One of the most marked proofs of its efficacy," says Dr. Bonwill, "was the case of a boy of eleven years of age for whom I had to extract the upper and lower first permanent molars on both sides. He breathed rapidly for nearly a minute, when I removed in about twenty seconds all four of the teeth. He declared there was no pain, and we needed no such assertion, for there was not the slightest indication that he was undergoing a severe operation."

The administration of chloroform often produces distressing after-effects, nausea and sick-headaches, that sometimes continue for days together; and I remember two instances in the records of a French military hospital where it resulted fatally in the case of patients who had in vain protested and offered to forego the benefits of the anæsthetic—perhaps actually from an instinctive consciousness of some constitutional peculiarity which in their case increased the risks of its use. Ether-spray, on the other hand, is a legitimate application of the principle that *cold benumbs the feeling of pain.* Death by freezing is preceded by an absolute anæsthesia; and the painfulness of bruises, wasp-stings, etc., can be diminished by the topical application of an ice-poultice.

Apoplexy.—The proximate cause of apoplexy is due to a congestion of the cerebral blood-vessels, induced by alcoholism, dietetic excesses, combined with the influence of sedentary habits. Consciousness, at least, can generally be restored by lessening the tendency of the circulation toward the head. The patient should be propped up in a sitting posture, with his head erect, his neck bared, and his temples and occiput moistened with cold water, while friction or a warm foot-bath should determine the circulation toward the extremities. Open every window of the sick-room, and, after the patient has sufficiently recovered to sit up in his bed, direct him to turn his face toward the cool draught, and now and then cool his temples with a cataplasm of crushed ice. For the first twenty-four hours let him abstain from all solid food.

Persons with an apoplectic diathesis should adopt a frugal and aperient diet, and avoid prolonged sedentary occupations, especially in a heated room. They should also avoid superfluous bedclothing, and open their bedroom-windows in all but the stormiest nights. The feet, however, ought to be kept warm under all circumstances. Plethoric gourmands ought at least to renounce late suppers and alcoholic stimulants.

Burns and Scalds.—Loose cotton, slightly moistened with linseed-oil, has an almost magical effect in relieving the pain of severe burns. When inflammation has supervened, the feverish condition of the patient requires cooling ablutions and the free use of ice-water, both topically and as a sedative beverage. Slight burns can be treated with any emollient application, and a piece of common court-plaster is sufficient to protect the sore till a new skin has formed under the blister.

Chilblains. — The effect of frost-bites is often aggravated by a too sudden change of temperature, or rather by the application of the wrong kind of caloric. The restoring warmth should come from within rather than from without. It is not necessary to scrape a frost-bitten person with icicles, after the Russian plan ; friction of any kind above or around the affected part will restore, as far as possible, the suspended circulation of the blood, and thus initiate the remedial functions of Nature. Deep foot-sores should be bandaged with linen rags and clean, warm tallow.

Dropsy.—It is a suggestive fact that the prevalence of dropsy has decreased since bleeding has gone out of fashion. There was a time when venesection was resorted to in nine out of ten kinds of diseases, and at that time a complaint which in its chronic form appears now almost only as a consequence of outrageous dietetic abuses was nearly as frequent as consumption. Bleeding impoverishes the blood, and dropsy, in any of its forms, can nearly always be traced to a depravation of the humors by unwholesome food or drink, or a disorder of the blood-making organs. As a symptomatic complaint, for instance, dropsy frequently appears in the last stage of pulmonary consumption, when the wasted lungs have become unable to fulfill the chief purpose of respiration. Next to the alcohol-habit, the habitual breathing of impure air is the present main cause of dropsy, for air is gaseous food, and a sufficient supply of oxygen a chief preliminary in the conditions of the blood-making process. Malarial diseases likewise impoverish the blood by a direct process of disintegration; * and dropsy appears as an occasional after-effect of a long-continued ague. Remedies: Mountain-air, a light but nourishing diet, and strict abstinence from alcoholic stimulants.

EMETICS.—Tepid water is a prompt, and the most harmless, emetic. In urgent cases (poisonings, etc.) add a modicum of white mustard (*Sinapis alba*), and tickle the fauces with the wing-feather of a pigeon, or any similar object. Excessive vomiting can be checked by stimulating applications to the pit of the stomach and the extremities.

EPILEPSY.—Epilepsy, or the falling-sickness, is a complication of nervous derangements,† and results more frequently from sexual excesses than from all other causes combined. In young children, however, epilepsy is sometimes a consequence of teething-difficulties, of acidity in the stomach, and of worms, and in such cases can be readily cured by a change of regimen,‡ or, in malignant cases, by a protracted fast. For adults, strict continence and out-door exercise is the best prophylactic. Excessive heat, however, should be carefully guarded against, as well as all exciting passions.

EXCORIATION.—Infants are apt to become "galled" in particular parts of their bodies, about the groins, the lower part of the neck, and under the arms—especially in consequence of the condemnable practice of tight swaddling. To dry up such sores, "galling-plasters" (acetate of lead, etc.) often lead to worse complications, and the best remedy is cleanliness, and fine lint, smeared with spermaceti-ointment or warm tallow.

FAINTING-FITS, OR SYNCOPE. — Syncope, or "fainting," "*Ohnmacht*," "*Desmayo*," as three nations have called it with a correct appreciation of its chief cause, as distinct from that of apoplexy and convulsions, results from a general deficiency of vital strength. Cold water, applied to the neck, the feet, and the palms of the hands, by means of a bathing-brush, is the best restorative. In severe cases inflation of the lungs by mechanical means has often proved effective. Dr. Engleman mentions the case of a lady in child-bed, who, "after being happily delivered, suddenly fainted and lay upward of a quarter of an hour apparently dead. A physician had been sent for; her own maid, in the mean while, being out of patience at his delay, attempted to assist her herself, and, extending herself upon her mistress, applied

* "Climatic Fevers," "Popular Science Monthly," vol. xxiii, p. 477.

† "Nervous Maladies," "Popular Science Monthly," vol. xxiv, p. 454.

‡ "Enteric Disorders," "Popular Science Monthly," vol. xxiv, p. 196.

her mouth to hers, blew in as much breath as she possibly could, and in a very short time the exhausted lady awakened as out of a deep slumber, when, proper things being given her, she soon recovered. The maid being asked how she came to think of this expedient, said she had once seen it practiced by a midwife with the happiest effect."

A little stream of water falling from a height on the face and neck, the irritation of the olfactory nerves by means of snuff or pungent smells (burned pepper, etc.), the motion of a rumbling cart, have now and then sufficed to restore suspended animation. Persons subject to fainting-fits can use no better prophylactic than gymnastics in winter, and cold baths and pedestrian excursions in summer-time.

Febrile Affections.—In all disorders of a malarial and typhoid character, as well as in scarlet fever, measles, small-pox, and epidemic erysipelas, *refrigeration* * is more efficacious than any medicine. In several zymotic diseases, besides cholera and yellow fever, the action of antiseptic drugs is annulled by the inversion of the digestive process: the chyle is forced back upon the stomach, and, mingled with the red corpuscles of the disintegrated blood, is voided in that discharge of *cruor* known as the black-vomit. Bleeding, instead of reducing the virulence of the fever, is apt to exhaust the little remaining strength of the patient. Lord Byron, for instance, was bled to death as surely as if the surgeon had cut his throat.

Gout.—A paroxysm of this dread penalty of idleness and intemperance is preceded by certain characteristic symptoms—lassitude, eructations, a dull headache, involuntary tears, a shivering sensation about the groins and thighs. If the lassitude has not yet taken the form of an unconquerable lethargy, the patient may obviate the crisis of his affection by severe and unremitting physical exercise, a prophylactic which, though doubly grievous in a debilitated condition, is incomparably preferable to the hellish alternative. I knew an old army officer who kept a spade in his bedroom, and, at the slightest premonitory symptoms, fell to work upon a sandy hill-side, and once dug a deep trench of forty-five feet in a single night, and toward morning staggered to his quarters and had barely time to reach his bed before he sank down in a *deliquium* of exhaustion, and awakened late in the afternoon as from a fainting-fit, with sore knees and sorer hands, but without a trace of the gout from which his compact with the powers of darkness proved to have respited him for a full month. The racking pain can be somewhat relieved by such counter-irritants as blisters, violent friction with hot flannel, etc., or actual cautery and the topical application of opiates. The experiments of sixteen carnivorous and alcohol-drinking nations have revealed dozens of similar palliatives, but only two radical remedies—frugality and persistent exercise.

Headache.—Chronic headache is generally a symptom of disordered digestion. To attempt the suppression of the effect while the

* "Climatic Fevers," "Popular Science Monthly," vol. xxiii, p. 477.

cause remains can bring only temporary relief, or even increases the subsequent malignity of the disorder. Strong black tea may thus act as a charm—for a day or so; but with the next morning the trouble not only returns, but returns aggravated by the supposed remedy, for chronic headache has no more potent single cause than the habitual use of narcotic drinks. A frugal, non-stimulating regimen, on the other hand, brings help more slowly but permanently, unless the patient abuses the restored vigor of his digestive organs. Acute headaches can generally be traced to influences which tend to obstruct the free circulation of the blood—tight clothing, coldness of the extremities, oppressive atmospheric conditions, etc.—and can be cured only by a direct removal of the cause. As a symptomatic result of a vitiated state of the humors, as in scrofula and venereal diseases, headaches that defy all medicine often yield to a grape-cure.*

Heart-burn, or Cardialgia.—Both words are misnomers, the seat of the pain being the pit of the stomach, and the cause gastric acidity; remedies—fasting and "passive exercise," a ride in a jolting cart, kneading of the abdomen, etc.

Hypochondria, Chronic Melancholy, Spleen.—Robert Burton, in his "Anatomy of Melancholy," enumerates some six thousand causes of chronic despondency, and about as many different remedies, of which only six or seven are apt to afford permanent relief: frugality, temperance, early rising, life with a rational object (altruistic, if egotism palls), constructive exercise in the open air, a sunny climate, and social sunshine—the company of children and optimists.

Insomnia.—The proximate cause of sleeplessness is plethora of the cerebral blood-vessels, and a palliative cure can be effected by anything that lessens the tendency of the circulation toward the head. But a permanent cure may require time and patience. By night-studies brain-workers sometimes contract chronic insomnia in that worst form which finds relief only in the stupor of a low fever, alternating with consecutive days of nervous headaches. Reforming topers often have to pass through the same ordeal, before the deranged nervous system can be restored to its normal condition. Fresh air, especially of a low temperature, pedestrian exercise, and an aperient diet, are the best natural remedies. Under no circumstances should sleeplessness be overcome by narcotics. An opium torpor can not fulfill the functions of refreshing sleep; we might as well benumb the patient by a whack on the skull.

Jaundice.—Jaundice and chlorosis are kindred affections, and the yellow tinge of the skin is often in both cases due to an impoverished state of the blood—especially a deficiency in the proportion of the red blood-corpuscles—rather than to a diffusion of bilious secretions. Jaundice, as a consequence of obstinate agues, is evidently the result of a catalytic process which disintegrates the constituent parts

* "Enteric Disorders," "Popular Science Monthly," vol. xxiv, p. 457.

of the blood. The bite of poisonous animals has often a similar effect. The most frequent predisposing cause, however, is want of sunlight and out-door exercise. Jaundice and chronic melancholy are often concomitant affections, and both a penalty of our dreary, sedentary modes of life. The ancients, indeed, ascribed both complaints to the same cause, for *melancholy* is derived from a word which means literally "atrabilious," or black-biled. But the truth seems to be that functional disorders of the liver are the result rather than the cause of a general torpor of the vital process. Remedy—outdoor sports, combined with as much fun and sunshine as possible. Alcoholic jaundice-cures may restore the ruddiness of the complexion by keeping the system under the influence of a stimulant fever; but we might as well congratulate ourselves on the return of health when pulmonary affections mimic its color with their hectic glow.

Mental Disorders.—The *Lalita Vistara* says that on the day when Buddha, the savior, was born, all the sick regained their health and the insane *their memory*. Insanity might, indeed, be defined as a partial derangement or suspension of the faculty of recollection. Nature takes that method of obliterating the memory of impressions which the soul is unable to bear, and thus preserves life at the expense of its intellectual continuity. Lunatics are generally *monomaniacs*; their judgment may be sound in many respects, but, at the mention of a special topic, betrays the partial eclipse of its light. It may be possible that people have been killed by the sudden announcement of good news, but, for one person who has lost his reason from an excess of joy, millions have lost it from an excess of sorrow—a crushing calamity, or the oppressive and at last unbearable weight of the dreariness, the soul-stifling tedium of modern life in many of its phases. The sick soul may have stilled its hunger with a long-hoarded hope, till the evident exhaustion of that hoard leaves only the alternative of despair or refuge in the Lethe of dementation. Where insanity is at all curable it can be cured by the removal of its chief cause—sorrow; and the best remedies are kindness, mirth, and a pleasant occupation. In the middle ages, when both lunacy and the love of earthly happiness were ascribed to the machinations of the devil, lunatics were chained and horsewhipped for the double benefit of their souls, and with results which almost justified the demon hypothesis. Breughel's best illustrations for Dante's hell were made after studies in an Austrian mad-house. The extreme antithesis of such *infernos* is perhaps the State Lunatic Asylum at Tuscaloosa, Alabama, where the shadow of gloom has been so successfully banished that the happiest results of the cure have almost been anticipated by its methods: the restoration of reason itself could hardly give the patients an additional reason for being happy. They have a park, a flower-garden, and a pet nursery of their own; they have books and music, gymnasia, bathrooms, and amateur workshops. Wherever their road leads, they can travel it in sunshine, even on hobby-back if they choose, for they have a philosophical weekly of their own, with full permission to explain the revelation of St. John.

Myopia—short-sightedness, and far-sightedness (presbyopia), were formerly regarded as absolutely incurable affections, because they were evidently not amenable to the influence of any known drug. But "drug" and "remedy" have at last ceased to be synonymous terms ; and, though constitutional defects of the eye may preclude the possibility of a complete cure, there is no doubt that those defects can be modified by a judicious treatment, especially by a mode of life tending to restore the general vigor of the system, by out-door exercise, and by rambles in green, sunny woods, for the colors of the summer forest are as beneficial to the eye as its atmosphere to the lungs. Weak eyes can be strengthened by gradually exercising the capacity of the optic nerve, scrutinizing small objects, first at a moderate and by-and-by at a greater distance, but withal guarding against a fatiguing effort of the eye.

Pimples.—The best cosmetic is a grape-cure, i. e., a frugal, saccharine, and sub-acid diet, combined with out-door exercise in the bracing air of a highland country.

Rheumatism.—Rheumatism, like gout, is a consequence of dietetic abuses. Counter-irritants, hot baths, etc., can effect a brief respite, but the only permanent specific is fasting. Before the end of the second day a hunger-cure benumbs the pain ; the organism, on being obliged to feed upon its own tissues, seems to undergo a process of renovation which alone can reach the root of the complaint. Exercise and great abstemiousness will prevent a relapse.

Scrofula.—A scrofulous taint is in some cases hereditary, and yields only to years of dietetic reform, but, on the whole, there is no more perfectly curable disease. In all but its most malignant forms it yields readily to the influence of pure air and pure food—out-door life, and a wholesome, vegetable diet. Skin-cleaning nostrums only change the form of the disease by driving it from the surface to the interior of the body.

Toothache.—The extraction of every unsound tooth and the insertion of a "new set" would certainly remove, *in ipsa radice*, the seat, if not the cause, of the evil. But the trouble is, that the function of proper mastication is an indispensable preliminary of digestion, and that for practical efficacy the last stump of a natural tooth is infinitely preferable to the best artificial substitute. The best plan would, therefore, be to let the stumps remain, and get rid of the pain, and the latter end can be attained by a slow but infallible method. Within half a year after the change of regimen, *absolute abstinence from hot drinks* (especially boiling hot, sweet tea) and a *very sparing use of animal food* will benumb the sensitiveness of the irritated nerves. I knew an old Mestizo who had learned to chew apples with his bare gums, but only after necessity had reduced him to a frugal regimen. A saccharine diet in the form of sweet ripe fruit has certainly nothing to do with the decay of the teeth, and it is a suggestive fact that toothache is almost exclusively an affliction of the northern nations.

Warts and Corns.—The predisposing cause of warts is unknown, and the popular remedies are rarely permanent. I have known warts to reappear after they had been thoroughly removed by the use of corrosive acids. The popular belief that they "spread" if the operation involves bleeding seems not to be wholly unfounded, and large warts can be more effectually cured by means of a tight ligature that gradually deadens the tissue. Warts on the upper side of the fingers can generally be atrophied by exerting a long-continued strain upon the adjoining muscles, as in holding up a heavy weight, or seizing the rings of a grapple-swing and dangling by one hand as long as the fingers can support the strain. A callous skin is thus formed under the wart, and before long the excrescence disappears. Corns are entirely owing to the pressure of tight shoes, and can be cured by the use of more commodious foot-wear. To suppress the symptom, while the cause remains, is of little avail, and, before a chiropodist could keep his promise to "remove corns with the root," he would have to eradicate the folly of heeding the mandates of fashion rather than the appeals of Nature.

THE MORALITY OF HAPPINESS.

By THOMAS FOSTER.

EVOLUTION OF CONDUCT.—(CONTINUED.)

THERE is only one way of escape from the conclusion reached in our last—that conduct is good or bad according as its total effects are pleasurable or painful—in which statement be it understood the word total *means* total, and is not limited in its application to the person whose conduct is spoken of. If it is supposed that men were created to suffer, that a power which they were bound to obey had planned such suffering, so that any attempt either to take pleasure or to avoid pain was an offense, then of course the conclusion indicated is an erroneous one.

No system of religion has ever definitely taught so hideous a doctrine. Even where sorrow and suffering are recognized as the lot of man, and even where self-inflicted anguish and misery are enjoined as suitable ways of pleasing Deity, it is never said that such sufferings are the ultimate desire of the Supreme Power. These tribulations are all intended for our good: we are to torture ourselves here and now, that hereafter we may avoid much greater pains or enjoy much greater pleasures than here and now we could possibly experience.

Yet underlying this doctrine of greater and longer-lasting happiness as the result of temporary suffering or privation, there has been and is in many so-called religions the doctrine that pain and suffering are pleasing to the gods of inferior creeds and even to the Supreme Power of higher beliefs. The offerings made systematically by some races to their deities imply obviously the belief that the gods are pleased when men deprive themselves of something more or less valued. Sacrifices involving slaughter, whether of domestic animals or of human beings, mean more, for they imply that suffering and death are essentially pleasing to Deity. Even when such gross ideas are removed and religion has been purified, the symbolization of sacrifice in most cases takes the place of sacrifice itself. The conception may and often does remain as an actually vital part of religious doctrine that pleasure is offensive to the Supreme Power and pain pleasing.

If this conception is really recognized, and any men definitely hold that to enjoy or to give pleasure is sinful, because displeasing to God, while the suffering or infliction of pain is commendable, then for them —but for them only—the doctrine is not established that conduct is good or bad according as its total effects are pleasurable or painful. But if there are such men, then they are mentally and morally the direct descendants of the savage of most brutal type, who, because he himself delights to inflict pain, deems his gods to be of kindred nature and immolates victims to them (or, if necessary to gain his ends, shows the reality of his belief by self-torture) to obtain their assistance against his enemies.

If there are such men among us still, then, as Mr. Herbert Spencer says, "we can only recognize the fact that devil-worshipers are not yet extinct." The generality of our conclusions is no more affected by such exceptions as these than it is by the ideas which prevail in Bedlam or Earlswood.

But on the one hand the doctrine thus reached may be passed over as a truism (which it ought to be and indeed is, though, like many truisms, unrecognized); and on the other it may be scouted as Epicurean (which is unmeaning nonsense, however) and as mere pig-philosophy. For it sets happiness as the aim of conduct, and, whether self-happiness or the happiness of others is in question, many find in the mere idea of pleasure as a motive for conduct something unworthy —thereby unconsciously adopting the religious doctrine which has been justly compared with devil-worship.

This expression—Pig-philosophy—has indeed been applied to the doctrine we are considering, by a philosopher who, with Mr. Ruskin and Mr. Matthew Arnold, may be regarded as chief among the wonders of our age—and standing proof of the charm which the British race finds in Constant Grunt, Continual Growl, and Chronic Groan.

It must be considered, therefore, as certain that to some minds a philosophy which sets the happiness of self and others as a worthy end must appear unworthy. Such minds find something pig-like in the desire to see the happiness of the world increased. Yet grunting and groaning are at least as characteristic of the porcine race as any desire to increase the comfort of their fellow-creatures or even their own. Mr. Herbert Spencer's lightsome pleasure-doctrine, the essence of which is that we should strive to diminish pain and sorrow (our own included) and to increase joy and happiness, is less suggestive of porcine ways (at least to those who have noted what such ways are) than—for instance—the following cheerful address to Man: "Despicable biped! what is the sum total of the worst that lies before thee? Death? Well, Death; and say the pangs of Tophet, too, and all that the Devil and Man may, will, or can do against thee! Hast thou not a heart; canst thou not suffer whatsoever it be; and, as a Child of Freedom, though outcast, trample Tophet itself under thy feet, while it consumes thee?" Were this but stern resolution to endure patiently, and even cheerfully, such sorrows as befall man, it were well. Nay, it would fall in with the philosophy of happiness, which enjoins that for their own sake as for the sake of those around them men should bear as lightly as they may their burden of inevitable sorrow. But what Carlyle calls the New-birth or Baphometic Fire-baptism is not Patience but Indignation and Defiance. This is the veritable Pig-philosophy: the "Everlasting No" (*das ewige Nein*) is in truth the Everlasting Grunt of dyspeptic disgust, the constant Oh-Goroo-Goroo of a jaundiced soul.

Are the teachings of living professors of the Everlasting Groan school brighter than those of the gloomy Scotsman? Here are some of the latest utterings of the chief among them: "Loss of life!" exclaims Mr. Ruskin, cheerfully. "By the ship overwhelmed in the river, shattered on the sea; by the mine's blast, the earthquake's burial—you mourn for the multitude slain. You cheer the life-boat's crew; you hear with praise and joy the rescue of one still breathing body more at the pit's mouth; and all the while, for one soul that is saved from the momentary passing away (according to your creed, to be with its God), the lost souls yet locked in their polluted flesh haunt, with worse than ghosts, the shadows of your churches and the corners of your streets; and your weary children watch, with no memory of Jerusalem, and no hope of return from *their* captivity, the weltering to the sea of your Waters of Babylon." *Oh! Goroo! Goroo-oo!*

Any philosophy which hopes for other than misery and disgust in life must indeed seem strange doctrine to teachers such as these—even as the smiles of the cheerful seem unmeaning and offensive to those whose souls are overcast with gloom and discontent. Sir Walter Scott tells a story of his childhood which well illustrates the unreasoning hatred felt by the Everlasting Growl school for the doctrine that conduct should be directed to the increase of happiness. One day, his healthy young appetite made him enjoy very heartily the brose or porridge of the family breakfast. Unluckily, he was tempted to say aloud how good he found his food. His father at once ordered a pint of cold water to be thrown in, to spoil the taste of it! Possibly he meant to inculcate what he regarded as a high moral habit; but rather more probably Mr. Walter Scott, Sen., objected to his son's enjoying what he had no taste for himself. Much of the sourness of the Growl Philosophy may be thus interpreted.

