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THE REMEDIES OF NATURE.

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CONSUMPTION.

THE organism of the human body is a self-regulating apparatus. Every interruption of its normal functions excites a reaction against the disturbing cause. If a grain of caustic potash irritates the nerves of the palate, the salivary glands try to remove it by an increased secretion. The eye would wash it off by an immediate flow of tears. A larger quantity of the same substance could be swallowed only under the protest of the fauces, and the digestive organs would soon find means to eject it. The bronchial tubes promptly react against the obtrusion of foreign substances. The sting of an insect causes an involuntary twitching of the epidermis. If a thorn or splinter fastens itself under the skin, suppuration prepares the way for its removal. If the stomach be overloaded with food, it revolts against further ingestion.

These automatic agencies of the organism generally suffice to counteract the disturbing cause, and the sensory symptoms attending the process of reconstruction constitute merely a plea for non-interference. The suppurating tissues push the thorn outward, and resent only a pressure in the opposite direction. The eye volunteers to rid itself of the sand-dust, but remonstrates against friction. The rum-soaked system of the toper undertakes to eliminate the poison, and only asks that the consequences of the outrage be not aggravated by its repetition. But, if that plea remains unheeded, it finally takes the form of the emphatic protest we call *disease*. For, even in its urgent manifestations, the reaction against a violation of Nature's health-laws is a cry for peace, rather than a petition for active assistance in the form of medication. "Accustom yourself in all your little pains and aches," says Dr. Jennings, "and also in your grave and more distressing affections, to regard the movement concerned in them in a friendly aspect—designed for and tending to the removal of a difficulty of whose existence you were before unaware, and which, if suffered to remain and accumulate, might prove the destruction of the house you live in—and that, instead of its needing to be 'cured,' it is itself a curative operation; and that what should be called *disease* lies back of the symptoms which, in fact, are made for the express purpose of removing the real disorder or difficulty" ("Medical Reform," p. 310).

Drugs can rarely do more than change the form of the disease, or postpone its crisis. Mercurial salve, which conscientious physicians have almost ceased to regard as a lesser evil of any alternative, was once a favorite prescription for all kinds of cutaneous diseases: it cleansed the skin by driving the ulcers from the surface to the interior of the body. A drastic purge counteracts constipation—for a day or two—by inducing a still less desirable state of artificial dysentery. Combined with venesection the same "remedy" will suppress the symptoms of various inflammatory affections by compelling the exhausted system to postpone the crisis of the disease; in other words, by interrupting a curative process. The best way to "assist" Nature in such cases is to give her fair play by forbearing to meddle with her restorative methods, and by removing the predisposing cause of the disorder. Diseases plead for *desistance*, rather than for assistance, and the discovery of the cause is the discovery of the remedy. For there is a strong upward and healthward tendency in the constitution of every living organism: Nature's revenge is but an enforced condition of peace. *Pain, discomfort, and even the premature loss of organic vigor, are the attendant symptoms of a reconstructive process, and their permanence is a presumptive proof that, in spite of such admonitions, that process is a struggle against a permanent obstacle, or against a constantly repeated frustration of its efforts.*

To this self-regulating tendency of the living organism, certain disorders (the *lues veneris*, prurigo, etc.)—probably due to the agency of microscopic parasites—oppose a life-energy of their own, and have thus far resisted the influence of hygienic or non-medicinal remedies. But, with that exception, it may be laid down as