V.—SELF *VERSUS* OTHERS.

We teach our children, the preacher tells his flock, but few follow the precept—Care more for others than for self. It sounds a harsh doctrine to say, instead—Each must care for himself before others. Yet it is not only true teaching, it is a self-evident truth. It would not be even worth saying, so obviously true is it, were it not that in putting aside the doctrine because of its seeming harshness men overlook, or try to overlook, the important consequences which follow from it.

If a man's whole soul—nay, let me speak for a moment in my proper person—if my whole soul were filled with the thought that my one chief business in life is to make those around me, as far as I can make my influence felt, as happy as possible, to increase in every possible way the stock of human (nay, also of animal) happiness, I must still begin by taking care of myself. For if, through want of care, I myself should cease to exist, I can no longer, in any way, serve others; nay, it is even conceivable that my immature disappearance from the scene of my proposed exertions for others' benefit might cause some diminution of the totality of happiness.

If the very thought of care for self should suggest that there can be no real love or care for others where self-care comes first (self-evident though the proposition be that care of self *must* come first), let us replace the case rejected as imaginary by a concrete and familiar illustration.

None can question the unselfishness of the love which a mother feels for her infant babe. None can doubt that, if question arose between the babe's life and hers, her own life would be willingly sacrificed. Of course there are exceptions, perhaps many, but no one can doubt, and multitudes of cases have proved, that the rule holds generally. Now, the nursing mother not only has, in her very love for her babe, to take care of herself, but to care for herself *first*, and to take more care of herself than, but for her pure, unselfish love for her child, she would have troubled herself to take.

Let this case suffice to show that care of self before others (not, therefore, necessarily more than others), besides being a self-evident duty (which many may regard as a mere trifle), may be not only perfectly consistent with regard for others, and even with devotion to others, but may be absolutely essential to the proper discharge of our duties toward others. In fact, it is little more than a truism, instead of being, as many would at a first view imagine, a paradox, that the more earnest our wish to increase the happiness of others, the more carefully must we look after our own welfare.

If we take a wider view, and, instead of considering a single life, study the development of families and races, we still find the same lesson. As the man who wishes his life to be useful to his fellows and to increase their happiness must take care of that life, so he who would wish to benefit humanity through his family or race must not only nourish his own life and strength, but must develop those activities which advance his own welfare and the welfare of his family. Otherwise come, inevitably, the dwindling of the faculties on which his own value depends, and the loss in his descendants of good qualities which they might otherwise have inherited from him. Or it may be that such qualities are inherited in less degree than had he duly exercised powers and capacities which were in a sense held in trust for them. We are apt to overlook the importance of individual action in such cases, not noticing that the progress of a race depends on the aggregate of acts by the individual members of the race.

To take a concrete instance here, as of the simpler case: If a number of persons in any nation or at any epoch, impelled by a desire to benefit their fellows, devote their lives to celibacy, they influence in important degree the qualities of the next and succeeding generations. They diminish the proportion in which their personal qualities—presumably valuable—will appear in future generations, and relatively increase the proportion of other and less desirable qualities. This is obvious enough. It should, however, be almost as clear that, in whatever degree such persons in a community as possess the best qualities fail to advance, in all things just, their personal interests, they diminish the influence of the better qualities, not only in their own time, but in times to come. If, to take another concrete example, all persons of the better sort, forgetting their duties to themselves and their race, enter of set purpose on lives of poverty, asceticism, and dreariness, they not only diminish in large degree the good they might do during life, but they injure their offspring, and, through them, posterity.*

Under its biological aspect, then, the doctrine that care of self must necessarily take precedence of care and thought for others, is incontestable—it is the merest truism—though many speak, and some act, as if the doctrine were iniquitous.

* Many would probably be startled if a just estimate could be formed of the degree in which the qualities of the civilized races of the world have suffered through the well-meant but mistaken zeal which led large classes of men in former ages to sacrifice their *power* to do good in *order* to do good.

But this doctrine has its moral aspect also. The question of duty comes in at once and very obviously so soon as the actual consequences of conduct have been shown to be good or bad. But it may be well to show more definitely what the true line of duty is in regard to self. I shall, therefore, next consider cases where self-abnegation leads directly to the diminution of general happiness.—*Knowledge.*

WHY THE EYES OF ANIMALS SHINE IN THE DARK.

By SWAN M. BURNETT, M. D.

THAT the eyes of some animals, particularly the cat, are luminous when they are in the dark, is a fact established from time immemorial. It is surprising, however, to find the exact nature of the phenomenon entirely misunderstood even by scientists whose lines of investigation lie in the particular field to which it belongs. In conversing, not long ago, for instance, with one of the first physicists of this country, who is at the same time an ardent sportsman, he gave me a graphic description of a "still hunt" for deer. This method of hunting, as is well known, consists in placing a bright light in the bow of a boat and propelling it noiselessly through the water. The deer is attracted by the light and goes toward it, but is prevented by its glare from seeing his enemies who are concealed in the shadow. The hunter, looking straight ahead, sees in the outer darkness—rendered Egyptian by contrast with the bright light immediately in front of his own eyes—two large, luminous bodies, like balls of fire. These are the eyes of his victim; and, making his calculation as to the distance from the eyes down to the breast, the valiant sportsman (who probably is also a strong anti-vivisectionist) fires, intending to send his bullet through the heart. The eminent physicist, in speaking of this luminosity, referred to it as due to the *phosphorescence* of the eyes, in that final way in which we are accustomed to speak of things beyond dispute.

But it is hardly less surprising to read in the article "Light," in the ninth edition of the "Encyclopædia Britannica," the following remarkable statement by Professor P. G. Tait, on the *sources* of light: "3. A third source [of light] is physiological; fire-flies, glow-worms, *medusæ*, dead fish (?)—the eye of a cat" (vol. xiv, p. 379).

If these are the opinions of acknowledged authorities in optics, we can hardly expect the mass of even ordinarily intelligent and informed persons to have more correct ones, and should expect thorough credence to be given to the story of the man who claimed that he was able to recognize an antagonist who struck him in the dark by means of the light emitted from his own eye as the result of the blow.

The fact is, there is no phosphorescence in the eyes of animals—at least, so far as my knowledge extends, none has been demonstrated; and, that it is absent from the eyes of the cat, Professor Tait can demonstrate conclusively for himself, by taking a cat, be it ever so black (and these I believe are supposed to have the luminous power in the greatest degree), into a completely dark room where there can come no ray of extraneous light, and he will find that the eyes can not generate enough light to make even the darkness visible.

The real cause of the luminosity of the eyes of animals in the dark is now thoroughly understood by physiological opticists and by many practical oculists, and depends upon the well-demonstrated laws of the refraction and reflection of light. For a clear apprehension of the phenomenon, however, it is necessary to understand the properties of the eye as an optical instrument.

The office of the eye as an optical instrument, pure and simple, is to bring rays of light to a focus on the membrane at the back part known as the *retina*, in such a manner that small and inverted images of external objects shall be formed there. For this purpose there is a general plan, which is subject, however, to more or less variation in different animals. The basis of this plan is the *camera-obscura*, in which the box is represented by the hollow globe or ball of the eye, the small aperture through which the light enters, by the pupil, and the lens by which the inverted and reduced images of external objects are formed, by the refracting surfaces of the eye, which are usually two—the cornea, or clear part of the front of the eye, and the crystalline lens.

Now, the eye, in its capacity of optical instrument, is obedient to the same laws as any other apparatus reflecting and refracting light. It may astonish some to be told that the eye reflects the light passing into it. It was for a long time believed that all light that entered the eye was in some manner consumed there, and that none ever found its way out again. It was considered one of the functions of the choroid or pigmented coat of the eye to absorb such light as was not used in the formation of the image. The basis of this opinion was that, under ordinary circumstances, no matter how bright the light may be in which the eye is looked at, the pupil always appears black. But no fact is more clearly demonstrated now than that the eye does throw back a large part of the light which enters its pupil.

One of the fundamental principles of optics is what is called the law of conjugate foci. This is readily understood by means of the accompanying diagram (Fig. 1). If the object is at *a*, the lens *l* will form an image of that object at *c*. The law of conjugate foci is that the image can exchange places with the object and the object with the image, and the result be still the same. That is to say, if the object were placed at *c*, its image would be formed at *a*. Or, expressing it in another way, the rays of light follow the same lines, whether going from the image to the object or from the object to the image.

Let us now apply this law to the case of the eye. We will suppose the eye to be in a normal optical condition; that is, that the retina on which the image is formed is to be found exactly at the focus of

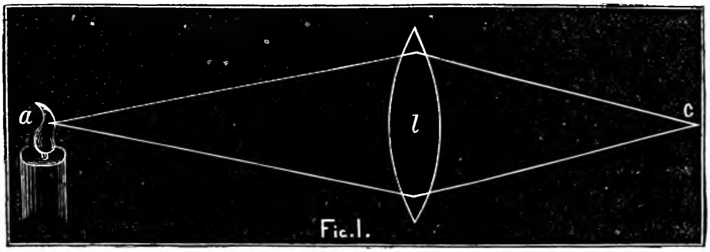

FIG. 1.

the lenses by which the light is refracted. By consulting Fig. 2, we can follow the course of the rays of light in both directions. We have rays going from *a* in the flame *a b*, which after refraction by the lenses of the eye are brought to a focus at *c*, and form the lower end of the inverted image; whereas, these going from *b* are united again at *d*. But, since the bottom of the eye is a reflecting surface, and sends back a part, at least, of the light which falls on it, some of these rays pass out again, but, in accordance with the law of conjugate foci, they must follow the same lines as in entering; therefore, the rays from *c* will come back to *a*, and those from *d* will come

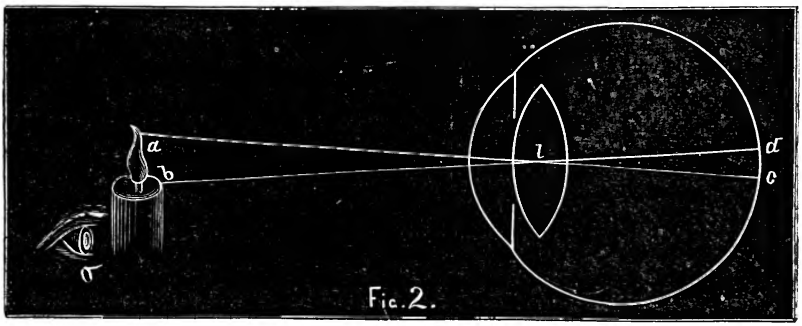

FIG. 2.

back to *b*. If we could place our eye at *a b*, then we would catch some of these rays, and the bottom of the eye would appear illuminated just as any other surface from which light was reflected. But our eye and the candle can not occupy the same place at the same time, and if we place it behind the candle, the flame itself cuts off the rays of light, and if we place it in front, our head obstructs the passage of the light to the eye to be observed. So, under these circumstances, it is impossible for an eye, at *o*, for instance, to get any of the light that is constantly coming from the bottom of an eye which has been illuminated. But, if we were able by any contrivance to place our eye in the position of the source of light, we would be able to catch the rays coming from the bottom of the observed eye, and it would appear illuminated. Now, there is such a contrivance, and it is called the *ophthalmoscope*, and it owes its existence to the genius of Professor Helmholtz. The principle of its construction is so simple that the wonder is that no one ever thought of it before; but never, until the year 1851, had any one ever seen in anything like detail the interior of a living eye. If you take a piece of bright tin and punch a small hole in it, and, placing the hole directly in front of your own pupil, throw the light from a lamp into the eye of a child, the pupil, instead of appearing black as it usually does, will be of a beautiful yellowish-red color. This is because you have, to all intents and purposes, put your eye in the place of the source of light. For the light reflected from the surface of the tin is that which passes into the eye, and it must come back to it after reflection. The eye placed behind the hole catches the small quantity which would fall on that part, and therefore sees the surface from which it comes, illuminated. This is the principle of *illumination* of the bottom of the eye, and, when you have your object sufficiently well lighted, it is only a matter of optical appliance to see it distinctly and in great detail. This digression is designed to show that, when we have favoring circumstances, by the action of well-known optical laws, the eyes of animals appear illuminated, and that it is not necessary to call in the supposition of phosphorescence to account for the phenomenon.

But, in the case of some animals, the eyes appear to shine without the intervention of any optical means, however simple. This, however, is only apparent, for the principle of illumination is applicable here as in the other cases.

In the case we have supposed, the retina, which in this instance is the reflecting surface as well as the membrane on which the image is formed, was found at the focus of the refracting surfaces of the eye. But this condition is met with only in what is accepted as the perfect optical state of the eye. As can be readily understood, the retina may lie either in front or behind the focus of the refracting media—that is, the eye may be too long or too short for its focus, and unfortunately such conditions are but too common. When an eye is too long, it is said to be near-sighted or myopic; when too short, it is far-sighted or hypermetropic.

The change in the position of the retina, then, must exercise an influence on the direction of the rays that are reflected from it. From the well-demonstrated properties of lenses we know that, when rays of light coming from a point at the focus of a lens pass through it, they are rendered parallel; when they come from a point *within* the focus, they are spread out, or rendered divergent; and when from *beyond* the focus, they are rendered convergent, or brought toward another focus.

In accordance with these laws, therefore, we must expect the rays of light to take a different course in coming out of an eye according as it is near- or far-sighted. The course of the rays coming from the far-sighted or hypermetropic eye is shown in Fig. 3.

If the retina lay in the focus of the refracting surfaces of the eye at E, then the light from the inverted image *c d* of the flame would travel back, in the same direction in which it came, to the flame *a b*

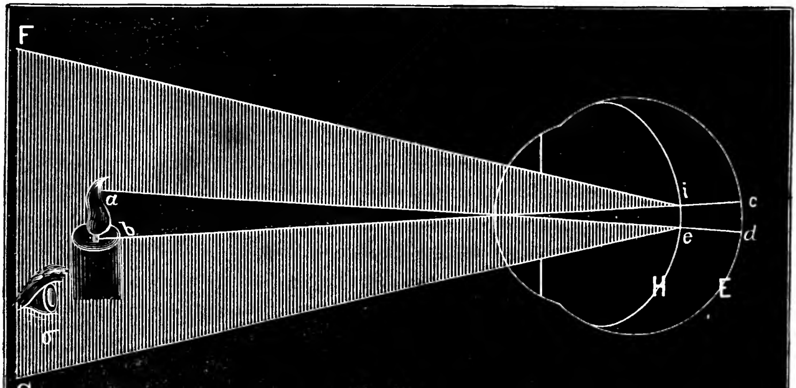

Fig. 3.

itself. If, however, it meets the reflecting surface of the retina *within* the focus at H, then the rays from the confused image *e i* would come out in a *divergent* manner, and form a cone of light, F G, like that from the head-light of a locomotive.

It is now easy to see that if an observing eye is placed anywhere in the vicinity of the source of illumination, as at *o*, it will take in some of the rays coming from *e i*, and see it illuminated. There are very few human eyes so accurately adjusted as to their focus that all the rays come back to the source of light; some of them are scattered, and by a very simple arrangement it is possible to catch them in sufficient number to show the bottom of the eye illuminated.

Place a child (because the pupils of children are large), and by preference a blonde, at a distance of ten or fifteen feet from a lamp which is the only source of light in a room, and cause it to look at some object in the direction of the lamp, turning the eye you wish to look at slightly inward toward the nose. Now, put your own eye close behind the lamp-flame, with a card between it and the flame. If you will then look close by the edge of the flame covered by the card into the eye of the child, you will see, instead of a perfectly black pupil, a reddish-yellow circle. If the eye happens to be hypermetropic, you will be able to see the red reflex when your own eye is at some distance to one side of the flame.

This is the true explanation of the luminous appearance of the eyes of some animals when *they* are in comparative obscurity. It is simply the light *reflected* from the bottom of their eyes, which is generally of a reddish tinge on account of the red blood in the vascular layer of the choroid back of the semitransparent retina, and not light that is generated there at all. This reflection is most apparent when the animal is in obscurity, but the observer must be in the light, and somewhat in the relative position indicated in the above-described experiment—that is, the eye of the observer must be on the same line with the light and the observed eye. The eyes of nearly all animals are hypermetropic, most of them very highly so, so that they send out the rays of light which have entered them in a very diverging manner.

The circumstances under which the phenomena of luminosity are usually seen are, it will be noted, those most favorable for the success of the experiment. The animal is always in an obscure corner, under a table or chair, as in the case of the cat, while the deer is in the outer darkness of the night. It is well known that the pupils dilate when in the dark, and they often attain an immense size in the eyes of those animals with nocturnal habits, and the size of the cone of light is governed by the size of the pupil, since its circumferential boundary is formed by it.

In making some experiments on dogs and cats, for the purpose of determining the size of this cone of light, I found that it had actually about twice the diameter it should have theoretically, from the amount of hypermetropia present, as determined by means of the ophthalmoscope. This I can account for only by the great dispersion of light at the periphery of the lens and cornea, rendered possible by the immense dilatation of the pupil ; and this I think, too, is the reason why the phenomenon is not more frequently observed in the higher animals affected with hypermetropia. The pupil in man never attains the size, under the same circumstances, as that of the cat, for example ; and, moreover, it is most likely that the surfaces of the cornea and lens are more regular in their curve, even at their more peripheral parts, and consequently disperse the light in a very much less degree.

PREHISTORIC ART IN AMERICA.

By the Marquis de NADAILLAC.

THE world of science was astonished a quarter of a century ago by the discovery made in the caves of Vézère, France, of works of art executed by the prehistoric troglodytes. The specimens consisted of representations of mammals, birds, fishes, and of man himself, sculptured in relief or engraved upon elephants' tusks, bears' teeth, the shoulder-blade of a reindeer, the long bones of deer, or on stones or beach-pebbles, and included the huge cave-bear, the mammoth with its heavy mane and upturned tusks, the seal, the crocodile, and the horse. These drawings, the first efforts of man, are crude in shape, but suggestive of vital action. One of the stag-horns, engraved with representations of reindeer and fishes, is a almost a masterpiece. The deer are following one another, and one of them has turned to look back, doubtless so as to see her fawn ; the heads are all drawn in profile and without foreshortening, as in the Egyptian paintings and sculptures ; sometimes the lines are light, at other times they are cut deeply to bring out certain parts. By a curious caprice the artist, after having completed his first design, has put fishes in all the vacant spaces, and they too are wonderfully truthful. M. Massenat has discovered, at Laugerie Basse, a piece of reindeer-horn about ten inches long, on which was plainly engraved an aurochs running from a young man who is about to shoot an arrow at it. The animal has its head down with its horns in a position of menace, expanded nostrils, and tail raised and curved, all being signs of terror and irritation. The man is naked and has a round head, with coarse hair, which is brought up over the top of his head, and an obvious beard on the chin. His whole physiognomy expresses joyousness and the excitement of the chase. The women have flat breasts and prominent hips. One of them, very hairy, is drawn between the legs of a deer, and wears a collar around her neck. Unfortunately, her head is wanting.

A considerable number of engraved stones and bones have been brought to light in the excavations of the cave of Thayngen, Switzerland. Among them is a reindeer, standing with its head inclined toward the ground, and drawn with a precision showing a really remarkable acquaintance with the form of the animal. The artist had attained such perfection that observers were at first tempted to ask if they had not been invited to look at one of the archæological frauds that have unhappily become so common. But the excavations had been watched with unremitting care ; the witnesses of the discovery were honorable men of science ; the calcareous deposit of more than a yard thick had been taken up under their eyes ; there were found in the cave reproductions of animals which had disappeared centuries ago—the musk-ox, for instance ; and the engraving was so faithful that it could have been made only from nature. It was necessary, then, to surrender to the evidence. Away back in the quaternary ages, in the midst of the hardest conditions of life, of the struggle for existence, and of incessant conflicts against the great pachyderms, the bears, and the feline animals that swarmed around him, man already had the feeling or the instinct of art. He tried to draw the likenesses of the animals he saw and of the trees that shaded the cave he lived in ; and the productions of his industry, found again after so many ages, are all the more interesting from the fact that the extemporizing artist had, to assist him in his work, only some wretched flints or roughly-sharpened bones. The inquiry whether these discoveries made in the west of Europe are verified in other countries, and whether this art-feeling was innate in man and has characterized him always and everywhere, is one of much interest. The excavations in Asia and Africa are still too few, and the discoveries that have been made there are of too little importance, to warrant the drawing of serious conclusions respecting those quarters. We must, then, turn to America, where eminent archæologists and enthusiastic collectors have eagerly studied all that relates to the past of the human race. With the aid of their publications and the photographs they have distributed with rare liberality, we are able to follow the ancient populations in their migrations from the shores of the Atlantic and the Pacific, to study their habits and their progress, and to show that among them also art was born at a very early epoch, and that it grew up with the generations.

It has now been ascertained that man lived in America during the quaternary ages, contemporaneously with the mastodons and the huge edentates and pachyderms, which had no other resemblances with the mammals of the Eastern continents than those of size. Like their contemporaries in Europe, the primitive Americans wandered in the solitary wilderness, and disputed with animals for the prey on which they fed and the caves that sheltered them, having for weapons of offense and defense only the flints that lay at their feet. Their barbarism appears to have been lower than that of the troglodytes of Europe, and to have been destitute of all artistic feeling and taste for ornament. Ages passed, the duration of which we can not compute; the quaternary animals disappeared, and man became sedentary; and he has left as evidences of his long abode in the same place the heaps of refuse exemplified in the shell-mounds and kitchen-middens of the Atlantic coast, the Gulf of Mexico, the banks of the Mississippi and the Amazon, the Pacific coast, and Tierra del Fuego. Excavations made at several points have brought out hatchets, knives, harpoons, and tools of every shape, of stone, bone, and horn, all bearing witness to a backward social condition, fragments of carbonized wood, bones of animals, and fish-bones, all having evidently been accumulated by men who knew nothing of agriculture and lived by hunting and fishing. Occasionally a few shards of pottery have been found among the remains, made of clay mixed with pounded shells, fashioned by hand, and dried in the sun. Sometimes plaited vines or canna-stems have been impressed on the wet parts, or lines have been scratched on the vessel with the point of a shell or a flint. These are the first efforts at ornamentation, and are singularly like those of the most ancient potteries of Europe. Ornaments designed for the decoration of the person are more rare than the potteries. We can only cite a few bears' or cats' teeth and shells bored for the purpose of being hung from the neck, except in the *sambaquis* or kitchen-middens of Brazil, where a few figures of fishes and idols in gold and silver have been found in very ancient deposits of guano.

We can form only the most imperfect estimates of the dates of these remains. Geological evidences give no definite clew. The growth of trees over the kitchen-middens may fix dates previous to which they certainly existed, but when we have admitted the five or six centuries it took the trees from the time the wind wafted the seed to the spot, how are we to compute the number of generations of plants that were required to furnish the soil on which they could grow? One point only is ascertained, and that is that no bones of quaternary animals have been met under the kitchen-middens, and, with the exception of the figures we have mentioned, no metallic objects. The remains must, then, have been accumulated between the period of the disappearance of the larger animals and the time when the metals came into habitual use. Must we say, then, that during that long series of ages no artistic tendency revealed itself in man? Yes, if we judge by the individual objects that have been collected; no, if we attribute to that epoch the pictographs, or the figures, scenes, hieroglyphics, or rebuses, as we might call them, which are painted, engraved, and sculptured on the cliffs, the sides of caves, the bowlders, and erratic rocks, or wherever a vacant space may have been offered to the artist. Men have at all times with a childish vanity endeavored to delineate their migrations, their contests, their hunts, and their victories. Egypt has transmitted its ancient history to us on granite; the rocks of Scandinavia still wear the likeness of the Vikings' vessels; and those around the *lac des Merveilles*, near Nice, bear pictures of men extremely primitive in design; curious engravings have been noticed in Algeria; the Bushmen, who are among the most degraded populations of the globe, have drawn on stone, with wonderful fidelity, their hunting scenes and their loves; and the rock-paintings of New Zealand, the work also of a barbarous race, but evidently superior in execution to the scratches of the Bushmen, have been described before the London Society of Anthropology. These are isolated facts, though curious ones; but in the two Americas the number of pictographs and the extent of surface they cover give them an exceptional importance. The desire, not only to reproduce striking events, but also to give precision to their sense by conventional signs, by graphic strokes, or by hieroglyphics or phonetic or symbolical characters, is one of the most remarkable traits of the different races that have succeeded each other on the new continent. Although the initial date of these engravings is unknown, we can nevertheless affirm that they continued to be executed through many ages, and that while the most ancient ones ascend to remote epochs, in some instances these historic drawings only a little while preceded the arrival of the Europeans. Pictographs are especially abundant in the regions that formerly constituted Spanish America: in Nicaragua, near the extinct volcano of Masaya; in the

United States of Colombia, on the banks of the Orinoco; and in Venezuela, where in consequence of their antiquated condition they will soon cease to be distinguishable. The rocks of Honduras are covered with sharply-cut designs; the *conquistadores*, in 1520, remarked similar works in the Isthmus of Darien; and in the State of Panama entire cliffs were charged with hieroglyphics that might afford matter for very interesting studies. In the Sierra Nevada, between Columbus, Nevada, and Benton, California, are hosts of figures of men and animals and uninterpretable signs. About twenty miles south of Benton, the road follows a narrow defile, bounded on both sides by nearly perpendicular rocks, and these are covered with figures in respect to which no clew exists as to the people that designed them.

Pictographs are little less numerous in Arizona, New Mexico, and Colorado—in parts of the country which, though now desolate, were formerly inhabited by a considerable population. The glacier-polished bowlders of the valley of the Gila River have figures that may be compared with those of Thuringia. On the banks of the Mancos and the San Juan, and in the deep cañons stretching up toward the east, the figures are visible at dizzy heights, some deeply engraved, others drawn in red or white. Among them is a procession of men, animals, and birds with long necks and legs, all going in the same direction. Two of the men are standing on a sledge drawn by a deer, while others direct the march of the drove. The artist evidently intended to represent a migration of his tribe. In another pictograph on the banks of the San Juan, among figures of strange forms and of drawing incorrect but full of movement and life, may be recognized a number of flint hatchets, exactly similar in pattern to the symbolical hatchets that are cut on the megaliths of Brittany. At another spot, a cliff is covered, for a space of more than sixty square feet, with figures of men, deer, and lizards; and M. Bandelier has seen, near the ruins of Pecos, pictographs, the high antiquity of which is attested by the degree of effacement they have undergone. They represent the tracks of men or children, a human figure, and a tolerably regular circle. On the banks of the Puerco and the Zuñi, two of the affluents of the Colorado Chiquito, designs have been remarked having the appearance of hieroglyphics, but their significance is unknown, and we can not even affirm that they had any. The cliffs near Salt Lake in Utah are adorned with sculptures, among which are human figures of the natural size, cut in a hard rock more than thirty feet above the ground. All together show an amount of labor of which the Indians are incapable, and a sum of difficulties which they could not have overcome; and the height at which some of the sculptures appear allows the supposition that some geological phenomenon, perhaps a depression of the lake, may have occurred since they were executed. Many drawings on stone have also been observed in the eastern parts of the United States.

Pictographs to which we are disposed to accord a great antiquity are to be seen on the sides of caves in Nicaragua. Some grottoes in the mountains of Oajaca also bear witness to the labor of man, in the shape of coarse paintings in red ochre. Among them is frequently repeated the imprint in black of a human hand. This imprint, which is probably borrowed from some myth, seems to have played a great part in America. It is found reproduced in regions very remote from one another, standing out on the potteries, sometimes in red on a black ground, sometimes in black on a red ground. In our own days it is occasionally found in use among Indians as a totem or coat-of-arms.

All that we have just said bears witness to a still primitive condition of art. The men who executed the works, barbarous as they seem to have been, were capable of rising higher. This is proved by works of a manifestly later epoch. Guatemala, the ancient land of the Quiches and the Cakchiquels, abounds in ruins. Bas-reliefs, statues, and monoliths covered with arabesques to the height of twenty feet, meet the traveler frequently. At Quirigua, a small port on the Bay of Honduras, a statue of a woman has been found, footless and handless, with a crowned idol on its head; excavations by the side of it have brought to light a tiger's head in porphyry. At Santa Lucia Cosumalhuapa, at the foot of the Volcan de Fuego, among the cyclopean stones and the statues of tapirs and caymans, lie colossal stone heads, of a strange type, hitherto unknown. Two of these heads wear the immense ear-rings peculiar to the ancient Peruvians, and a head-dress similar to the Asiatic turbans. Farther on are bas-reliefs in hard porphyry, larger than nature, representing personages as odd in conception as in execution, and mythological scenes that have no relation to any known form of worship. The most interesting bas-relief represents a human sacrifice. The principal personage is a priest; he is naked and, according to the custom of the Aztec priests, wears a garter around his left leg; only the left foot is shod. The head-dress is a crab. One hand holds a flint, doubtless the sacrificial knife, while the other hand grasps the head of the victim to be slain. On a second plane, two acolytes are carrying human heads. One of them is a skeleton, a sinister symbol of death. Its head is of a simian shape, mingling the grotesque with the terrible. To cite more similar facts would merely involve unpleasant repetitions. We shall only add, then, that the figures are of a grinning aspect and a repulsive ugliness. The ancient American races did not seek for the beautiful, or, rather, did not comprehend it as we do, who have been taught by the immortal creators of the high art of Greece.

We have just occasion to be surprised when we think of the time that was required to execute these works, and consider what inefficient mechanical means the artists had to use. They had to detach blocks of hard stone by means of wretched tools of quartzite and obsidian, and to saw granite and porphyry with agave-fibers and emery. A coarse outline design indicated the part to be removed. The labor was executed either by sawing partly through the stone and deftly breaking off the fragment, or by pecking it away with a flint-point. Lastly, the surface of the planes was rubbed with flat stones or polishers to remove the traces of the chippings. Other processes also appear to have been employed. The artist drew his figure in coarse tracings, and covered with ashes the lines he desired to bring out in relief. The whole surface was then heated with fire; the parts which were subjected to the direct action of the flames were decomposed, and left hollow places, while those that were protected by the ashes remained intact.*

For finishing his work, the sculptor had nothing better than a flint-point or a copper chisel,† the only tools in use, for iron was unknown. He was obliged, in order to execute those colossal figures and the bas-reliefs which now make such an impression of astonishment upon us, to cut with those imperfect tools in a very hard rock to a depth of three or four centimetres. The fact of the performance of a labor of such length is a certain indication of the infancy of the society in which it was done, where man had not yet learned to appreciate the value of time.

The region of the *piedras pintadas* (painted stones) in South America extends from Guiana to Patagonia. They are found in the wilds of Brazil and La Plata as well as in the more civilized districts of Peru and Chili, and they betray everywhere a remarkable analogy. In the solitudes of Pará and Piauhy, Brazil, are numerous intaglio-sculptures, executed by unknown peoples; they represent animals, birds, and men, in various attitudes. Some of the men are tattooed; others wear crowns of feathers; and the picture is finished off with arabesques and scrolls. At la Sierra da Onça are drawings in red ochre, isolated and in groups, without apparent order, and the rocks of the province of Ceará and those of Tejuco are covered with tracings not unlike those on the rocks of Scandinavia. Humboldt describes intaglios on the right bank of the Orinoco, representing the sun and moon, pumas, crocodiles, and serpents, ill-formed figures defined most frequently by a simple outline and declaring little advancement in art. Nevertheless, since they are cut in the hardest kind of granite, it is

* Mr. Wiener saw the natives excavating an irrigation canal in the valley of Chicama de Sausal, through a rock which stood in the way. The workmen piled ashes along the line of the edges of the canal, covered them with dried manure and burned it. After eight days they succeeded in forming by this process a channel through a granite rock containing a vein of basalt 1·20 metre wide, 0·80 metre deep, and 2·30 metres long.

† There has been found near Quito a chisel that was used in working the large blocks of trachyte employed in paving the roads of the Incas' empire. It weighed 198 grammes. The surface was worn, the edge was nicked, and the head appeared to have been hammered upon, all indicating that it had been subjected to long use. An analysis of a piece of it by M. Damour gave ninety-five parts of copper, a little more than four parts of tin, and slight traces of iron, lead, and silver..

impossible to attribute them to the barbarous tribes that inhabited the country at the time of the arrival of the Europeans. These tribes were incapable of executing works of this kind, and even of comprehending any art, however crude it may appear to us. Who, then, were the peoples to whom we can attribute the painted stones? What was their origin? The illustrious German traveler tells us nothing that can diminish our ignorance on this point.

There are mentioned as among the works in the country of the Chibkas, in the United States of Colombia, a stone probably designed for sacrificial purposes, and sustained by caryatides, a jaguar sculptured at the entrance to a cave near Neyba, and gigantic llamas. In the land of the allied tribe of the Muiscao, the granitic and syenitic rocks are adorned with colossal figures of crocodiles and tigers, guardians doubtless of the images of the sun and moon, the supreme gods of the South American natives. All of these figures are coarsely executed, and betray, like the North American figures, an extreme absence of taste and an absolute inability to reproduce objects faithfully.

Abundant examples occur on the Pacific coast of an art which we can best compare with that of Guatemala. A granite block near Macaya, known as the Piedra de Leon, is covered with sculptures which all are agreed are very ancient. The most important group represents a face-to-face struggle of a man and a puma. The figures suggest movement, and the man and the animal appear to be really struggling. Near the little city of Nepen may be seen a colossal serpent; a short distance from Arequipa, trees and flowers; farther on, bisons with bored noses are wearing movable rings cut in the same stone. At the Pintados de las Rayas, geometrical figures, circles, and rectangles, the meaning of which can not be defined, take the place of figures from life. In the province of Tarapacá, considerable surfaces are covered with figures of men and animals mostly fairly good specimens of work, and with a kind of characters arranged vertically. The lines are from twelve to eighteen feet long, and each character is quite deeply engraved. This is not an isolated instance. Inscriptions very much worn have been found near Huara, and between Mendoza and La Punta, Chili, is a large pillar on which letters have been imagined analogous in some respects with the Chinese alphabet. These evidences are very vague, and, however well disposed to discover in them the beginnings of graphic art, we can not as yet found so important a conclusion upon them.

The use of colors was certainly known to the Americans from the most remote antiquity. The ochres, soot-black, and lime doubtless furnished them their first coloring elements, and there was nothing in the idea of using these pigments above the most primitive conceptions. Experiment induced a rapid progress, and mėn learned to extract vegetable colors from leaves, fruits, roots, stems, and seeds. A coloring-matter was also borrowed, like the Tyrian purple, from sea-mollusks. The Peruvians and the Mexicans knew how to place the colors upon their cloths. The goods were then exposed to the action of the light, and tints varying from a delicate rose-color to a dark violet were obtained. The colors were so well fixed that they were not even modified by the decomposition of dead bodies. In the collection of cloths from the Peruvian *huacas* at the museum of the Trocadéro, in Paris, wrappings of mummies that have been buried for centuries still retain the primitive color on their time-eaten threads.

The Mexicans probably obtained the remarkably brilliant coloring of their pictographs by somewhat analogous processes. These pictographs, manuscripts of which only a smaller number have reached us, embrace the history of the country, its national traditions, the genealogies of its kings and nobles, the rolls of provincial tributes, the laws, the calendar, religious festivals, and the education of the children—a complete summary, in fact, of all that concerns the manners, customs, and life of the people. They were painted in various colors on cotton cloth, on prepared skins, or on a strong and tough paper made from the fibers of the agave. At times the artist depicts scenes from real life; at other times he records facts by means of hieroglyphical, symbolical, or phonetic characters, conventional signs that have been handed down for generations, and on which innovation is prohibited. Another series of pictures illustrates the education of children and their food and punishments. The father teaches his son to carry burdens, to steer a canoe, or to manage the fishing-tackle. The mother instructs her daughter in domestic duties; she sweeps the house, prepares *tortillas*, and weaves cloths. These pictures present the distinct outlines and bright colors which the Americans sought first of everything. Evidently we must not ask them for models of decorative painting. Their complete ignorance of proportions and the laws of perspective demonstrates that their art was the exclusive product of their own genius, or of the instinct of their race, and that they had not been subject to any foreign influence.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

RECENT GEOLOGICAL CHANGES IN WESTERN MICHIGAN.

By C. W. WOOLDRIDGE, B. S., M. D.

WESTERN Michigan is a region noted for its lumber, its peaches, and its sand. It has other claims, however, to the attention of those who are interested in the workings of Nature, that are not nearly so well known as they deserve to be, for it bears the marks of very extensive geological changes in recent times, which are even yet in progress, but have not attracted the attention that their importance merits, and have been overlooked altogether by some geological writers, whose observations might be expected to cover their field. Let us take a look at this region and examine briefly some of the marks in which Nature has written its history. We find it in the main a sandy plain, wooded with white-oak, beech, maple, hemlock, and pine, varying in the proportion which they bear to one another, and interspersed with other trees and undergrowth in all the variety which the prolific flora of that region affords. In places the land sinks so low as to constitute a timbered swamp, and in others it rises to a moderate height above ground-water ; often it appears, as indicated by the vegetation it bears, to be very fertile, but occasionally it is almost naked in its barrenness. Taken as a whole, it is of a lower degree of fertility than the heavier soils found in the more central and southern parts of the State, and for this reason it is less generally under cultivation than it otherwise would be.

This plain is, however, interspersed with tracts of land of a very different character. These consist mostly of a clayey loam, containing bowlders, as the sandy levels generally do not, having a more rolling and irregular surface, and, so far as it has been the writer's privilege to observe them, lying at a higher level than the sandy plain by which they are surrounded.

On scanning the map of Michigan, it will strike one as a peculiar feature of this west side of the State, that nearly every stream, large or small, that flows into Lake Michigan, expands into a small lake near its mouth, a fact that may have given rise to a query in some as to why such a peculiar feature should exist, especially in a country all of whose features are post-glacial—carved, indeed, out of the glacial drift or built upon it everywhere ; and it is with the hope to throw some light on this matter, as well as other peculiarities of the region, that this article is written.

Our principal field of observation is the country near Whitehall, Muskegon County, Michigan, where the writer began to reside in the summer of 1878. This village is situated at the head of White Lake, on White River, which opens into Lake Michigan some six miles to the southwest.

In this river-lake one may see in many places an old water-line on piling, which at that time was at an elevation of three feet or more above the water. The fact that this line was continuous at a uniform level on lines of piling that were apparently undisturbed rendered the theory of uplifting by ice that was often given in explanation of it exceedingly unsatisfactory ; and when old residents of the neighborhood were heard to speak, as they often did, of schooners loading and unloading, a few years before, in places where there was not at this time water enough to float a raft, it left very little room for doubt that this old water-line recorded a real change of relative level between the water and the land.

On passing along the borders of the lake, however, another phenomenon was observed that seemed to contradict this hypothesis, or to indicate that the change of level had been the other way. This was the existence of the stumps of large trees, evidently in the position where they had grown, but at this time standing in the water. And again, a living witness was found to corroborate the testimony of the stumps, in the person of an old resident who tells of the willows growing far out on what is now a shallow in the lake, and forming a haunt that the deer used to frequent in the years when this country was first settled.

That summer (1878), a new trestle was built across the head of the lake for the Chicago and West Michigan Railroad. In building it piles were driven and sawed off beneath the surface of the water for the bottom sill of each bent to rest upon, but before the next spring these piles began to lift their heads out of the water, and, before the summer of 1879 had passed, the sills that rested on them were lifted from ten to fourteen inches above the water-level. During the summer of 1879 an iron swing-bridge was built across the mouth of White River, at the head of the lake, and, as a foundation for the turn-table, a bed of piling was driven in the center of the channel, which was sawed off at a considerable depth below the surface of the water. On this piling a platform of lumber was built, so that its surface, when completed, was at a depth of some six inches below the surface of the water, and on that a tower of stone-work was built for the turn-table to rest on. As the lake was considered to be at a low level at this time, it was supposed that this platform would be perpetually under water; but the bridge was not yet completed when it began to rise above the surface, and, by the next spring, it was some eight inches above the water-level. At this point, however, the water again began to rise, and at present this platform is again under water.

Another matter must now claim our attention, that speaks of a time somewhat more remote; but first, perhaps, it will be as well to glance briefly at the immediate border of Lake Michigan. Here, along the border of the low-lying, sandy country, there is generally a strip, varying from a few rods to half a mile or more in width, on which the sand has been piled up by the wind into dunes. Here the surface of the ground is fantastically irregular. Sharp crests, gorges, valleys, and crater-like depressions abound everywhere, and the whole is generally covered with forest and filled in with a rank undergrowth. In places, however, especially at the foot of the river-lakes, the sand is yet without vegetation, except here and there, on some sheltered slope, a few bunches of beach-grass or a stunted shrub; white and shining, its surface rippled by the wind, and traced at times with the strangely varied tracks of insects, birds, small creatures from the neighboring woods, turtles from the water, and, most numerous of all, the mimic tracks made by light objects that are moved along by the wind, such a scene is in itself a study for a naturalist.

In some places, Lake Michigan is year by year building out the land with fresh deposits of sand, but oftener it is cutting it away with every storm. A reach of coast, extending perhaps a mile and a half southward from the foot of White Lake, is particularly interesting to one who wishes to study the structure of the country. Here, of late years, the lake has been eating away the land. The bluff facing the water is from fifty to one hundred and fifty feet high; sometimes its face is covered from top to bottom with earth that has slid down so as to conceal its structure, at other times this is all swept away and the strata are revealed. At such times an old surface-line of vegetable mold may be seen through the entire extent of the section at a height of from ten to twenty feet above the lake. Above this line all is sand, below it all is a heavy solid earth, of which clay forms the principal part. In the depressions of this line, where channels of drainage in this ancient line of surface may be supposed to be cut across, springs flow out. In one such depression there is a bed of peat, marking the site of an ancient swamp, and near each edge of this bed it is full of timber that has fallen into it when a swamp and there been preserved. Some of this wood seems to be but little changed, while other pieces have almost the color and texture of charcoal. Here we have found elm, oak, and black-ash, the species of which might be recognized as easily as if just from the forest. Some branches had been charred by fire, and altogether the deposit is exactly what we might expect to find in the edge of a Michigan swamp of the present day, with the difference that this has been compacted and hardened by time and pressure and drainage. The clay soil in which this old swamp was situated seems to underlie the sand everywhere in this region at varying depths, but on excavating to it we do not everywhere find the vegetable mold that here marks its surface. From these facts the conviction has grown that here in Western Michigan the condition of things has varied somewhat like this: First succeeding the introduction of the present order of things at the close of the last Glacial epoch, the entire country was at an elevation above Lake Michigan much greater than at present, great enough to drain the bottoms of all these river-lakes which, it should be noticed, are deepest near the great lake, and generally terminate in a swamp at their head, and each of which is elongated in the same general direction as the valley the foot of which it occupies. This condition of things lasted until the configuration of the land had become substantially what it is at present; then a subsidence took place, until all the lower levels of the country were beneath the waters of Lake Michigan. Again the country began to rise, and as the submerged lands were lifted above the water they were covered with sand, exactly as the lake now deposits sand on a retreating coast. When this uplifting reached such a degree that the action of the waves was disturbed by the bottom near the edge of the deep water marking the ancient boundary of the lake, sand-bars would be deposited there as we find them, and these would stretch across the mouths of the submerged river-valleys, and on further uplifting they would separate the waters occupying them from those of the great lake, which, meanwhile, would go on adding more sand to them from without. This is the condition of things existing at present. The changes of level that have brought it about have not been uniform and constant; they may have consisted of a single sinking and rising, but more probably there were many. Even yet we see that the solid-seeming earth is sinking and swelling there in a most capricious manner. It is hard to tell to what the present movements are tending even—whether for a long period the land is to remain substantially at its present level, whether it is to rise until the river-lakes are drained and the Western Michigan lake-ports are left stranded inland, or whether the country is to be again submerged. We see, within the memory of those now living there, a variation of level to the extent of six feet at least, and in both directions. Forty years ago the land seems to have been at a higher level than it is at present, and to have continued so long enough to permit the growth of large trees on land since submerged. Then there was a subsidence to an extent of several feet, then an uplift until the waters were below their present level, and at last accounts another subsidence seemed to be in progress. Who can tell us its limits, either as to time of continuance, rapidity, or extent? What is the nature of this movement? There are difficulties in the way of accounting for it that would not exist if Lake Michigan were the ocean. A rising and falling of the land as a whole would include the bed of the lake, and would not produce these changes of relative level. To lift the bed of Lake Michigan, might pour out a part of its contents, and so cause an enormous increase in the volume of the St. Clair, Detroit, and St. Lawrence Rivers, with a corresponding diminution when a subsidence was taking place, the rivers rising as the lake was going down, and falling as the waters of the lake were rising; but this, we believe, has not taken place. Is it a shrinking and swelling of the upper strata of Western Michigan, leaving the deeper strata in which the bed of the lake rests comparatively undisturbed? Is it a rocking of the lake-bed from side to side, one part sinking as another rises? What is the extent of the country through which these movements are felt? These questions, and others relating to the matter, would seem to be of interest. Perhaps, if the Government would take the subject in hand and cause a record to be kept of the water-level at all light-houses and life-saving stations, a few years might throw light upon it.

SKETCH OF AUGUST WILHELM HOFMANN.

By EDWARD J. HALLOCK, Ph. D.

THE recent visit of this distinguished scholar and chemist to our city is worthy of more than a passing notice, and we would commemorate it in a feeble manner by placing before our readers a sketch and portrait of the man who has contributed so much to the advancement of science and of human progress.

August Wilhelm Hofmann was born in Giessen, April 8, 1818. After completing the usual gymnasium course, he entered the University of Giessen at the age of eighteen. Having acquired a taste for the modern languages during his travels in Italy and France, he at first took up the study of philology, to which he devoted himself assiduously for several years. To this we may undoubtedly attribute much of his power as a writer and speaker. At this time his father, who was an architect, was engaged on the plans for Liebig's new laboratory, and thus young Hofmann became acquainted with that famous chemist. His influence turned the whole course of Hofmann's life, for he at once took up the study of chemistry, and we next hear of him as the assistant of Liebig. He remained in this position until the spring of 1845, when he was appointed professor in Bonn, but he was not destined to remain long upon the Rhine, for, in the latter part of the same year, he was called to London and placed in charge of the newly established Royal College of Chemistry. Through the exertions of Professor Hofmann, and his popularity as a lecturer and teacher, this school soon acquired such a prominence that, in 1853, the Government united it with the Royal School of Mines. It was during this time that he made several of those important researches which have resulted in discoveries of the greatest importance. In addition to his other labors, he found time to deliver courses of lectures to workingmen, which were well attended, and to investigate various technical and sanitary questions upon which his opinion was sought. His success in solving difficult expert problems soon won for him an influential position in England. In 1856 he was appointed Warden of the English Mint, which position he continued to hold until he left England. He was made a fellow of the Royal Society in 1861, and ten years later was nominated President of the London Chemical Society. He served on the jury in the International Exhibitions held in London in 1851 and 1862. Among the important investigations of public interest was a chemical examination of the waters of London, and, with Professor Graham, an investigation of the bitter ales at a time when the brewers were suspected of using strychnine as an adulterant.

His early philological studies enabled him rapidly to master the intricacies of the English language, so that he became a fluent speaker and a correct writer in our tongue. Several of his works have appeared in English first, and subsequently been translated into German.

His reputation as one of the most successful teachers of chemistry of the present day brought him many offers from German governments, for at that time he stood almost alone as a teacher of organic chemistry according to modern ideas. In 1862 he was called to Bonn, where he undertook the building of a fine chemical laboratory, but he was not permitted to finish his undertaking, for in 1863 he was appointed the successor to Mitscherlich at the Frederick William University in Berlin.

His first work in Berlin likewise consisted in the planning, erecting, and equipping of a new chemical laboratory, which was opened in 1868. It consists of a substantial brick edifice, built in the form of a hollow square, in the center of which is a large, airy, and well-lighted lecture-room, capable of seating about two hundred students. Two large courts, one on each side of the lecture-room, afford abundant light to the various work-rooms, laboratories, and smaller lecture-rooms. The entire structure occupies a lot of ground one hundred and forty by one hundred and sixty-five feet on Georgen Strasse, with an extension seventy feet wide running through to the Dorothean Strasse. On the latter are the library and residence of the professor. The situation is a central one, near the principal station of the elevated railroad (Stadtbahn), and but five minutes' walk from the university building on Unter den Linden.

Professor Hofmann's lectures are illustrated by very elaborate experiments, and the fundamental laws of the science are demonstrated by means of apparatus devised by himself for this special purpose. No other living chemist, Bunsen perhaps excepted, has invented so many new and useful forms of lecture apparatus as Hofmann. Besides his earlier papers on this subject, a season rarely passes, even now, without some new contribution to this kind of literature from his fertile pen. His lectures are so interesting, his manner so animated, that his lecture-room is thronged with students from all parts of the globe.

Soon after his removal to Berlin, Professor Hofmann founded the German Chemical Society, of which he has several times been president, and the growth of which has been largely due to his efforts. Although German in name and in language, it numbers among its twenty-seven hundred members persons of every nation where chemistry is cultivated, and its proceedings are the chief means of communication between a large portion of the chemists of this and other countries. The number of original papers published by it is larger than that of the English, French, and American chemical societies combined.

Although Hofmann excels as a lecturer and teacher, his reputation rests chiefly on his valuable and numerous contributions to the science of organic chemistry, foremost among which are his investigations on the coal-tar colors.

He first began the study of the bases in coal-tar under the direction of Liebig, and in 1843 we find him publishing his first original paper on this subject. One of these bases, then known as "cyanol," attracted his special attention, and by working over half a ton of coal-tar he succeeded in obtaining this rare base in sufficient quantity to investigate its properties, which he found to be the same as those of "benzidam." Further investigation also enabled him to prove that "aniline," the name then given to a substance that had only been obtained from indigo by distillation, was identical with both cyanol and benzidam. Here, then, were three sources for obtaining this rare material. Evidently there could not be much of it in coal-tar, when only three pounds could be separated from half a ton of tar; indigo, too, was an expensive source; hence it was a fortunate circumstance that Zinin had discovered another method of making it, and that too from a far more abundant constituent of coal-tar, namely, benzol; it is from that all the aniline of the present day is prepared.

Hofmann, it is said, noticed that aniline gave rise, under certain conditions, to the production of a red color, but he failed to publish the fact, and to Perkin belongs the credit of having discovered the first aniline dye—mauvine. This took place in 1856, and two years later Hofmann discovered a red dye, then called Hofmann's red, which was formed by the action of chloride of carbon upon aniline. Aniline was beginning to attract the attention of manufacturers as well as of chemists, and many different methods were devised for making what seemed to be the same substance, a fine red dye variously known as magenta, solferino, fuchsine, and aniline red. Hofmann undertook a careful investigation of the dye, which resulted in his discovery of the surprising fact that the red dye was in reality the salt of an organic base, like an alkaloid, and that this base, to which he gave the name of "rosaniline," was *colorless*. From this base he prepared another which he called "leucaniline" by reducing it with zinc. Turning his attention to the blues, greens, and purples, he found them to be derivatives from this same base, but of more complex construction. The importance of these investigations can scarcely be overestimated. The production of dyes from aniline was no longer a matter of blind experimentation; empirical methods gave place to scientific ones, and the process of making dyes has gone on to the present day nearly in the same direction. One of the earliest practical results of this discovery was the invention of a series of most beautiful purples which still bear the name of Hofmann. Like Leverrier's discovery of Neptune, their elements had been calculated beforehand, their existence foretold, and they needed only to be made.

Before taking up the investigation of the aniline dyes, Hofmann had been engaged in a line of research, which, though apparently of mere theoretical interest, had especially fitted him for this work, namely, the study of organic ammonias, or amines. In 1849–'50 Hofmann made the discovery that when ammonia was acted upon by certain alcoholic iodides, such as methyl iodide, one, two, or three of the hydrogen-atoms of the ammonia could be replaced by the alcoholic radical. In this way he prepared trimethylamine, a substance which he subsequently found to exist ready formed in herring-pickle, and from which it is still obtained for medicinal purposes. For his investigations on the molecular constitution of the organic bases, he was awarded the Royal Medal in 1854, and in 1867 he received the great prize of the World's Fair at Paris.

Engaged in studies of this sort, the resemblances between aniline oil and ordinary ammonia, and more especially between their respective salts, could not escape his notice. Each contains one atom of nitrogen; the substitution of a certain group of atoms known as the phenyl group for one of hydrogen will convert ammonia into aniline. In the more complex molecule of rosaniline, with its three atoms of nitrogen, he naturally sought for a triple ammonia, but he found the phenyl group alone incompetent to form this base, which led to his discovery of the very important fact that no dyes can be made from *pure* aniline, an admixture of its homologue, toluidine, being essential to the production of the rosaniline and its derivatives.

Organic bases, containing other elements than nitrogen, have also attracted his attention, and through his labors much has been added to our knowledge of the "phosphines," phosphonium, etc.

Another class of subjects, to which Hofmann has devoted much attention, includes the mustard-oils, both natural and artificial, and the sulpho-cyanides of organic bodies. These researches have resulted in the artificial production or synthesis of many pungent oils and ethers. He has also fearlessly attacked the cyanides themselves, and succeeded in producing some new organic compounds that fairly rival Bunsen's well-known cacodyle in their repulsive odors.

Among the analytical processes introduced by Dr. Hofmann are several of importance, including the separations of arsenic from antimony, and of copper from cadmium, and the detection and estimation of carbon disulphide. Hofmann's method of determining the specific gravity of vapors is as remarkable for its simplicity as for its accuracy.

Although a fertile writer, Professor Hofmann is not given to writing books. He has, however, contributed a great many original papers to various chemical journals, of which the "Journal of the London Chemical Society" contains more than ninety, and nearly two hundred more are to be found in the "Berichte" of the Berlin Chemical Society. He was for a time one of the editors of Fowne's "Manual of Chemistry," and since 1874 has also been one of the editors of the "Annalen der Chemie und Pharmacie," established by Liebig.

A portion of the course of lectures upon inorganic chemistry, which he had delivered so acceptably before the Royal College of Chemistry in London, was published in book form in 1866, under the title of "Lectures on Chemistry." It was soon after translated into German, and has passed through several editions under the more appropriate title of an "Introduction to Modern Chemistry." We know of no other book in any language on this trite subject that exhibits so much originality of treatment, or that is more pleasing in style, convincing in its demonstrations, and logical in method. Taken in connection with the ingenious apparatus therein described, it has had avery beneficial effect upon the methods of teaching chemistry.

The substance of his lectures upon organic chemistry was published in 1872 by one of his former assistants, Dr. A. Pinner, and during the past year it has been translated into English by Professor P. T. Austen, one of his American pupils.

Hofmann's "Life-Work of Liebig" is a worthy monument to the great chemist; while his biography of the great French chemist, Jean Baptiste André Dumas, in the "Nature" series of scientific worthies, is a charming specimen of English composition. His memorials of deceased scientists are worthy of more than passing mention. Among those whose memories have been perpetuated by his pen are Thomas Graham, Gustav Magnus, and last of all Friedrich Wöhler.

Several of his addresses delivered upon special occasions have been published, among which are two academical orations delivered recently in Berlin, which have appeared under the title of "Chemische Erinnerungen aus der Berliner Vergangenheit." His inaugural address upon assuming the rectorship of the Berlin University has provoked some discussion, owing to the position taken in regard to classical studies, and has already been referred to in our pages. His largest and most important work is his "Report on the Development of Chemical Industries," which first appeared in 1875-'76.

CORRESPONDENCE.

OLD STUMP-WELLS IN THE MISSISSIPPI "BOTTOM."

Messrs. Editors:

IT is a fact well known to all who have made any study of the "Bottom," or alluvial plain, formed during the lapse of ages by the great Mississippi River, that the river channel, or bed, is forever shifting, and in its mighty contortions it has moved laterally eastward and westward over vast spaces. Many of the abandoned channels are now curved lakes, with no connection with the river; others, connected with it more or less during floods, are called "old rivers." So thoroughly the river does its work in forming the land that, besides these crescent-shaped lakes and old rivers, there is little in view to indicate where the bed of the river lay one hundred or one thousand years ago. When the river changes its channel, by suddenly or gradually cutting through a point of land, or when one chute of an island is closed by a bar, a lake or an old river is formed; but, when the river shifts its position, by continued abrasion on one side, and by corresponding deposit of sediment on the other, the latter slowly but steadily rises to the average height of the neighboring land, and in a few years is covered by a heavy forest-growth, and there is no visible sign left to show that it has not been thus since the creation, or at least since the Gulf of Mexico deserted that particular point on its everlasting retreat southward.

The tract of land on which I reside, and which I have owned for more than forty years, was washed, up to about the year 1855, by the main body of the Mississippi River, swinging around the western side of a plano-convex-shaped island; at that period three fourths of all the water of the river passed my door, but about that time, the exact year I do not remember, the channel began to change, and in a very few years the main body of water was, and has since then been, running down the plano and eastward side of the island, and the head of the western chute is largely obstructed by bars. Whether the bars formed first, and forced the channel eastward, or whether the change of the channel caused the bars to form, has not, so far as I know, been satisfactorily answered. At all events, my land now lies on an "old river," which is never entirely dry, although often very nearly so, and the growing obstructions threaten to cut me off, at no distant day, from outside communication, at least by water, except at very high stages. I will add, in passing, that it is in contemplation by the National River Improvement Commission (which is spending millions in the interest of navigation, with no especial thought as to riparian interests) to hurry up this consummation by piling, willow-mattressing, etc., so as to force the entire body of water, even in its highest stages, through the eastern or shorter chute.

In addition to being located on an "old river," my land lies, as I believe, just where a river-formed lake existed at a remote period, but which has in process of time, long before memory goes, been filled up by deposits from overflows, until now it is somewhat higher than the general level of the neighboring sections, and I will give my reasons for so thinking as briefly as I can. At certain periods of the year, as there are no small running streams in this section, cattle suffer from thirst, although the great river runs by our doors, for then the stream is low, and the banks are either precipitous, or, when sloping, terminate in a quicksand, in which many uncared-for cattle are lost every year; hence the necessity for abundant wells and cisterns.

Seeing some water standing in an old, hollow cypress-stump, about four fee tin diameter, the surface of which water was at least fifteen feet above the surface of the river at the time, I was curious enough to investigate the matter. An outside rim of the stump, about four inches in thickness, remained sound, but the interior portion (all except a hollow of about a foot in diameter, down which I had observed the water) was composed of dry-rotted wood, still clinging closely in place. I had the rotted portion taken out down to the surface of the water, and the water pumped out, finding the reservoir to extend down sixteen feet. In about six hours the water had returned to its former level. Pumping it out again, I had the rotten wood removed; this was done with very little trouble. With a little more digging, and removing the old wood, which had previously fallen to the bottom, I discovered where the main roots of the tree started at a distance of about seventeen feet below the surface of the ground, plainly showing that, when the tree first sprang from the seed, the surface of the ground was many feet lower than at present. After thoroughly cleaning out the well, I permitted the water again to rise, and found it cool and wholesome, with a slightly brackish taste, but not at all offensive.

Subsequent investigation showed me that every hollow cypress-stump (and there are a large number of them) on my place is a natural well, but varying in depth, proving that the ground on which these trees sprouted was not level, or at least that the level was changed from time to time. I have one of these wells in my stable-yard; it is about four feet in diameter and nine feet in depth. I cut the stump off level with the ground, floored it over, and placed a pump in it, and in the driest seasons it furnishes abundant water for my stock. I have about fifteen dug wells on my place, all within the space of two square miles; the depth of the water-surface in these varies from eight to fifteen feet. A large curbed well stands in my gin-house, within twenty feet of the bank of the river, and to-day the water stands in this well at least fifteen above the surface of the stream, and is in no manner affected by its rise or fall. It would not be difficult to form a reasonable theory to account for the deeply-rooted cypresses, but the formation and existence of the wells require the presumption of an enormous deposit of clay, and to account for the presence of the latter is the difficulty. The Mississippi brings down in suspension a comparatively small portion of argillaceous material, but it is certainly here in a solid stratum, and it came at a period subsequent to the sprouting of the old cypress-trees, for it is highly improbable that a tree should send down a tap-root eighteen feet, and then spread out its lateral supports. The cypresses, forty years old, make no such indications, but have their radical processes corresponding with those of the other trees of the forest.

JAMES B. CRAIGHEAD.

NODENA, ARKANSAS, *August* 1, 1883.

WORK OF SHOD AND UNSHOD HORSES.

Messrs. Editors:

IN the February number of your magazine appears an article, by Arthur F. Astley, on the "Working Capacity of Unshod Horses," in which the writer states, "*In New Mexico, horses are ridden barefoot forty miles day after day, and perhaps twenty miles of this will be over a rough mountain-track.*" Now, I have served with my regiment in New Mexico for several years, most of the time as post-quartermaster, having large numbers of both horses and mules under my charge. While it is true that most horses are ridden unshod by the natives in the *valleys*, where the roads are sandy and soft, it should be borne in mind that even there the majority do so simply because they are too poor to have their horses shod; but, when it comes to traveling over rough mountain-tracks, the writer's statement is simply absurd. The Indians (Apaches) understand the inability of unshod horses to travel over mountain-trails so well, that they cover their horses' feet with raw-hide bags, and, when the latter wear out, the horses soon become disabled, and I have frequently found Indian horses abandoned on the trail, with their hoofs bleeding and worn, and the poor animals in a most pitiful plight. Again, when Indians are enlisted as scouts, they furnish their own mount, and, when reaching the post, they always request to have their horses shod. There can be no question that a *properly*-shod horse has a superior working capacity, but I confess that most shoeing, from the ignorance of the average farrier, is simply a process of torture and violation of nature, and crippled horses are the result. Most farriers place the horse upon an iron tripod, the weight of the animal resting entirely upon three points of the foot, and those *not* the parts intended to bear the shock of travel, or to sustain his weight. The position of the frog becomes one of hopeless inaction, and the motion of the unsupported bones within the hoof produces inflammation at the points of extreme pressure. But I did not intend to write an essay on horse-shoeing.

Respectfully, yours,

THEODORE SMITH,

Lieutenant, United States Army.

WASHINGTON, D. C., *February* 17, 1884.

AMERICAN LOESS-DEPOSITS.

Messrs. Editors:

I HAVE just read Mr. D. W. Williams's interesting article in your December issue on "The Loess-Deposits of Northern China," and am rather surprised to find no allusion therein, by way of comparison or otherwise, to the very extensive loess-deposits of the United States—especially, since it was here, in the valley of the Mississippi, that this peculiar soil was first studied and named *loess* by Sir Charles Lyell, during his second visit to the United States in 1846.

Mr. Williams speaks of the loess-beds of China as among the most remarkable and important geological phenomena hitherto brought to light in Middle Asia, and says "the term *loess* has been used to designate a tertiary deposit appearing in the Rhine Valley, along the Danube, and in several isolated sections of Europe," etc. But the loess-beds of Nebraska, alone, exceed in extent of area those of all Europe combined; and their aggregate extent within the States of Nebraska and Minnesota and the Territory of Dakota falls but little, if any, below that of the loess-beds proper of Northern China. It is believed that the total extent in square miles of this deposit within the States and Territories drained by the Missouri and Mississippi Rivers exceeds that within the Chinese provinces drained by the Yellow, the Wei, and the northern tributaries of the Yangtse.

Mr. Williams does not give any analyses

of the Chinese loess, but it appears to be not essentially unlike that of the Rhine, which, as analyzed by Bischoff, contains a larger proportion of alumina than the samples hitherto analyzed from Nebraska. Bischoff found in four analyses of Rhine loess:

	NUMBER OF ANALYSIS.			
	1.	2.	3.	4.
Silicic acid	58·97	79·53	78·61	62·43
Alumina	9·97	13·45	15·26	7·51
Peroxide of iron	4·25	4·81		5·14
Lime	0·02	0·02	....	....
Magnesia	0·04	0·06	0·09	0·21
Potash	0·11	1·05	3·31	1·75
Soda	0·84	1·14		
Carbonate of lime	20·16	....	....	11·63
Carbonate of magnesia	4·21	....	....	3·02
Loss by ignition	1·37	....	1·89	2·31

Dr. Hayden, in his "Final Report on the Geology of Nebraska," gives, on page 12, two analyses of the loess from Hannibal, Missouri, made by Dr. Lytton, as follows: in one hundred parts, there were of—

	No. 1.	No. 2.
Silica	76·98	77·02
Alumina and peroxide of iron	11·54	12·10
Lime	3·87	3·25
Magnesia	1·68	1·63
Carbonic acid	undetermin'd	2·83
Water	2·01	2·43
Total	96·17	99·26

Dr. Aughey, in his "Report on the Superficial Deposits of Nebraska" (United States Geological Survey, 1874), gives the analyses of five samples of the Nebraska loess taken from widely-separated sections, showing the wonderful homogeneity of the deposit over the large area which it covers in that State—estimated at not less than fifty-eight thousand square miles. His analyses are as follows:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Insoluble (siliceous) matter	81·82	81·83	81·35	81·30	81·32
Ferric oxide	3·86	3·87	3·83	3·85	3·86
Alumina	·75	·75	·74	·73	·74
Lime, carbonate	6·07	6·06	6·03	6·05	6·09
Lime, phosph'te	3·58	3·59	3·58	3·57	3·59
Magnesia, carbonate	1·29	1·28	1·31	1·31	1·29
Potassa	·27	·29	·35	·34	·32
Soda	·15	·16	·14	·16	·16
Organic matter	1·07	1·06	1·05	1·06	1·06
Moisture	1·09	1·08	1·09	1·08	1·09
Loss in analysis	·59	·54	·53	·55	·47
Total	100·00	100·00	100·00	100·00	100·00

It will be seen from these several analyses that the loess of the Rhine and that of the Republican and the upper and lower Missouri are not chemically dissimilar. The latter is thoroughly homogeneous and of uniform color from whatever depth taken. Dr. Aughey says: "I have compared many specimens taken three hundred miles apart, and from the top and bottom of the deposits, and no difference could be detected by the eye, or by chemical analysis. Over eighty per cent of this deposit is finely-comminuted silica. . . . So fine, indeed, are the particles of silica that its true character can alone be detected by analysis or under the microscope." The tendency, noted by Mr. Williams, in the Chinese loess to crystallize spontaneously, and form the cylindrical and spherical concretions which the Chinese call "ginger-stones," is also noticeable over all the loess-regions of the West. Wherever the sod is broken or the earth freshly disturbed from any cause, whether by the plow, or "prairie-dogs," these "ginger-stones" literally cover the ground. This feature is presumably due to the richness of the soil in the phosphates and carbonates of lime, which constitute about one tenth of the entire mass.

In their structural as well as chemical characteristics our Western loess-beds seem to be identical with those of China. They present, also, the same striking peculiarities of landscape-contour, erosion-products, and surpassing fertility, so well described by Mr. Williams. The unique and often exceedingly fantastic forms assumed by the loess-bluffs wherever they have been subject to erosion, as along the Missouri and lower Platte, have long excited the curiosity of tourists. Indeed, so quaint and striking are many of these natural carvings—now stately and now grotesque—that it is not easy on first acquaintance to accept them as the products of natural causes merely, and not rather as the gigantic labors of past generations. In point of architectural adaptability, too, these Nebraska bluffs are the fellows of their Chinese congeners, and fulfill the same generous function of affording cheap and healthful domiciles to whomsoever will carve out their homes in them. Many are the happy and well-to do families, scattered over these fertile regions—especially in Nebraska, Dakota, and Southwestern Minnesota—who have known no other home since "coming West" than the smoothly-hewed walls of the facile loess. Nor, for ends of comfort, cleanliness, or health, do they need to seek better homes—only at the behest of taste or fashion; though, as wealth increases, the American squatter, unlike the Mongolian, soon builds for himself a more pretentious dwelling, and converts his old home into a stable or piggery. I have sometimes had occasion to seek shelter from a storm in one of these "dug-outs," and in traveling have often spent a night in them, and can testify as to the excellent quarters they afford for both man and beast. Like the "adobe" houses of the Mexicans and Pueblo Indians, they are cool in summer and warm in winter, but are superior to "adobe" dwellings in point of dryness and cleanliness. This superiority is due to the fact that wherever the soil is smoothly cut the slight chemical union, which speedily takes place under the influence of the atmosphere between the silica and the carbonate of lime, coats the surface as if with a light washing of cement, and so prevents crumbling. One may note spade-marks as clean-cut and fresh-looking as if newly made on the walls or ceiling of "dug-outs" that have been occupied for years. When the threatened (?) "Mongolian invasion" comes, what hosts of happy Celestials will find here congenial homes! And if, for their better contentment, they rechristen the Missouri the Yellow River, it will be no serious misnomer.

In point of fertility our Western loess-beds are the counterpart of those described by Mr. Williams, except that they do not seem to suffer equally in seasons of drought. The greater depth of the Nebraska deposits—exceeding in many places two hundred feet—and, possibly, their more perfect capillary structure, may explain this difference.

As to the origin of the loess-beds of the United States, the belief of Drs. Hayden, Aughey, and others that they are lacustrine deposits has been hitherto accepted. But it is curious to note how many of their peculiar characteristics are explained, and their general features harmonized with the geological and meteorological phenomena of the great region lying between them and the summit of the Rocky Mountains, by the hypothesis that they are subaërial rather than subaqueous deposits. Nearly all the arguments adduced by Baron von Richthofen in support of his theory of the origin of the loess-beds of Asia may be adduced with equal force, *mutatis mutandis*, in support of a like theory here. Of more than one hundred and twenty species of shells found and identified in the loess-deposits of Nebraska, as given by Dr. Aughey on pages 267 and 268 of "United States Geological Report" for 1874, it will be seen that a large proportion are land-shells. And it appears from the same "Report" that, while the deposits are rich in the remains of land-animals, no considerable number of aquatic species have ever been identified.

Dr. Aughey says, page 254: "Occasionally I have found the teeth and a stray bone of a fish, but have not been able to identify any species. The remains of rabbits, gophers, otters, beavers, squirrels, deer, elk, and buffalo are frequently found. Through the entire extent of these deposits are many remains of mastodons and elephants." To one who has ever encountered a dust-storm on the great plains west of these deposits, when the landscape to either horizon is obscured with flying clouds of powdery dust, like drifting fog, and has noted the almost continuous belt of sand-hills extending from Western Kansas through Eastern Colorado and Wyoming and Western Nebraska, evidently formed by these high winds, whose prevailing direction is always eastward, and marking the deposit of the heavier particles dropped from the flying mass of dust-freight which they had gathered in their fury from the arid foot-hills and high plains still farther westward, the theory of Von Richthofen commends itself with peculiar force. And if a period of still greater aridity be conceived of, before these high regions, the American analogues of the Asiatic steppes, had received their present scant protection of stunted grasses, the conviction arises that, even assuming the volume and velocity of the wind to have been no greater then than now, its prevailing direction being the same, our loess-deposits of the Northwest, like those of China, may be accounted for, both as to their origin and chief peculiarities, by reference to known causes still existing, whose action has been, indeed, greatly modified but not wholly suspended; and without recourse, necessarily, to the lacustrine hypothesis.

William T. Holt.

Denver, Colorado, *January* 4, 1884.

EDITOR'S TABLE.

THE EDINBURGH REVIEW ON THE SPENCERIAN PHILOSOPHY.

There is obviously a decline in the influence of malign criticism in recent times. Even the savage "quarterly reviewer" has lost many of the terrors with which he used to be invested. An excellent example of this is afforded by the history of Spencer's "Synthetic Philosophy." It has been tempting game for the critical sports, and they have pursued it unweariedly. It had but few friends and multitudes of enemies. A new departure in philosophy, it incurred the hostility of the devotees of all old philosophies. Dealing with the larger aspects of science, it kindled the jealousy of narrow-minded scientific specialists. Antagonizing established political opinion and cherished religious beliefs, it provoked the wrath of all who rest contented in tradition. Appearing in successive parts and volumes for twenty-five years, it was constantly before the public, and has been all that time subject to a degree of abuse, ridicule, and detraction, which is quite without parallel in the past history of such enterprises.

And yet during all that time Spencer's system of thought has increased in recognition, appreciation, and power over the mind of the age. Its doctrines permeate our serious literature, as is widely shown by the periodicals; many books are written for and against them; and their author stands to-day the representative man of the most influential and growing school of thought in modern times. This view is further verified by the increasing public demand for his works, more of the solid volumes of the "Synthetic Philosophy" having been called for during the last twelvemonth than in any former year. The inexorable critical resistance Spencer's works have met with has no doubt hindered their spread, but it has failed to arrest them, and has only served to test and demonstrate the inherent strength of his systematic work.

And now the sluggish old "Edinburgh Review" has at last awakened, girded itself up, and entered the lists against Mr. Spencer. The current number contains an article entitled "The Spencerian Philosophy," to which we here call attention, not because it has the slightest value as a contribution to the subject, but because we may gather from it an instructive lesson regarding the decline of the influence of vindictive criticism. It happens that the "Edinburgh Review" has a history in this matter. This is not the first time it has practiced its bludgeon upon the representatives of advancing knowledge. Let us, therefore, first notice its early record in relation to one of the most important steps in the progress of modern science—the establishment of "the undulatory theory of light" by Dr. Thomas Young. We give the "Review" full credit for consistency in an unprincipled course; the instinctive meanness of its infancy, long since execrated by the world, is not in the least abated in its senile dotage.

The "Novum Organon Renovatum" of Dr. William Whewell is an able work devoted to the philosophy of the inductive sciences, of which the same author is also the eminent historian. Dr. Whewell has selected the two most conspicuous examples of comprehensive and valid induction afforded by physical science, and by means of charts he has illustrated in a very striking way the extent of the observed and experimental facts, and the minor inductions, that are brought into unity by all-embracing theories. The first chart is an "Inductive Table of Astronomy," and it shows in a very interesting manner how completely astronomical phenomena are explained and brought into harmony by "the theory of universal gravitation." The second chart is "An Inductive Table of Optics," and in a corresponding way it exemplifies the elucidation of luminous phenomena, and the explication of general optical effects which result from "the undulatory theory of light." Whatever may be the imperfection of these theories, they have fulfilled the purposes of giving rational interpretation to wide ranges of natural phenomena, and of guiding the human mind in the pathway of new discovery by the power of prediction that they have conferred, and the two theories stand together as eminent triumphs of physical reasoning. The name of Newton will be forever associated with the law of universal gravitation, and in the same way Dr. Thomas Young will be immortal as the man whose genius established the undulatory theory of light, and who has hence been very appropriately designated as the Newton of the science of optics.

The optical theory which reigned in the scientific world until the beginning of the present century was known as the theory of emission, which assumed that all luminous effects are due to the darting, rebounding, and deflecting of some kind of material corpuscles or particles. The idea of vibratory or undulatory action as the cause of light was early broached by Huygens and maintained later by Euler, but was generally regarded as a crude speculation without scientific value. Dr. Young, devoting his great powers to optical research, soon perceived that the evidence was decisive in favor of the undulatory view; and, in the case of the interference of light, he proved that it affords a complete interpretation of the effects where the emission theory wholly breaks down. He developed his ideas in elaborate papers published in the "Proceedings of the Royal Society," and gave them mature expression in the Bakerian Lecture of 1802. It was at once seen by a few discerning scientific men that the old controversy between the theories of light was virtually brought to an end. But the old explanation, long accepted, and sanctioned by the great authority of Newton, was, of course, still supreme, while the new explanation had its way to make in scientific circles and in the general mind.

The "Edinburgh Review" now appears upon the scene. This quarterly had just been established, and was supported by a brilliant corps of writers who attracted wide attention, and gave to the periodical an extensive and powerful influence. Henry Brougham, afterward Lord Chancellor of England, was among its founders, and was one of its most versatile and effective writers, and he had himself dabbled somewhat in optical science. He reviewed Young's Bakerian Lecture on "The Theory of Light and Colors," which appeared in the "Philosophical Transactions," and the article was published in the first volume of the new Edinburgh quarterly issued in 1803. It was an insulting and malignant attack upon Dr. Young, whom he ridiculed in the coarsest manner. Mr. Brougham characterized the Bakerian Lecture as worthless, and bitterly denounced the authorities of the Royal Society for degrading science by admitting such foolish speculations into their published proceedings. The event is so memorable that we shall be excused for making some quotations from the article. It opens with these words: "*As this paper contains nothing which deserves the name either of experiment or discovery, and as it is in fact destitute of every species of merit*, we should have allowed it to pass among the multitude of those articles which must always find admittance into the collections of a society which is pledged to publish two or three volumes every year. . . .

"We wish to raise our feeble voice against innovations that can have no other effect than to check the progress of Science, and renew all those wild phantoms of the imagination which Bacon and Newton put to flight from her temple. . . .

"It is difficult to argue with an author whose mind is filled with a medium of so fickle a vibratory nature. Were we to take the trouble to refute him, he might tell us, 'My opinion is changed, and I have abandoned that hypothesis, but here is another for you.' . . .

"We demand if the world of science, which Newton once illuminated, is to be as changeable in its modes as the world of taste, which is directed by the will of a silly woman or a pampered fop. Has the Royal Society degraded its publications into new and fashionable theories for the ladies who attend the Royal Institution? *Proh pudor!* Let the professor continue to amuse his audience with an endless variety of such harmless trifles; but in the name of Science let them not find admittance into that honorable repository which contains the works of Newton, Boyle, Cavendish, and Herschel. . . .

"From such a dull invention nothing can be expected. It only removes all the difficulties under which the theory of light labored to the theory of this new medium which assumes its place. It is a change of name; *it teaches no truth, reconciles no contradictions, arranges no anomalous facts, suggests no new experiments, and leads to no new inquiries.* It has not even the pitiful merit of affording an agreeable play of the fancy. *It is infinitely more useless and less ingenious than the Indian theory of the elephant and the tortoise.* We have a right to demand that the hypothesis shall be so consistent with itself and so applicable to the facts as not to require perpetual mending and patching—that the child which we stoop to play with shall be tolerably healthy, and not of the puny, sickly nature of Dr. Young's productions which have scarcely *stamina* to subsist until the fruitful parent has furnished us with a new litter; to make way for which, he knocks on the head or more barbarously exposes the first."

This is certainly poor stuff, read in the light of subsequent history. Of the man so shamefully vilified by a reckless critic, Professor Helmholtz thus speaks: "His was one of the most profound minds that the world has ever seen; but he had the misfortune to be too much in advance of his age. He excited the wonder of his contemporaries, who, however, were unable to follow him to the heights at which his daring intellect was accustomed to soar. His most important ideas lay, therefore, buried and forgotten in the folios of the Royal Society until a new generation gradually and painfully made the same discoveries, and proved the exactness of his assertions and the truth of his demonstrations."

Nevertheless, the "Edinburgh Review" had power to extinguish the influence of this extraordinary genius, and it was the article from which we have quoted that did the work. Rubbish as it now appears, it was accepted as truth, and the effect was to close the channels of reply to Dr. Young, and push him into obscurity as nothing better than a shallow pretender. As Professor Tyndall remarks: "For twenty years this man of genius was quenched—hidden from the appreciative intellect of his countrymen—deemed, in fact, a dreamer, through the vigorous audacity of a writer who had then possession of the public ear, and who, in the 'Edinburgh Review,' poured ridicule upon Young and his speculations."

Such was the power of base-minded criticism at the beginning of the century; and such the first great exploit of the "Edinburgh Review" in relation to the progress of scientific thought.

Eighty years have since passed away, but the old Scotch quarterly has learned nothing. Oblivious of the great changes that have taken place in the world of thought, it undertakes to repeat upon Herbert Spencer the tactics which proved so effectual in suppressing the greatest scientific man of the opening century. It will fail, and not only this, but the absurd anomaly of its action will be certain to defeat the end it proposes to accomplish. There could hardly be a greater compliment to the work of Spencer than that the "Edinburgh Review" should at this time have printed so incompetent and ridiculous an assault upon it.

The reviewer entitles his article "The Spencerian Philosophy," but it is false to its title in that it makes not the slightest attempt to deal with that philosophy. It shows no appreciation of it, and conveys no shadow of an idea of its real character. The discussion is confined to "First Principles," the opening volume of the philosophical system, which was published twenty-two years ago, and the article is characterized throughout by the most inexcusable ignorance of the subjects considered. It is spiteful, contemptuous, and flippant in spirit, vicious in misrepresentation, and mean in its covert insinuations and outright imputations. Brougham's assault upon Young is its model, and the phraseology of disparagement is almost identical in the two papers, as we illustrate by italicized passages. The reviewer says of Spencer: "*He has not ascertained or discovered a single new fact, nor put any old ones together in such a way as to justify any new inference as to their causes*, either immediate or ultimate. He has only applied new and fanciful terms to the collections he has made." And this is the way he sums the matter up: "This is nothing but a philosophy of epithets and phrases introduced and carried on with an unrivaled solemnity, and affectation of precision of style concealing the loosest reasoning, and the haziest indefiniteness on every point except the bare dogmatic negation of any 'knowable' or knowing author of the universe; which, of course, is the reason why this absurd pretense of a philosophy has obtained the admiration of a multitude of people who will swallow any camel that pretends *to carry the world standing on the tortoise that stands on nothing*, provided only it has been generated by a man out of his own brains, and asserted in imposing language with sufficient confidence." The philosophy of the universe, it may be remarked, which is tacitly held by the writer, is simply mathematics and physics *plus* Scotch orthodoxy.

We have no space to go into particulars in regard to this performance, but may give one illustration of its looseness and lack of decent regard for truth. Its fragmentary quotations are made in the most slovenly manner, and mixed up with the language of the writer so as to convey his own perverted meaning; and, as if conscious of this, he seems to think it necessary to make at least one fair extract. So he says: "This time we will not omit a word for brevity. We ought to give at least one specimen of Mr. Spencer's most careful and precise style unreduced." Then follows an extract of eighteen lines, and, if the reader will believe it, the passage *was reduced by the dropping of whole clauses*, which were not only significant, but made the entire statement unintelligible. And if the reader hesitates to believe this on *our* authority, as too improbable a thing, then let us say that Mr. Proctor has exposed it in his London journal, and convicted the reviewer of mutilation by publishing the extract, with the omissions bracketed.

The "Edinburgh Review" will not succeed at this late day in the revival of its old tactics. Its "slashing" article will be rated at its true worthlessness because there are now multitudes who have some intelligent understanding of the Spencerian philosophy, even if the chosen reviewer knows nothing about it, cares nothing about it, and only takes it up to make a sensational caricature of it. In confirmation of this, we quote a passage from a recent letter of Mr. Richard A. Proctor to the "New York Tribune":

The "Edinburgh Review" makes a savage assault on Herbert Spencer this quarter, in an article written in a style so familiar that it might as well have been signed. Those who admire the work which has already been achieved and is in progress of achievement by the leading philosopher of the century, will be scarcely less pained by this unfair and acrimonious attack than those who have a regard for the reputation of Sir Edmund Beckett. Sir Edmund has attacked the Bacon of this day in terms that would be hardly appropriate if applied to one of those absurd persons who go about with theories that the earth is flat, the law of gravity a gigantic blunder, and the squaring of the circle child's play. Belonging myself to both categories above mentioned, I am doubly grieved. I value Sir Edmund Beckett as a kind personal friend, a masterly reasoner within certain lines, and one of the most skillful advocates, whether of a good or of a mistaken cause, that I have ever met. Herbert Spencer I esteem, I may almost say reverence, as the teacher of the soundest system of philosophy the world has yet, in my judgment, known. That a man whose researches reach so widely should at times fall into error in matters of detail may be readily admitted. Only a few weeks ago I pointed out in the pages of my weekly journal, "Knowledge," what *I* hold to be an entirely erroneous view of Herbert Spencer's respecting the probable origin of the system of asteroids. Yet even in matters of detail belonging to the work of specialists he has been singularly clear-sighted. He first pointed out the fallacies underlying the long-accepted teaching respecting the stellar system, star-clusters, nebulæ, etc., which men like Arago and Humboldt had dealt with without detecting error. In every department of science, in fact, though a specialist in none, Herbert Spencer has left his mark.

The attack in the "Edinburgh Review" leaves Spencer's fame untouched. It is evident in every line of this sour production that the enmity which Sir Edmund Beckett has always felt and expressed toward the teachings of the school of which Spencer has been the Bacon, the Darwin, and the Newton, has made it impossible for him to read with even average attention the work which he pretends to criticise. He has not caught the veriest glimmer of a notion of Mr. Spencer's real meaning. From the only passage which he claims to quote entire he has allowed several important words to drop—by accident doubtless, but yet not by mere accident in transcribing what he had already carefully read and understood; for the reasoning which follows falls to the ground so soon as the omitted words are restored.

Let one example suffice to show how utterly Sir Edmund Beckett either has missed or misrepresents the meaning of the famous contemporary whom he assaults. Herbert Spencer, speaking of the Great First Cause, transcending all laws, Absolute, Unconditional, says that we only perceive It, can only recognize It, by the persistence of force which, as it were, symbolizes It. Sir Edmund regards this as equivalent to saying that the Great First Cause *is* nothing else but persistent Force. Beckett rebukes Spencer for speaking of the "laws of motion" as the results of experience, saying that Newton regarded them as self-evident. He must have forgotten Newton's "Principia," where these laws are presented by Newton as now spoken by Spencer.

LITERARY NOTICES.

Hand-Book of Sanitary Information for Householders, containing Facts and Suggestions about Ventilation, Drainage, Care of Contagious Diseases, Disinfection, Food, and Water. With Appendices on Disinfectants and Plumbers' Materials. By Roger S. Tracy, M. D., Sanitary Inspector of the New York City Health Department. New York: D. Appleton & Co. Pp. 110. Price, 50 cents.

There are now but few persons who have the hardihood to say that hygienic knowledge, or information concerning the preservation of health, is without value. But if it have any value whatever for its purpose, then is it of very great importance, for the maintenance of health and life is the supremest earthly interest. It may of course be said that our fathers got along very well without all this bother about ventilation, drainage, and other hygienic matters, but this is only an apology for ignorance, or a plea for indolence. Through the whole history of the world, and everywhere, long life and vigorous health have been dependent upon the necessary conditions, and, where these have been wanting, feebleness, invalidism, severe sickness, premature death, and the destruction of countless thousands by pestilence, have been the results. In the ignorant ages—the theological ages, when the phenomena of sickness and death were accounted for by the providence of God, against which it was in vain to strive—little was known of the real causes of disease, and it was therefore a subject that attracted but slight attention either privately or publicly. But in this more scientific age, devoted so assiduously to the extension and diffusion of knowledge, men are beginning to feel the importance of a better understanding of those physical conditions and physiological laws upon which health is dependent, and there is, of course, a good deal said about their urgency, and the need of reducing them to practical application. Ignorant and stupid people, and often excellent and pious people, are no doubt much bored by all this modern hygienic agitation, but in the happy order of the world this class of persons are certain to be gradually got out of the way, and they are to be replaced by others who will regard these subjects as not only of the first importance, but full of the liveliest interest. A good sanitary education involves a very considerable understanding of the method of Nature.

We heartily welcome, therefore, the increasing hygienic literature of the age, and are glad to see that the best minds are devoting themselves to it, and giving the public the results in various forms of their serious and careful studies. The little volume now before us is a timely and most valuable contribution to the subject in its practical, every-day aspects for the use of householders. First of all, it is a careful and trustworthy book by a thoroughly prepared man, who has had large experience of hygienic subjects as Sanitary Inspector of the New York City Health Department. It has been Dr. Tracy's business to apply sanitary science to the art of living under our present domestic constructions and arrangements. He has had to meet actual difficulties that arise from the influence of bad air, bad sewerage, bad drainage, bad house-construction, bad precautions respecting infectious diseases, bad food, bad water, and bad plumbing. It seemed to him that there was needed a little book simply of facts and results, free from theory, discussion, or speculation, and written in the plainest style, that would serve for every-day guidance in relation to all these sanitary subjects. It is full of brief rules and directions, and useful information regarding sanitary contrivances, how they are to be obtained and what they cost, and from this point of view it may be regarded as a practical summing up of the most urgent requirements, the best facilities, and the clearest directions, that will be of service every day and to everybody. We have read the book with care, and can recommend it, without hesitation or qualification, as one that should be kept for constant reference in every house.

INTERNATIONAL SCIENTIFIC SERIES.

The Concepts and Theories of Modern Physics. Second edition, revised; with an Introductory Essay. By J. B. Stallo. New York: D. Appleton & Co. Pp. 358. Price, $1.75.

The first edition, and a pretty large one, of this profound work was exhausted some time ago, which speaks well for the interest of American readers in the thorough discussion of the fundamental ideas that are at the basis of science and philosophy. The continued demand for the work making necessary a second edition, the author has subjected the text to a close revision, and prefixed to it a masterly introduction of forty-four pages. He here avails himself of the criticisms passed upon the work, both in this country and abroad (where several editions of it have also appeared), to restate the purpose of the volume, which has been a good deal misunderstood, and to reply to such objections as seemed to require attention. The effect of this lucid and brilliant discussion will be to greatly facilitate the general apprehension, and to enhance the interest of the work to those who take it up for the first time.

In our review of Judge Stallo's book upon its first appearance, we pointed out that it is a philosophical study of the relations of metaphysics to physics, designed to show that many of the leading physicists of the age are by no means as far emancipated from old metaphysical influences as it is customary to believe. He attacks some of the fundamental ideas of modern physics as being strictly metaphysical assumptions, and shows historically how they have survived, and performed their old duties in new relations. But the book was construed as an onslaught upon the foundations of modern physics in the interests of a bad metaphysics, and the author was called upon to offer his substitutes for the fundamental doctrines he aimed to sweep away. We quote some passages from the new introduction, which leave no room for further misunderstanding:

The misapprehension I speak of is very surprising, in view of the explicit declaration, contained in the very first sentence of my preface, that the book is "designed as a contribution not to physics, nor certainly to metaphysics, but to the theory of cognition." Notwithstanding this declaration, most of my critics assume it to be my purpose to expose the short-comings and defects of particular theories as devices for the colligation of facts, or as instruments of research, and suppose that my endeavor is simply, as one of my critics expresses it, "to pick flaws in these theories," or, in the language of another critic, "to classify and develop contradictions" between them, to "set facts by the ears," and "bump friendly heads together"—in short, in the spirit of a sort of scientific pyrrhonism, to discredit the familiar methods of physical science, if not to invalidate its results. And they complain that I fail to apprehend what one of them is pleased to term the "laboratory function" of a physical theory or hypothesis, and to appreciate the distinction between a "working hypothesis" and a theory advanced with the claim of its final validity or truth.

Now, the fact is, that for the purposes of the inquiry to which my book is devoted, I am not *directly* concerned with the "laboratory function" of "working hypotheses" or physical thories at all. My object is to consider current physical theories and the assumptions which underlie them in the light of the modern theory of cognition—a theory which has taken its rise in very recent times, and is founded upon the investigation, by scientific methods analogous to those employed in the physical sciences, of the laws governing the evolution of thought and speech. Among the important truths developed by the sciences of comparative linguistics and psychology are such as these: that the thoughts of men at any particular period are limited and controlled by the forms of their expression, viz., by language (using this term in its most comprehensive sense); that the language spoken and "thought in" by a given generation is to a certain extent a record of the intellectual activity of preceding generations, and thus embodies and serves to perpetuate its errors as well as its truths; that this is the fact hinted at, if not accurately expressed, in the old observation according to which every distinct form or system of speech involves a distinct metaphysical theory; that the metaphysical systems in vogue at any particular epoch, despite their apparent differences and antagonisms, on proper analysis are found to be characterized by certain common features in which the latent metaphysics of the language in which such systems have originated, or are presented, are brought to view; that philosophers as well as ordinary men are subject to the thralldom of the intellectual prepossessions embodied in their speech as well as in the other inherited forms of their mental and physical organizations, and are unable to emancipate themselves from this thralldom otherwise than by slow and gradual advances, in conformity to the law of continuity which governs all processes of evolution whatever. It being my belief that all this applies to the votaries of science as well as to the devotees of metaphysics or ontology, I sought to enforce this belief by an examination of the general concepts and theories of modern physics. According to the opinion of contemporary men of science, these concepts and theories are simply generalizations of the data of experience, and are thus not only independent of the old *a priori* notions of metaphysics, but destructive of them. But, although the founders of modern physical science at the outset of their labors were animated by a spirit of declared hostility to the teachings of mediæval scholasticism—a fact which is nowhere more conspicuous than in the writings of Descartes—nevertheless, when they entered upon the theoretical discussion of the results of their experiments and observations, they unconsciously proceeded upon the old assumptions of the very ontology which they openly repudiated. That ontology—founded upon the inveterate habit of searching for "essences" by the interpretation of words and the analysis of the concepts underlying them, before the relations of words to thoughts and of thoughts to things were properly understood—was characterized by three great errors: its hypostasis of concepts (notwithstanding the protest of the nominalists against the reification of universals); its disregard of the twofold relativity of all physical phenomena; and its confusion of the order of intellectual apprehension with the order of Nature. These errors gave rise to a number of cardinal doctrines respecting the "substance of things," among which were the assertion of its existence as a distinct thing or real entity, apart from its properties; the further assertion of its absolute permanence and immutability; and, finally, the assertion of the absolute solidity and inertia of its parts and their incapacity to act upon each other otherwise than by contact. And all these doctrines lie at the base, not only of Cartesian physics and metaphysics, but of the scientific creed of the great majority of the physicists of the present day. The eminent physicist and physiologist who declares that "before the differential equations of the world-formula could be formed" (i. e., before the ultimate, true, and exhaustive theory of the universe could be constructed), "all processes of Nature must be reduced to the motions of a substratum substantially homogeneous, and therefore totally destitute of quality, of that which appears to us as heterogeneous matter—in other words, all quality must be explained by the arrangement and motion of such a substratum," and the equally distinguished physicist and mathematician who enters upon the attempt at a solution of the problem thus stated by endeavoring to deduce the phenomenal diversities and changes of the universe from imaginary vortical motions of the undistinguishable parts of an assumed universal, homogeneous, continuous, and incompressible fluid, are both as truly instinct with the spirit of the old *scientia entis quatenus entis* as the most ardent disciple of the Stagirite in the times of Erigena or Aquinas. The physicist who insists upon impact theories of gravitation, cohesion, or chemical affinity, has the same intellectual blood in his veins which coursed in those of the old disputants about "first matter" or "substantial forms." When the Professor of Physics in the University of Edinburgh teaches that matter is absolutely passive, *dead*, that all physical action is action by contact, that nothing is real which is not indestructible, etc., he stands as unmistakably upon scholastic ontological ground as did Descartes or any of his ecclesiastical contemporaries. The proposition of the modern kinematist, that the true explanation of the phenomena of heat, light, electricity, magnetism, etc., consists in their reduction to the elements of matter and motion, differs in little else than its phraseology from the metaphysical theorem that all the "secondary qualities" of the universal substance are mere specifications or derivatives of its "primary qualities."

Aboriginal American Authors and their Productions; especially those in the Native Languages. By Daniel G. Brinton. Philadelphia: 115 South Seventh Street. Pp. 63. Price, $1.

The present memoir is an enlargement of a paper which the author presented to the International Conference of Americanists at its last meeting in Copenhagen, in August, 1883. In it Dr. Brinton shows that the native Americans had a literary faculty, which is indicated by a vivid imagination, a love of narration, and an ample, appropriate, and logically developed vocabulary. They have left behind them a creditable literature of considerable extent which would have been larger, but much of it was wantonly destroyed by their self-styled civilized conquerors. They wrote in their own language, in Spanish, and in Latin, narrative, didactic, and oratorical works, poems, and dramas, the general character of which is briefly sketched and a partial list given. The Northern Indians are less fully represented in this literature than the Mexican and South American.

Cassell's Family Magazine, American edition. January and February, 1884. New York: Cassell & Co., Limited. Pp. 64 each. Price, 15 cents a number; $1.50 per year.

"Cassell's Magazine" is conducted with reference to the tastes of the family, and is designed to furnish that which will profit as well as amuse. Well-selected fiction is provided, in serial stories as well as in those that are completed in one number; and in addition to this are given, regularly, papers on "Household Management," "Domestic Cookery," "Gardening," "Education and Recreation," the "Family Doctor's Papers"; a department for the discussion of social questions of the day, papers on remunerative employment for women, records of useful inventions and discoveries, and numerous illustrations.

Natural Philosophy. By Isaac Sharpless, Sc. D., and G. M. Philips, A. M. Philadelphia: J. B. Lippincott & Co. 1884. Pp. 350.

So many text-books on natural philosophy have appeared within the past few years that the teacher of to-day is embarrassed by the surplus of riches. In most of these an effort may be observed to introduce the only true method, that of personal experimentation. Many difficulties remain to be overcome, and the task is not an easy one. Although the authors state in their introduction that this treatise differs from others in the large number of practical experiments and exercises which it contains, we are somewhat disappointed at the small number of novel and simple experiments adapted to the average school-room, while more difficult and dangerous experiments are given in detail, such as the preparation of cyanide of silver from a silver coin for electro-plating. In other cases there is a lack of fullness, as for example, under electrolysis of water no mention is made of the kind or size of battery required; under electrophorus the composition of the rosin-cake is not given, and the pupil is led to infer that it is pure rosin. Neither the Holtz nor Windhurst electrical machines is pictured and described, but the old cylindrical machine takes their place. The Morse registering apparatus is illustrated instead of the sounder actually in use, and the duplex, quadruplex, and ocean-cable systems are referred to in a manner neither satisfying nor instructive. Notwithstanding these obvious defects, there is much to recommend the book as quite equal to the average text-books on this subject, and in some respects it is an improvement on them. The illustrations are excellent, the type clear, and the paper good.

Transactions of the American Dermatological Association at the Seventh Annual Meeting, August, 1883. By Dr. Arthur Van Harlingen. Baltimore: Thomas & Evans. Pp. 49.

The pamphlet contains the official report of the proceedings of the Association, with abstracts of the papers read, a list of publications and writings of members of the Association during the year ending in July, 1883, and a statistical report of cases treated.

The Winter Resorts of Florida, South Georgia, Louisiana, Texas, California, Mexico, and Cuba. By John Temple Graves. Published by the Passenger Deparment of the Savannah, Florida, and Western Railway Company. Pp. 103, with Maps and Illustrations.

An attractive and popular guide-book to a whole region of health resorts and winter residences that are every year attracting more attention. It furnishes brief descriptions of the points of interest to the tourist, invalid, immigrant, or sportsman, and of the way to reach them.

GOD AND THE STATE. By MICHAEL BAKOUNINE, Founder of Nihilism and Apostle of Anarchy. Translated by BENJAMIN R. TUCKER. Boston: Benjamin R. Tucker. Pp. 52. 15 cts.

THE name of the author of this pamphlet ought to give a sufficient indication of its character. His apostleship of anarchy appears to have been as active in a religious as in a social and political aspect. We are informed that the work "contains an attack upon the theistic idea from a new stand-point, which, if successful, will result in tremendous consequences." It is certainly of interest to the student of mental phenomena, and of the order of social movements of which the author is a most conspicuous representative. A preface is furnished by Carlo Cafiero and Elisée Reclus.

POPULAR ESSAYS ON THE MOVEMENTS OF THE ATMOSPHERE. By Professor WILLIAM FERREL. Washington: Government Printing-Office. Pp. 59.

THE papers that make up this volume were originally published in the "Nashville Journal of Medicine and Surgery," "The American Journal of Science," and "Nature." They relate to the winds and currents of the ocean; the motions of fluids and solids relative to the earth's surface; the cause of low barometer in the polar regions and in the central part of cyclones; the relation between the barometric gradient and the velocity of the wind; and researches on cyclones, tornadoes, and water-spouts.

ELEMENTARY BOTANY, with Student's Guide to the Examination and Description of Plants. By GEORGE MACLOSKIE, D. Sc., LL. D., Professor of Natural History in the J. C. Green School of Science, Princeton, N. J., and Medalist of Queen's and London Universities. New York: Henry Holt & Co. 1883.

MACLOSKIE'S "Botany" is a marked departure from our cherished models of botanical text-books, and we confess that it has taken considerable time for us to get accustomed to its novelty. It is a wholly modern work, and conforms to the revolution of method that followed the translation of "Sachs's Botany," from the German. The body of the book, which is devoted to the general principles of the science, is unusually free from the technicalities of text-books. The treatment is very fresh and interesting, and in his aim to supply a readable sketch of botany the author has well succeeded.

As a "guide to work in the field and laboratory," if supplemented by the further guidance of the master, the work will no doubt prove a success; but as a manual for private study it strikes us as unattractive and unsatisfactory. But such a use of it was probably not in the author's mind in its preparation.

Many people will object to Macloskie's innovations in descriptive botany. If anything in science is firmly settled it is thought that botanical technology might make the claim. But our author has not scrupled to alter and amend its time-honored usages; yet, if improvement be a sufficient warrant for change, we suspect that he can justify himself. He has certainly gained in brevity, if not in greater precision of statement, by which beginners in the study will be gainers. Old botanists, however, will be slow to adopt the new terms. We cordially commend the volume to that large class of readers who wish to know something of the fundamental principles and philosophical bearings of this important science.

THE SUN CHANGES ITS POSITION IN SPACE, THEREFORE IT CAN NOT BE REGARDED AS BEING "IN A CONDITION OF REST." By AUGUST TISCHNER. Leipsic: Gustav Fock. Pp. 37.

THE obvious truth expressed in the title is used as a basis of attack upon the adequacy of the received theories of astronomy. "The smallest movement of the sun," says the author, "overthrows the entire fabric of Copernicus." If the sun is moving, the orbits traversed by the planets can not be closed; and the astronomical dictum that, with reference to the planets, we may regard the sun as being in a state of rest, involves absurdity, for it assumes a motion which is at rest.

A DICTIONARY OF MUSIC AND MUSICIANS. Edited by GEORGE GROVE, D. C. L. Parts XVII and XVIII. London and New York: Macmillan & Co. Pp. 240. $2.

THE present double part of the "Dictionary" contains the titles from "Sketches" to "Sumer is icumen in," with the title-page and a list of contributions to Volume III. The article in the midst of which the part opens, on "Sketches," is one of great interest, and is liberally illustrated with musical citations. "The Sonata" is fully considered. Forty-eight pages are given to the subject of "Song," which is treated historically and systematically with reference to the characteristic features of the songs of different nationalities. The work appears destined to be one that no musician will be willing to be without.

Evolution: A Summary of Evidence. By Robert C. Adams. New York: G. P. Putnam's Sons. Pp. 44.

This paper is the substance of a lecture delivered in Montreal, in which the evidence in favor of the doctrine of evolution is reviewed and stated in brief in a very clear and forcible manner. Concerning the orders of life, the author shows that animals and plants appear as they would have done if one race sprang from another; that each being does spring from (embryonic) forms common to the races below it; and that life has appeared on the earth in the order that it would have done if each higher race had been developed from a lower one. Brief consideration is also given to the evolution of mind and of the universe as postulated by the nebular hypothesis; and, finally, the author, admitting that evolution does not solve all the mystery of life, asserts that it does not either question the existence of God, but "only concerns itself as to the manner in which the Supreme Power works, and claims that it acts through natural law, and not through miracle.

Lessons in Qualitative Chemical Analysis. By Dr. F. Beilstein. Translated, with Copious Additions, by Charles O. Curtman, M. D. St. Louis Stationery and Book Co. 1883. Pp. 164, and Thirteen Woodcuts. Price, $1.50.

Dr. Beilstein's little work is the text-book in several German and Russian universities, and more than one English translation has already appeared in this country. The present translation differs essentially from the previous ones in the amount of new matter added. The short introduction on chemical manipulations will prove valuable to the student who is working alone or in laboratories imperfectly supplied with instructors, and in any case saves a great deal of oral teaching and demonstration. Next follow the special examples of the original with several additional ones, but rearranged so as to place the reactions for bases and acids under separate headings, and eliminating those which require too long a time in preparation. A new chapter is then introduced to serve as a guide in the various practical examinations during the course. An excellent table of spectra accompanies the book, with a chapter on the use of the spectroscope. Directions are also given for the detection of a few organic substances such as alcohol, chloroform, glucose, phenol, and the alkaloids. The book closes with a chapter of thirty-eight pages on volumetric analysis, in which very full directions are given for preparing test solutions, with description of apparatus employed. The course embraced in Dr. Curtman's book is sufficient for physicians and others who do not intend to become chemists, while it is a useful introduction to a more thorough course for the latter.

A Manual of Chemistry, Physical and Inorganic. By Henry Watts, B. A., F. R. S. Philadelphia: P. Blakiston, Son & Co. 1884. Pp. 595.

The name of Watts is already familiar to the chemists of all countries, not only as the author of the only complete dictionary of chemistry in the English language, but also as the editor of the leading English journals of that science, "The Chemical News" and the "Journal of the London Chemical Society." In 1868 Mr. Watts revised Fowne's well-known "Manual of Chemistry," and from time to time new editions of that work have appeared under his editorial care. The book continued to increase in size until it became necessary to divide it into two volumes, the one containing the inorganic and physical portion, the other being devoted to organic chemistry. The work before us is but a new edition of the first volume of Fownes's, having the same ancient woodcuts, and in most cases the same matter accompanies them. We notice, however, new cuts of a Holtz machine and a Ruhmkorff's coil, but none of any modern dynamo, although the obsolete cylinder machine is still paraded before the reader. In matters more intimately associated with the chemical laboratory there is less to criticise. Sprengel's air-pump is illustrated and described (Bunsen's modification is not); the modern methods of determining vapor densities, devised by Hofmann and Victor Meyer, are illustrated and explained. The theoretical portions have been mostly rewritten, and many improvements are noticed. The order of studying the non-metals has been changed so that the halogens precede oxygen and other dyads. The metals are grouped in their natural order, so that silver no longer finds itself in the same box with sodium, as it did in the artificial grouping according to quantivalence adopted in previous editions.

Abstract of Report on the Geology of the Eureka District, Nevada. By Arnold Hague. Washington: Government Printing-Office. Pp. 48, with Map and Sections.

The Eureka District embraces a region about twenty miles square, situated on the Nevada Plateau, in Central Nevada, midway between the basins of Lake Lahontan and Lake Bonneville. It is doubtful, in the opinion of Mr. Hague, if there is any region of equally restricted area in the Great Basin that surpasses it in its grand exposures of palæozoic formations, especially of the lower and middle portions of the series. It also possesses a great economic interest as the seat of an active mining industry, and has been, moreover, the center of intense volcanic action. It is therefore selected for a more careful survey and study than had heretofore been given to any region of sedimentary rocks in Nevada. The results of this survey and study are recorded in the present memoir.

United States Geological Survey. Second Annual Report, 1880–'81. Pp. 588, with 61 Plates; Third Annual Report, 1881–'82. Pp. 564, with 32 Plates. By J. W. Powell, Director. Washington: Government Printing-Office.

Many of the special papers included in the second volume of the report have already been noticed in the "Monthly," as monographs. The whole list includes Captain Dutton's "Tertiary History of the Grand Cañon District," Mr. Gilbert's "History of Lake Bonneville," Mr. Hague's "Geology of the Eureka District," Mr. S. F. Emmons's "Geology of Leadville," Mr. G. F. Becker's "Geology of the Comstock Lode," Professor Pumpelly's "Statistics of Coal and Iron," Dr. Irving's Copper-bearing Rocks of Lake Superior," Mr. Clarence King's "Precious Metal Statistics," Mr. Eliot Lord's "History of the Comstock Lode," and Mr. G. K. Gilbert's "New Method of Hypsometry." The other volume (third report) contains papers on "Birds with Teeth," by Professor O. C. Marsh; "The Copper-bearing Rocks of Lake Superior," by Roland D. Irving; the "Geological History of Lake Lahontan," by Israel C. Russell; "The Geology of the Eureka District, Nevada," by Arnold Hague; a preliminary paper "On the Terminal Moraine of the Second Glacial Epoch," by Thomas C. Chamberlin; and "A Review of the Non-Marine Fossil Mollusca of North America," by Dr. C. A. White.

The Natural Genesis. By Gerald Massey. New York: Scribner & Welford. 2 vols. Pp. 552 and 535.

Mr. Massey has given his critics a hard task to perform. He states that Mr. Alfred Russel Wallace, having read the previous volumes of his series, expressed the fear that there might not be a score of people in England who were prepared by their previous education to understand the book; and he intimates that few of its reviewers could be included among that number. Herr Pietschmann, a German Egyptologist, was startled by the "unheard-of suggestions" the book contained, and thought it was "inspired by an unrestrained lust for discovery." "The Natural Genesis" is the second part of "A Book of the Beginnings," of which two volumes had previously been published, the whole containing "an attempt to recover and reconstitute the lost origins of the myths and mysteries, types and symbols, religion and language, with Egypt for the mouth-piece and Africa as the birthplace." It is written "by an evolutionist for evolutionists," is intended to trace the natural origins and teach the doctrine of development, and is based upon the new matter supplied by the ancient monuments. The predominant argument of the book is, that Africa and not Asia was the birthplace of articulate man, and therefore the primordial home of all things human;

and that the human race and human development started from the interior of the dark continent, and went out down the Nile and through Egypt, confessedly the oldest civilized nation, to all the quarters of the earth. As a corollary to this, all customs, all myths, all civilization, all speech, and all religion, had their origin in Egypt, and are traceable directly back there. Another corollary is that all the sociological science and comparative philology that have been built up on the theory of a primitive Aryan race and civilization and language are idle speculations, except as these Aryan institutions are admitted to be children of the Egyptians. The Christian religion also suffers at Mr. Massey's hands; for this work, to use his own language, "culminates in tracing the transformation of astronomical mythology into the system of equinoctial Christology called Christianity, and demonstrating the non-historic nature of the canonical gospels by means of the original myths in which the Messianic mystery, the Virgin motherhood, the incarnation and birth, the miraculous life and character, the crucifixion and resurrection of the Saviour Son, who was the Word of all ages, were altogether allegorical." Having devoted a dozen years exclusively to his work, Mr. Massey has been able to bring to his aid a vast amount of learning, and has used it with considerable ingenuity. His text abounds with interesting facts and citations not to be found elsewhere in a whole library, and with skillful applications. If his conclusions do not carry conviction, it is not for lack of bravery and address on the part of their champion.

On the Contents of a Bone-Cave in the Island of Anguilla (West Indies). By Edward D. Cope. Washington: Smithsonian Institution. Pp. 30, with Five Plates.

Attention was first called to the interesting bone-deposit described in this memoir in 1868, when a load of the cave-earth was brought to Philadelphia as a fertilizing material, and the bones were examined by Professor Cope. Together with the bones was found a chisel of human manufacture, made from a shell. The quantity of animal remains in the deposit and their dimensions point to the former existence of a more extensive and larger fauna than the island as it now stands could have supported. This fact is regarded as confirmatory of the hypothesis that the Antilles were once connected by ranges which have been submerged since Pliocene times. In the light of these facts, Professor Cope claims that the study is of importance, because it is the first investigation of the life of the cave age in the West Indies; because it gives the first reliable indication of the period of the submergence by which the islands were separated; because it furnishes the first evidence as to the antiquity of man there; and because it describes some peculiar forms of life not previously known.

Cruise of the Revenue Steamer Corwin in Alaska and the Northwest Arctic Ocean, in 1881. Notes and Memoranda. Washington: Government Printing-Office. Pp. 120.

The notes include a very interesting paper by Dr. Irving C. Rosse, on the medical features of the expedition, with anthropological memoranda respecting the Esquimaux, and the effects of the Arctic climate on the members of the expedition and the natives; botanical observations, by Mr. John Muir; description of the birds of Behring Sea and the Arctic Ocean, by E. W. Nelson; and a list of fishes, by Tarleton H. Bean. The text is illustrated with heliotype and colored lithographic plates.

Report on the Oyster-Beds of the James River, Virginia, and of Tangier and Pocomoke Sounds, Maryland and Virginia. 1881. By Francis Winslow, U. S. N. Washington: Government Printing-Office. Pp. 87, with Plates.

This monograph is one of the series of "Methods and Results" of the United States Coast and Geodetic Survey. In it, Captain Winslow presents the results of an investigation which he was ordered in 1878 to make with the schooner Palinurus, and which should include the determination of the positions and areas of the oyster-beds and the depth of water over them, at both high and low water; the determination of the character of the beds, whether natural or artificial, and how the oysters were distributed; the determination of the temperatures of the surface and bottom water, and the velocity of currents; the preservation of specimens of oysters; the determination of the characters of bottoms and of the existence of any sediment or deposit; of the sources of sediment and the means of turning it away; the examination of the effects of ice on the beds; and the determination of the density of the water, with special reference to the displacement of salt water by fresh water from adjacent streams and rivers. The plan of the work was to make the investigation exhaustive over a limited area, and extend it afterward as circumstances should permit. The results are given in the present memoir.

Explosive Materials. By M. P. E. Berthelot. Translated from the French by Marcus Benjamin. New York: D. Van Nostrand. (Science Series.) 1883. Pp. 180. Price, 50 cents.

In these lectures M. Berthelot has summed up the results of his researches upon explosives, and indicated the theory of their action which they seem to him to warrant. He is mainly concerned in considering how an explosive is set in operation by means of shock, and reaches the conclusion that in all cases, whether the explosive influence be propagated from particle to particle of an explosive, or from one explosive body to another, not in contact with it, the action consists in the transformation of the energy of the shock into heat. Before an explosion can occur, some portion of the substance must be raised to the temperature necessary for the chemical reaction between its constituents. That this temperature should be reached, it is necessary that the impact be sudden, as otherwise the transformation into heat will take place so slowly that this heat will be distributed through too great a mass of material to raise its temperature to the requisite point. The explosion of one particle of the substance produces a sudden pressure, the energy of which, transformed into heat, causes the next particle to explode, and so on, the disturbance being thus propagated through the entire mass of the explosive. M. Berthelot rejects the synchronous theory of explosions by influence—where a body is exploded by another at a distance—of Abel, holding that the theory of transformation of mechanical energy into heat, and the retransformation of this into mechanical energy, is competent to explain all the phenomena. In discussing the conditions of maximum effect in explosion, he points out the reason for the extremely low velocity of propagation of the explosive wave in gases, obtained by Bunsen, and shows that this in reality moves with great rapidity.

Mr. Benjamin's translation appears to be accurate, and, despite occasional roughness, is fairly well done. The volume contains also a short historical sketch of gunpowder, translated from the German of Karl Braun, and a bibliography of works on explosives.

The Ores of Leadville and their Modes of Occurrence, as illustrated in the Morning and Evening Star Mines. With a Chapter on the Methods of their Extraction as practiced at those Mines. By Louis D. Ricketts, B. S., Princeton, N. J. Pp. 68, with Six Plates.

The author, in order to comply with the requirements of the W. S. Ward Fellowship in Economic Geology, in connection with Princeton College, devoted four months at Leadville to the study of the ores and their modes of occurrence, and to the extraction of the ores in the mines named in the title we have cited. The result of this study is given in the present paper, of which the first part considers the scientific and the second part the practical side.

J. A. Berly's British, American, and Continental Electrical Directory and Advertiser. London: William Dawson & Sons; New York: George Cumming, 219 East Eighteenth Street. Pp. 664. Price, $2.50.

This volume, which embodies a record of all the industries directly or indirectly connected with electricity and magnetism, and the names and addresses of manufacturers in England, the United States, Canada, and the European Continent, is a valuable book of reference for all persons interested in electrical art. The increased size and importance of this, the second edition, over the volume published a year previously, which was chiefly limited to England, is one of many signs of the rapidly expanding development of the applications of electricity. Another similar sign is afforded by the variety of trades—some of them appearing at first sight only very remotely related to electricity—that have been included within its scope. The relation is nevertheless real, for all these trades have been brought in to comply with some demand. A brief, comprehensive record of the progress in the applications of electricity and of events illustrating it, during 1882, adds value to the work. Classified indexes are provided, and reference is further facilitated by differences in the coloring of the leaf-edges of the several departments.

Recherches sur la Structure de quelques Diatomées contenues dans le "Cementstein" du Jutland (Researches on the Structure of some Diatoms contained in the "Cementstein" of Jutland). By MM. W. Prinz and E. Van Ermengen. Brussels: A. Manceaux. Pp. 74, with Four Plates.

A record of a minute and careful examination of the curious organic structures designated, of particular interest to microscopists and students of the *Diatomaceæ*. The authors claim, moreover, a kind of educational interest and utility for studies of the class to which this one belongs, because acquaintance with the exact forms of the varied and delicate designs that adorn the siliceous envelopes of the microscopic algæ facilitates the interpretation of similar images that appear in other microscopic investigations, and furnishes a safeguard against the causes of error and illusions to which microscopists are exposed from the presentation of figures under their instruments which do not conform to the reality.

Geological Survey of Alabama. Report for 1881 and 1882. By Eugene Allen Smith, Ph. D., State Geologist. Montgomery, Alabama: W. D. Brown & Co. Pp. 614, with Maps.

The present volume of the reports is devoted chiefly to an account of the agricultural features of the State. The author was commissioned to prepare the cotton report of Alabama in connection with the tenth census, and by joining the two works has been able to make both more complete than he could have made either separately. Special attention is given to the descriptions of the soils, as to the State and by counties, of timber-trees and other plants, and to cotton production. Excellent graphic, colored maps are inserted, showing the soils, the rainfall and temperature by the seasons and by the year, and the percentages of land in different parts of the State cultivated in cotton.

First Annual Report on the Injurious and other Insects of the State of New York. By J. A. Lintner, State Entomologist. Albany: Weed, Parsons & Co. Pp. 383.

Dr. Lintner has given a large amount of information on the subject of his report. Beginning with an exposition of the importance of entomological study, he considers the extent of insect depredations and the losses from them, particularly in the United States, the immense number of insects, and the necessity, for the sake of contending with them, of acquiring knowledge of their habits. He then reviews the progress that has been made in economic entomology, estimates the value of the various insecticides that have been introduced and of other remedies for and preventives of insect depredations, after which he furnishes descriptions and life-histories of the more injurious insects. Among the preventives of insect depredations suggested by Dr. Lintner is one which we believe is new: it depends upon the theory that insects are attracted to the plants they infest by the odor, and consists in the use of some substance by which that odor may be overcome or neutralized.

Hints on the Drainage and Sewerage of Dwellings. By William Paul Gerhard, Civil Engineer. New York: William T. Comstock, 6 Astor Place. 1884. Pp. 302. Price, $2.50.

This little work has grown out of a series of articles contributed by the author, under the signature "Hippocrates," to the periodical "Building." Its object is to give an account of the usual condition in which plumbing-work done years ago, and some quite recently done, may be found, and to give suggestions on the proper manner of doing the work. A valuable report on "Filth Diseases and their Prevention," by medical officer John Simon, of Great Britain, and other works on dwelling-house sanitation are referred to to fortify conclusions. The book is frequently illustrated with examples of bad work to be avoided and of good work to be patterned after.

The Trichiniasis Question.—D. Appleton & Co., of New York, will publish shortly a work on "The Relation of Animal Diseases to the Public Health, and their

Prevention," by Frank S. Billings, V. S., Boston. The trichiniasis question, now a subject of congressional investigation, is fully discussed by the author, whose researches on this subject have been thorough and long continued. He has also compiled many valuable statistics having a direct bearing on the question, and which are contained in no other volume in the English language. The book should be read by all who have an interest in the settlement of this most important question.

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Archæological Excursions in Wisconsin and Ohio. By F. W. Putnam. Pp. 16.

Massachusetts Agricultural College: Twenty-first Annual Report. Boston: Wright and Potter Printing Company. Pp. 73.

Pilot Chart of the North Atlantic for February, with Supplement of 3 pages showing position and detail of floating wrecks.

Inaugural Addresses of Stephen A. Walker, President of Board of Education, etc., of the City of New York. Pp. 22.

Beitrag zur Kenntniss der Kobalt,- Nickel,- und Eisen-Kiese. (Contribution to the Knowledge of Cobalt, Nickel, and Iron Stones.) By Leroy W. McCay, M. A. Freiberg (Saxony). Pp. 46.

Out-Door Relief, State of New York: Report of Standing Committee. Albany, N. Y. Pp. 15.

New York State Board of Charities: Report on Establishment of a State Asylum for Indigent Blind. Albany, N. Y. Pp. 9.

Value of the Nearctic as one of the Primary Zoölogical Regions: Reply to Criticisms. By Professor Angelo Heilprin. Philadelphia. Pp. 10.

Radiation: A Function of Gravity. By I. E. Craig. Camden, Ohio. Pp. 21.

Renal Circulation during Fever. By Walter Mendelson, M. D., of New York. Pp. 24.

Recent School-Law Decisions. By Lyndon A. Smith. Washington: U. S. Bureau of Education. Pp. 82.

Bulletin of the Buffalo Society of Natural Sciences. Vol. IV, No. 4. Julius Pohlman, M. D., Corresponding Secretary. Buffalo, N. Y. Pp. 138.

Medico-Legal Society of New York: Inaugural Address of President Clark Bell, Esq., etc. Pp. 24.

Connecticut Agricultural Experiment Station: Annual Report for 1883. New Haven, Conn. Pp. 120

Diccionario Tecnológico: Inglés-Español y Español-Inglés. (Technological Dictionary: English-Spanish and Spanish-English.) By Nestor Ponce de Leon. No. 5. New York: N. Ponce de Leon. Pp. 48. 50 cents.

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Massachusetts Institute of Technology: President's Report, 1883. Boston: J. S. Cushing & Co. Pp. 31.

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The Book of Plant Descriptions and Record of Plant Analyses, etc. By George G. Groff, A. M., M. D. Lewisburg, Pa.: Science and Health Publishing Company. Pp. 100. 30 cents.

Absence of Design in Nature. By Professor H. D. Garrison. Chicago. Pp. 19.

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The Teaching of Drawing in Grammar-Schools. By Walter S. Perry. Boston: The Prang Educational Company. Pp. 26.

The World's Industrial Cotton Centennial Exposition at New Orleans, Louisiana, to be opened in December, 1884: Announcement. Pp. 18.

"The Cornell University Register," 1883-'84. Ithaca, N. Y. Pp. 134.

Administrative Organization. By LL. B. Washington, D. C.: William H. Morrison. Pp. 108.

Woman Suffrage. By John George Hertwig. Pp 16. Sunday Laws. By John George Hertwig. Washington, D. C. Pp. 12. 10 cents each.

Reports of School Committee and of Superintendent of Schools of the City of Gloucester, Massachusetts, for 1883. Pp. 75.

Energy in Nature By William Lant-Carpenter. London, Paris, and New York: Cassell & Co. 1883. Pp. 212. $1.25.

Merv: A Story of Adventures and Captivity. By Edmond O'Donovan. New York: Funk & Wagnalls. 1884. Pp. 313. $1.

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The Land Laws. By Frederick Pollock. London: Macmillan & Co. 1883. Pp. 215. $1.

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A System of Rhetoric. By C. W. Bardeen. New York: A. S. Barnes & Co. 1884. Pp. 673. $1.50.

Life and Times of the Right Hon. John Bright. By William Robertson. London and New York: Cassell & Co. Pp. 688. $2.50.

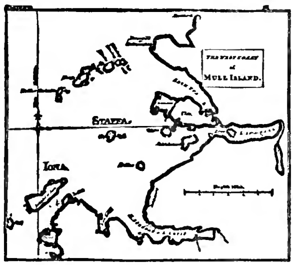
The Unity of Nature. By the Duke of Argyll. New York: G. P. Putnam's Sons. 1884. Pp. 571. $2.50.

POPULAR MISCELLANY.

Durability of Building-Stones. — Dr. Alexis A. Julien has made examinations of buildings of various ages, and of tombstones in some of the older grave-yards around New York city, to assist in determining the durability of the various stones used in building. The coarse brown-stone, which is largely employed, appears to be one of the most perishable materials in use, so that many builders are returning to brick, although the finer varieties of brown-stone are better and compare favorably with other materials. Among the causes for the decay of this stone are mentioned, erection on the edge of lamination, the heat of the sun on exposed sides, and imperfect pointing, with poor mortar, which falls away and leaves the joints exposed to the weather. The presence of sea-salt in the atmosphere has exerted no appreciable effect, and lichens growing on the stone do not appear to have occasioned any decay or corrosion. The light-colored Nova Scotia sandstones have been too recently introduced to show marked defect, but evidences of exfoliation and of slight moldering in damp spots have begun to appear. Buildings constructed of the Amherst (Ohio) sandstone show little decay, only discoloration; and that is regarded as a favorable sign rather than otherwise, for it indicates durability, while a stone that cleans itself does so by disintegration of its surface, the grains dropping out and carrying away the dirt. The coarse fossiliferous limestone from Lockport has disintegrated rapidly within the last ten years, chiefly on account of careless arrangement in masonry. The oölitic stone from Ellettsville, Indiana, shows an almost immediate and irregular discoloration, said to be produced by the exudation of oil. The oölite from Caen, France, has shown decay in several instances where it was not protected by paint. The dolomitic marble of Westchester County has decayed considerably after sixty years of use, but much of this is owing to the stone having been improperly laid. Often marbles, of various kinds, in tombstones, are in fairly good condition. Horizontal slabs show a tendency to bend. The frequent obliteration of inscriptions, the general and often rapid granulation of the surface, and the occasional fissuring of slabs, show that the decay of marble—in the varieties hitherto long used in New York city—is steady, inevitable, and but a question of time; and, if unprotected, this material is likely to prove utterly unsuitable for out-of-door use, at least for decorative purposes or cemetery records, within the atmosphere of a city. A blue-stone, or graywacke, is yearly coming into more general use, and, though somewhat somber in tone and difficult to dress, seems likely to prove a material of remarkable durability. The bluish Quincy granite has been used in many buildings, and rarely shows as yet many signs of decay. A fine-grained granite from Concord, New Hampshire, also promises to be durable. The light-colored and fine-grained granite of Hallowell, Maine, in which the white feldspar predominates, has shown some exfoliation, but in the single building in which this is remarked the stones appear to have been set on edge, and, as their structure is laminated, that is an important matter. "The weathering of granite does not proceed by a merely superficial wear, which can be measured or limited by fractions of an inch, but by a deep insinuation along the lines of weakness, between grains, through cleavage-planes, and into latent fissures. Thus, long before the surface has become much corroded or removed, a deep disintegration has taken place by which large fragments are ready for separation by frost, from the edges and angles of a block. When directly exposed to the heat of the sun, an additional agency of destruction is involved, and the stone is suddenly found ready to exfoliate, layer after layer, concentrically." The following is an approximative estimate of the "life" of different kinds of stone, signifying by the term life, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal: coarse brown-stone, five to fifteen years; laminated fine brown-stone, twenty to fifty years; compact fine brown-stone, one hundred to two hundred years; blue-stone, untried, probably centuries; Nova Scotia stone, untried, perhaps fifty to two hundred years; Ohio sandstone (best siliceous variety), perhaps from one to many centuries; coarse fossiliferous limestone, twenty to forty years; fine oölitic (French) limestone, thirty to forty years; fine oölitic (American) limestone, untried here; coarse dolomite marble, forty years; fine dolomite marble, sixty to eighty years; fine marble, fifty to two hundred years; granite, seventy-five to two hundred years; gneiss, fifty years to many centuries. Many of the best building-stones in the country have never yet been brought to the city.

Peroxide of Hydrogen.—Peroxide of hydrogen, though it was discovered in 1818, has only recently, by the aid of cheapened processes of preparation, come into general use. When pure, it is a colorless liquid, which in decomposing gives off four hundred and seventy-five times its volume of oxygen. Diluted solutions of it, kept in the dark at a temperature of not more than 80°, may be preserved for a very long time without decomposing. It is obtainable pure, in large quantities, and cheaply, in solutions of three per cent by weight or ten per cent by volume; and it has come into extensive use as a bleaching agent, for disinfection, household purposes, and the toilet. It is the really operative agent in air-bleaching on the grass, which has been in use from time immemorial, and is well adapted for bleaching substances of animal origin, in which chlorine agents often fail. In using it the substance to be bleached must first be carefully cleansed from dirt and oil. It may be applied as a bath in the shape of a weakly acid solution neutralized with a few drops of ammonia, or the substance may be dipped in it, and afterward slowly dried in the air. As the water evaporates, the concentration of the peroxide of hydrogen increases, and the bleaching goes on more energetically. Dumas and Pettenkofer have applied peroxide of hydrogen with much success and satisfaction to the cleaning of oil-paintings and engravings. This substance has recently been found to be one of the most valuable and effective disinfecting agents. In the household it has proved to be equal to the best of other known substances for purposes of washing and cleansing the person. It is adapted to the most tender skins. It has been pronounced preferable as a tooth-wash to all powders and to all other preparations which do not depend upon it. In bathing, with the addition of a drop or two of hartshorn, it quickly disintegrates and removes the dead skin without affecting the living tissue, except to make it more healthy and hardy. It is a salutary hair-wash, provided the hair has been prepared for it by previous washing with soap or spirit. Professors Alex. Classen and O. Bauer have found it a powerful agent in analytical chemistry.—*Die Natur.*

Fact and Fancy regarding Fingal's Cave.—At the Montreal meeting of the American Association in 1882, Mr. F. Cope Whitehouse offered a paper on "The Caves of Staffa, and their Connection with the Ancient Civilization of Iona." The Committee on Papers, having heard Mr. Whitehouse in exposition of his views, and examined his maps and drawings, and the testimonials which he was able to produce from men of authority in science, adjudged that there were sufficient merit and originality in his paper to justify giving it a hearing. The article was also regarded by us of enough interest to be given to the readers of "The Popular Science Monthly" in December, 1882; and a summary of it was published in "Notes and Queries," December 28, 1883. In it the author, regarding the situation of the Island of Staffa, which is shown in the map, the character of its



rocks, the form of Fingal's Cave, and the shape and direction of its exposure, concluded that it was extremely unlikely that the cave could have been hollowed out by the natural action of the waves, and suggested the question whether it might not have been artificially excavated. The paper has not yet been adequately answered. But the author was held up to ridicule, in a leading article in "Nature" of January 25, 1883, as the victim of "a thirst for scientific renown," who knew nothing of the subject concerning which he had given the result of his studies, but had succeeded in imposing himself upon a respectable scientific body, and upon a scientific journal. Mr. Whitehouse has taken his time to answer this attack, and has replied to it with vigor and to the point in a late number of the "Manhattan." Setting by the side of one another photographs of the Island of Staffa and Fingal's Cave, and the representations of them given in the current works on geology, he shows that a wonderful ignorance of what they are like exists in the scientific mind, and is transmitted to students. German works exhibit a structure supposed to have been exposed for millions of years to waves capable of hollowing out two hundred and twenty-eight feet of basalt, and open at both ends, which Fingal's Cave is not, compared with which "a wall of bricks without mortar would be solidity itself." Hitchcock's "Geology" long gave a view that did not show any part of Staffa, but the adjoining Island of Boo-sha-la. Dr. A. Geikie, Director of the Geological Survey of Scotland, gave, in his "Primer" in 1881, "a tolerable engraving of part of the island"; but, in 1882, he offered to more advanced students, in his "Text-Book of Geology," "a problem in physics and drawing which has hitherto passed uncriticised," "the bad copy of a picture for which its author apologized in 1819," "which picture was no more Staffa than a view inside the railings at the head of Wall Street would be Trinity Church." If our young American has been too hasty in his theories, upon which we do not undertake to decide, it certainly behooves his critics, and especially those who are on the spot and wear official titles, to attempt some approach to accuracy in fact.

Why some Bodies feel colder than others.—It is a familiar fact that, when we touch with the fingers different substances of the same temperature, some will feel colder than others. The differences of the feeling are commonly ascribed to differences in the heat-conducting powers of the several bodies. A correspondent of "La Nature" suggests that, besides this, the specific heat of the bodies and the degree of polish of their surfaces should be taken into account. The effect of specific heat may be observed by pouring alcohol upon water and plunging the finger in so that a part of it shall be in the water and a part in the alcohol. The part in the water will feel much colder than that in the alcohol. So brandy may be taken, with safety, at a degree of cold at which water would infallibly irritate the skin. The effect of the degree of polish may be tried with a piece of marble or glass one side of which is smooth and another rough, with a file one side of which has been ground down, or with glazed and unglazed paper. In every case the smooth side or substance, at ordinary temperatures, will appear colder than the rough one. The fact may be accounted for by remembering that the smooth body presents vastly more points of contact with the fingers, and consequently more conductors for the heat than the rough one. In like manner a liquid always seems colder than the vessel containing it, because it is in closer contact with the skin.

Are there Birds with Teeth? — The "Transactions" of the Natural History Society of Leipsic contains a paper by Dr. Paul Fraisse, on teeth and tooth-papillæ in birds. It is generally admitted that there is a series of birds having real teeth in their bills. Among these are the fossil archæopteryx of Solenhofen, and the odontornithes, discovered by Professor Marsh in the North American cretaceous. The jaws of the latter birds were furnished with teeth, and also with cavities containing supplementary teeth, like those of crocodiles. The curious relations which these birds exhibit with reptiles, as a kind of transitional stage between the two orders, suggest the question whether any living birds have teeth. On this point, Dr. Fraisse remarks that Geoffroy Saint-Hilaire in 1821 discovered in two embryos of the parrot (*Palæornis torquatus*) papillæ which he regarded as tooth-sacs and as homologous with the rudimentary teeth of other animals. In one of the jaws there even seemed to be duplicate rudiments, as among the mammalia. Cuvier accepted this announcement with a kind of reserve, and remarked that the horny texture of the bill seemed to spread over these vascular papillæ much in the same manner as the enamel over mammals' teeth. Blanchard resumed the investigation in 1860, and found in certain birds, among them some parrots, formations imbedded in the jaws, which when microscopically examined presented considerable similarity in composition with dentine and in structure with teeth; and he concluded that those birds possessed a real dental system. Dr. Fraisse believes that papillæ are frequently present in the horny bill of the parrot, that they are rich in vessels and covered with a veneer of peculiarly adapted horn-cells which Blanchard took to be dentine, and which in microscopic sections have quite a resemblance to that formation; but that real teeth do not exist in birds. "Whether any first rudiments of teeth may have been the origin of the growth of horn-teeth is very doubtful; but in all probability the horn-teeth should be regarded as secondary formations." The teeth of the odontornithes, in which Professor Marsh has found dentine and enamel, are excepted from this conclusion.

Alcohol regarded as a Beneficial Agent.—Dr. William Sharpe, an English physician, has published a pamphlet in which he seeks to demonstrate that alcohol is a factor in human progress. Looking into the history of the subject, he finds that the vine and the product of the vine have been in olden times more intimately associated with man's intellectual growth and development than with his purely physical wants. The stimulus of alcohol, when judiciously controlled, "always leads to active and higher mental efforts on the part of individuals," thus producing a contrary effect to that of other stimulants, which tend rather "to bring about a contented state of dreamy inaction" and to repress effort. "To understand fully," he says, "the beneficial action of alcohol as regards mental development, we must first get a clear view of the value of those states of cerebral excitement which most people, though in varying degrees, experience something of, rising as they then do mentally above the level of what may be called their ordinary every-day thoughts. This is not difficult, if we bear in remembrance that it is during such periods of high mental activity, in which the mind, transcending the more circumscribed limits of reason, sweeps intuitively into the veiled and distant regions of universal truth, that all great conceptions arise and have arisen in times past, crudely at first it may be, but which, nevertheless, when reduced to order and embodied in works, have been of inestimable value to mankind. . . . The stimulus produced by alcoholic liquors, if not nearly of so high an order, is more easily called into play, while in a practical sense, the latent ability being present, it is more vigorous and effective as regards actual work. Hence the value of alcohol, as a stimulant, lies in the fact that it produces artificially and sustains temporarily that state of mental excitement or exaltation necessary to the conception and projection, though not to the detailed elaboration, of those enduring works that, whether in the domains of art, architecture, or engineering, are remarkable for boldness of execution, originality, and grandeur of design; and further, that it is the only manageable stimulant which, when used in moderation, and in the form of wine or spirits, is not only not injurious, but conduces to the general health, while it favors both mental and physical development." Dr. Sharpe also assigns to alcohol a beneficial agency in stimulating genial thoughts and feelings.

Japanese Lacquers.—The Japanese distinguish in lacquers between crude lacquer, which is obtained from the trunks of live trees and forms the basis of nearly all the mixtures used in making lacquer-ware; branch lacquer; and black lacquer, a preparation. The yield of branch lacquer is only about one per cent in comparison with that of other lacquers, while the proportion of ninety per cent is required in working. Hence a mixture is made of various kinds of lacquers, sea-weed jelly, finely grated sweet-potatoes, and as much soot as is needed to color the mass. Each manufacturer has his own special mixture, but the extraneous additions are believed not to injure the quality of the whole. True branch lacquer becomes extremely hard when dry; but, since when used alone it will not dry under some twenty days, the pure sap is now but little used. The black lacquer is made by adding to crude or branch lacquer about five per cent of the tooth-dye used by women, a liquor formed by boiling iron filings in rice-vinegar, exposing to the sun, and stirring frequently for several days. In preparing all the lacquers it is an essential object to get rid of the water that exudes from the tree with the sap. This can not be effected without adding water, which is done in small quantities, three times a day, for two or three days. All the water then evaporates together. No lacquer will dry till this process has been gone through. If crude lacquer, which is originally of the color and consistency of cream, is exposed to the sun for a few days without adding water, it becomes black, or nearly so, thinner and translucent, but will not dry if applied to an article. If, now, water is mixed with it, it at once loses its black color and its transparency, becomes again of a creamy color, only slightly darker, and can be used after evaporation of the water, like any ordinary lacquer, and will dry. The greatest difficulty the lacquer-workers have to contend with is that of obtaining a clear, transparent varnish. What is called transparent varnish is really black to the eye, and has to be ground and polished after application before it will present a brilliant surface.

Superstitions about Stone Implements.—Richard Andrée, a German anthropologist, has remarked that, wherever prehistoric stone implements have been found, whether in Europe, Asia, Africa, or America, identical ideas, agreeing frequently in the minutest particulars, have been associated with them in the popular mind. It is really astonishing to find the negroes, the South American Indians, the Burmese, and the different European stocks entertaining the same superstitions respecting the origin and supposed wonderful properties of the stone axes. Such conceptions must be regarded as comparatively new, for they can only have originated after the implements had gone out of use, and the casual finding of them would be capable of exciting a mystified curiosity. They would naturally appear to the finders, who had no idea of their use, as something wonderful, perhaps having their origin in another world; and it would also be natural to attribute mysterious properties to them. The fall of meteoric stones would give a kind of a justification to such notions. People everywhere have thought the stone implements were the product of the lightning, or its bolts, and that the noise of thunder was caused by their striking the earth; and the belief is very common that the "thunder-axe," which is driven deep into the ground, will gradually rise to the surface again in the course of some definite period, as seven days, weeks, or years. The finder of one of these mysterious objects esteems it highly on account of the peculiar properties attributed to it, and transmits it to his posterity. Such stones are regarded as amulets in Asia and Europe, and as fetiches on the Guinea coast. They are believed to preserve one against harm, to prevent sterility in women, to give protection against fire and lightning; treasures are sought with them, and most effective medical properties are attributed to them. They have been believed to have a kind of life, and to sweat on the approach of a storm. These superstitions have no footing among people who are still in the stone age and acquainted with the use of stone implements. Thus, no trace of them is found in the South Seas and Australia; although a foundation for them appears to be laid among the West Australians, in the shape of a belief that certain smooth, oval stones have fallen from the sky.

A Subterranean River in Austria.—One of the recent publications of the Austrian Tourists' Club contains a description of the "Recca Cave," which it is claimed must be ranked among the greatest natural curiosities of the Austro-Hungarian monarchy. The cave is situated near the middle of the Karst mountain-land, in the bare and sterile plateau that spreads out above Trieste, in a region rich with caves, and has been formed by the flow of the Recca River under the cretaceous hills. Similar river-excavations are common in the region, but that made by the Recca surpasses all the others in extent. Near the railroad-station of Vistrica-Ternovo, the Recca is a stream some fifteen or twenty paces broad and two or three feet deep. Thence it flows along the border of the chalk and tertiary formations in a deeply cut but pleasant valley, till it comes to a point where the chalk crosses its course in a semicircular range, and seems as if it would stop its further progress with a dam nearly four hundred feet high. The river has, however, conquered this wall by boring under it a tunnel fifty feet high and half as wide, through which it rushes in a very lively torrent. In the course of a little over a hundred yards, it passes a chimney-shaped shaft, which extends to the whole height of the mountain and presents an opening more than thirty feet in diameter at the surface. After another hundred yards the stream crosses the floor of a *doline* (or sink-hole) four hundred feet broad, and then, after crossing a narrow ledge, enters the great *doline* of St. Canzian. Here the steep, frequently impending rocks on three sides form a gigantic kettle, the western wall of which falls perpendicularly more than five hundred feet. On the southern side a turf-covered slope descends toward the bed of the river, to end abruptly in a precipice of nearly two hundred and fifty feet. Having twice bored the hills for relatively short distances, the Recca continues its course till it meets the rock-wall a third time and excavates a third subterranean channel, this time of thirty-five kilometres, or twenty-two miles. This is the Recca Cave proper, and from it the stream emerges near San Giovanni di Duino into the important river, though a short one, the Timavo, the mystery of the origin of which has been solved by this tracing of the course of its main affluent.

Scottish and Irish Crannogs.—Dr. Robert Munro, in his "Ancient Scottish Lake-Dwellings or Crannogs," draws a parallel between the island-fortifications of the western Celts and the lake-dwellings of Switzerland, and then suggests a connection of development between the crannog and the moated castle of the middle ages. "Crannog" is a Gaelic term, from *crann*, a mast or tree, and seems to point to the fact that wooden piles or tree-trunks formed an important part in the structure. While the crannogs have several features in common with the Swiss pile-dwellings, they exhibit also some important points of difference, whereas the Irish and Scottish structures are essentially similar. The latter were really fortified islands, sometimes natural, but generally artificial. When complete and in use, they would present the appearance of small islands surrounded by strong palisades for defense, with buildings of various kinds on their surface, dug-out canoes ready for use, and in some cases a causeway or gangway communicating with the shore. They were certainly built with great skill, and with a solidity of which the endurance of parts of them to the present time is the best evidence. Stone weapons have been found in the crannogs, but the bulk of the remains they yield are of bronze and iron, and some of the coins and pottery point to Roman influences. It is generally admitted that even the Irish crannogs are long subsequent in date to the earlier Swiss lake-dwellings. The crannogs, moreover, continued much longer in use than the corresponding lake-dwellings in Switzerland; those of Ireland down to the seventeenth century, those of Scotland to a century or two earlier. They were evidently used mainly for defense. In the more northern and wilder parts of Scotland the wooden structures gave way to stone castles, and in the end, as Dr. Munro points out, instead of the castle being brought to the water, the water was brought to the castle in the shape of a moat. It is certainly possible that some individual castles may be the direct representatives of former crannogs, but it would be very hard to prove that there has been, as Dr. Munro seems inclined to think, any general connection of the kind between the two structures.

Effects of Gases on Insects.—Mr. L. P. Gratacap reports, in the "American Naturalist," respecting experiments he has made upon the power of different insects to live in various gases. The Colorado beetle proved the hardiest of them; it was killed outright in the vapor of prussic acid, which it, however, stood longer than any other insect experimented with, while it was paralyzed for a time in illuminating gas, and died after two hours' imprisonment in nitrous oxide. The effects of oxygen were not very marked; hydrogen produced lethargy in flies, and was bad for snapping beetles, moths, and a wasp; carbonic acid killed flies at once, and threw Colorado beetles on their backs; carbonic oxide killed ants, but not Colorado beetles; prussic-acid vapors and nitrous-acid fumes destroyed everything, as did chlorine everything but Colorado beetles; nitrous oxide exhibited but slight effects; and illuminating gas appeared to produce death if the exposure was long enough. Mr. Gratacap recommends charging from time to time with illuminating gas as probably, and charging with diluted prussic-acid fumes as certainly, an efficient preventive of the ravages of insects in cabinet cases.

Backsheesh in Arcadia.—"How much to be envied are you Singalese!" says Herr Haeckel, in his "Indian Letters of Travels." "You are not troubled either about the cares of to-morrow or of the distant future. What you require for your own life and your children's grows of itself at your mouth; and whatever else you may want in the way of luxury you can get with the slightest exertion. You are, indeed, like the lilies of the field, that grow around your simple huts; they sow not, neither do they reap, and still heavenly Nature feeds them. You are not excited with political or military ambitions; no anxious thoughts about business, or the rise and fall of stocks, disturb your sleep. The highest honors, titles, and orders of civilized men are unknown to you. Yes, I believe it fully, you do not envy us Europeans for our thousand superfluities; you are happy in being simple men, Nature-men, living in a paradise, and enjoying that paradise. Yes, what care-burdened civilized man would not envy you your simple condition, and your paradisiacal contentment?" A few moments after indulging in these reflections, Herr Haeckel reached the last post-station before arriving at Point de Galle, and was still thinking he had come upon a place where the struggle for existence had no being. His porters awakened him from his dream by speaking to him of their "backsheesh." It was now time to attend to that matter, for it might be forgotten, in the hurry and confusion, if it was put off till they got to the city. Herr Haeckel had remarked that a native gentleman had given each of the porters a "double anna," and reasoned that, in consideration of his superior distinction as a "white man," it would be proper to quadruple the amount and give a shilling. The porters returned the coins with irritation, and gave their patron a very flattering lecture about the distinction to which he was entitled by reason of his purely white skin. The main point which they presented was, that every white man ought to give double what he had given, or a rupee; but that as white a man as he was, with his light hair, must belong to the very highest caste, the dignity of which would be suitably maintained by a still larger gift. Without acceding to the full force of this complimentary argument, Herr Haeckel yielded so far as to give the full white man's backsheesh of a rupee to each man, and had the pleasure of hearing himself pronounced a perfect gentleman.

The Chinese Superstition of Severed Queues.—Dr. D. J. MacGowan, in a report on the health of Wenchow, has published some facts concerning "epidemic frenzies," or "popular crazes," which frequently prevail among large portions of the Chinese population. One of them raged very extensively in 1876, when it was believed supernatural agencies were at work cutting off the queues of the people. A sorcerer, getting possession, with the aid of a spirit, of one of these queues, was believed to be able thereafter to evoke at will the soul of the owner and use it as a servile demon, while the man was fated to die. The only remedy within the reach of a person who has lost his queue is to cut off an inch or more of what hair he has left and soak it for eighty days in a cesspool; by this means the mysterious connection between the hair remaining on his head and that in possession of the sorcerer is severed. Amulets and charms are, moreover, relied on for the prevention of disaster to the queue. A charm for this purpose was invented by the Governor of Kiang-Su, who also recommended an anathema attributed to Tao Tse, which was to be chanted while copying it on yellow paper with the blood of a cock mixed in vermilion, after which the paper was to be burned and the ashes swallowed. The panic was created by some revolutionists, who secretly cut off the queues of a few passers-by in each large city, and then proclaimed that a diabolical agency was at work.

The Pygmies.—Dr. Emin Bey gives in a recent number of Petermann's "Mittheilungen" some later notices of the Akkas, the pygmy race discovered in Africa, and first described by Schweinfurth. They are a hunting people, divided up into numerous tribes that do not mingle with one another. They have no fixed abodes, but wander around in the countries of the Monbutte and the Amadi. When a small society of them sojourns temporarily around the settlement of some chief, they build little huts for the married ones, while the unmarried satisfy themselves with mere shelters from the sun. Usually they live in the groves that line the streams, which afford them game and good hiding-places. The chiefs provide them with grain and roots, and take their pay in the proceeds of the hunt. The Akkas are vengeful and dangerous when offended, and are skilled in the use of the bow and arrow. Emin Bey's measurements gave heights of between four and four and a half feet for full-grown Akkas. The color of their skin varies from a clear yellow to a glistening red. The whole body is covered with a thick, stiff, filthy growth of hair. A disposition of the skin to wrinkle, peculiarly observable in the eyelids, makes them look much older than they are.

Origin of Fires in London.—The statistics of fires in London for the thirteen years, 1870–'82, state the origin and nature of 22,262 fires, of which ten per cent attained serious proportions. The most fires were started in private houses, but they were the least dangerous ones, for only 2·4 per cent of them became serious, while in such establishments as saw-mills, furniture ware-rooms, rag-stores, and builders' shops, more than one fourth of the fires were destructive. No particular influence of seasons in promoting or diminishing the danger of fires appears from the London reports, where the difference in the number of outbreaks in the several months is comparatively small and irregular, but in agricultural districts the most fires seem to take place in July and August. According to the facts presented by Mr. W. G. McMillan, in a lecture before the Society of Arts, the distribution of fires over the hours of the day seems to be governed by a distinct and well-defined law. The curves illustrating the hourly distribution, through several years, show a remarkable symmetry and a wonderful agreement in general form. The most outbreaks occur between eight and nine in the evening, whence the numbers fall somewhat rapidly to a minimum at between six and nine in the morning. Thence the curves rise gradually to the evening maximum. By far the greatest number of the fires recorded originated in the use or abuse of light- and heat-giving apparatus. The most prolific source of danger still appears to be the candle, less dangerous than when the old-fashioned, spark-emitting tallow-candles were in use, but still operative by means of the ease with which it may be set under a shelf or carried within reach of light drapery. Surrounding the candles with tall shades like lamp-chimneys is recommended as a precautionary device. Petroleum is, with due precautions, a safe fluid, but there are other burning-fluids, and some kinds of petroleum, that are highly dangerous. Coal-gas is entirely safe, except from the danger of leaks at the joints of the pipes, which may be guarded against; but all burners should be fixed, else they may be carelessly brought within reach of drapery. Many fires are caused by carelessness in throwing away matches after they have been used. Directly and indirectly, artificial heating is responsible for a large proportion of fires. It operates through sparks shot out from open grates; through defects in flues; through the proximity of wooden beams and planks to flues, steam-pipes, or register-furnaces; and through carelessness in disposing of hot ashes. The red fire used in theatres is very liable to spontaneous combustion; plumbers sometimes allow their portable furnaces to set fires; and the sun shining through a body so shaped as to act as a lens to concentrate its rays, has been known to set papers on fire. Water is still the cheapest and most effective extinguisher; and other agents in use are good in their way. Gypsum, used as a plaster and in concrete, is an excellent fire-proofing material. Wood may be made uninflammable by painting it with asbestus; by impregnating its fibers with such substances as tungstate or silicate of soda, or with two soluble substances which, coming together, will form an insoluble one. If wood is impregnated, too, with a substance capable of volatilization, its taking fire will be delayed till the volatile substance has been driven off. Warning of fires is automatically and surely given by means of devices by which the expansion of a column of mercury by the developed heat is made to close the circuit of a galvanic battery and sound an electric bell.

The Sunny Skies of Kamchatka.—M. Leonhard Stejneger has published in the Norwegian journal, "Naturen," a paper on the fauna and flora of Eastern Kamchatka and the Commander Islands, which adjoin our own Aleutian Islands. While the climate of the islands is foggy and their vegetation scanty, Kamchatka is represented as rejoicing in Italian skies, smooth seas, and a mild temperature. The flora is so exuberant that some species, which only grow to be three feet high in Norway, there attain the height of a man. Among them are the birch, alder, willow, and service-tree, whose berries as well as those of a honeysuckle are finely flavored, and well relished by the inhabitants. The flowers of the wild rose, rhododendron, potentillas, and taraxacum, might be mistaken for Norwegian species. The birds are also well represented, and one of them, a warbler, is distinguished by a plumage that suggests the tropics, and a voice comparable with that of the nightingale. The fauna is generally palæ-Arctic, and few American forms are found.

NOTES.

Mr. James Stevenson, of the United States Geological Survey, has discovered some new cave and cliff cities in which a few peculiar features have been observed. One of them is a village of sixty-five underground dwellings situated near the top of one of the volcanic foot-hills of the San Francisco Mountains in Arizona. A common roof was furnished for the whole community by the hardened surface stratum of the hill.

Mr. Herbert McLeod has determined, by experiments instituted for the purpose, that India-rubber is altered under the combined influence of light and oxygen—absorbing oxygen and becoming cracked—but not by either agent alone.

Last year included the fiftieth anniversary of the lucifer-match, which was first made, in England, by John Walker, of Stockton-on-Tees, and also at Vienna, in 1833. In 1847 the red amorphous phosphorus was substituted for the more dangerous, corroding, ordinary phosphorus.

Professor Cohn has called attention to the fact that bacteria were first seen two hundred years ago, by the Dutch microscopist, Leeuwenhoek, who, in 1683, gave to the Royal Society a description of "very little animals moving in a very lively fashion," which he had detected, with his instrument, in the white substance adhering to his teeth. His drawings are very correct, and have never been surpassed till within the last ten years.

Captain T. G. Een, a well-known Swedish explorer, died from heart-disease on the Congo, while on his way to join Mr. Stanley.

M. Fayal, directing engineer of the coal-mines of Commentry, France, has published an account of his discovery of coal at that place, which has preserved to the very center of the beds the histological structure of the plants from which it is formed. The preservation is said to have been so distinct that M. Renault has been able to make specific determinations of several species of the carbonized plants.

A great impulse has been given to fruit-growing within the last ten years. The area of land devoted to this purpose in England increased, between 1872 and 1882, 26,696 acres; while the importations of fruit from different countries increased from 1,218,668 bushels in 1871 to 4,045,690 bushels in 1882. Much of this fruit is used for making jam. The acreage of fruit-land in Canada has been largely extended within the last fifteen years, and great interest in the promotion of the industry is taken by the Government and the land-owners. In the United States, two million acres were under cultivation as apple-orchards in 1878, and the value of the products had increased in twenty years from $6,600,000 to over $50,000,000. The drying and the canning of fruits have become very prominent branches of industry.

The author of the work on "World-Life," recently reviewed in our pages, regrets that the book contains a number of errata, and desires us to announce that slips of corrections will be mailed to any who will kindly signify their desire to receive them. Address Alexander Winchell, Ann Arbor, Michigan.

M. Arthur Roche, Professor in the Lycée of Montpellier, France, who died a few months ago, was well known for his researches on the figures of planets and comets and the cosmogonic theory of Laplace. He was the author of various memoirs on the equilibrium of a homogeneous fluid mass in rotation; on the effect, upon the figure of equilibrium, of attraction exerted by a center situated at a great distance; on the physical constitution and internal condition of the globe, in which he held that the density of the earth at the center is nearly double the mean density, and pronounced against the theory of the complete fluidity of the interior; on the figures of comets; and on the constitution of the solar system.

Archæological investigations in the Afrosnab suburb of Samarcand have brought many interesting relics to light. Among them are marble ornaments, mosaics, and articles of bronze, clay, and glass, belonging to the Arabian, Græco-Bactrian, or old Iranian schools, all of which have in their time flourished at that place. Chinese coins have been found at a depth of three or four metres.

At the December meeting of the Natural Science Association of Staten Island, New York, Mr. Hollick gave a description of the leaf-fossils which have been found at Tottenville. The fossils occur in three kinds of rock, all supposed to be cretaceous —a hard red or gray ferruginous sandstone, a soft gray sandstone, and a conglomerate composed chiefly of vegetable remains cemented with an oxide of iron. They are carbonaceous in the soft gray sandstone, only impressions in the other rocks. The rocks are found scattered, in blocks not more than a foot square, along the beach. The leaves are of willow, arbor-vitæ, viburnum, sour-gum, grass, a small fruit or nut, an equisetum, and indistinguishable fragments. Similar sandstones with similar fossils occur near Glen Cove, Long Island. At the January meeting of the Association, Mr. C. W. Leng read a paper on the "Cicindelidæ" (beetles) of Staten Island, of which he distinguished eight species

New pests are appearing, to consume our apples. The apple-maggot (*Trypeta Pomonella*), leaving the outside of the apple fair to look upon, honey-combs its interior till nothing is left of it. The marauder is of a greenish-white color about one fifth of an inch long, and comes from a fly not unlike our house-fly, having whitish glassy wings, with dusky bands shaped somewhat like the letters IF. It comes from Illinois, where it feeds upon the hawberries, but has learned the merits of Eastern summer apples, and is said to be trying the virtues of later varieties. Information is wanted by Professor J. A. Lintner, State Entomologist, of New York, concerning its life-history, and all assistance that observers can give him in studying its habits and learning the best method of contending against it.

The International Electrical Exhibition, to be held in Philadelphia under the auspices of the Franklin Institute, will open on the 2d of September and close on the 11th of October. The exhibits will be classified under seven heads or sections, viz.: I. Production of Electricity; II. Electric Conductors; III. Measurements; IV. Applications of Electricity (A, apparatus requiring currents of comparatively low power; and B, apparatus requiring currents of comparatively high power); V. Terrestrial Physics; VI. Historical Apparatus; and, VII. Educational and Bibliographical. The building will be opened for the reception of articles for exhibition on the 11th of August. Applications for space must be made before the 30th of August. Exhibitors are required to pay five dollars as entrance-fee, and space-charges for their exhibits in addition. Address Committee on Exhibitions, Franklin Institute, Philadelphia, Pa.

The life-saving stations of the United States Signal Service are now designated by name, the former designation by numbers having been abandoned on the first day of June last. As the new names are for the most part descriptive, or refer to some locality in the immediate neighborhood, the identification of them is greatly facilitated to persons who are not connected with the service, while it is not made any harder to those who are connected with it. The circular of the Bureau gives, together with the names, exact descriptions of all the stations.

A remarkable story of canine partiality is told in the English papers. Two men were out from Milford Haven in a boat, which was swamped. A dog, who was with them, caught one of them to help him out of his trouble, but, finding he was not his master, dropped him to drown, sought his master, and rescued him.

Successful experiments have been made at Coblenz, in Germany, into the practicability of substituting ravens for carrier-pigeons. Ravens, being stronger and bolder birds than pigeons, are less liable to be attacked and destroyed by birds of prey.

The people of Doll, M. Pasteur's native village, have set up a memorial tablet in the house where the great microbe-hunter was born. M. Pasteur was present on the occasion of the inauguration of the monument, and made a short address.

M. E. Peyrusson has called attention to the danger following the use of delf-ware in cases of infectious disease. It is liable to be marred by cracks and flaws in which germs may lurk. Only glass or porcelain should be trusted.

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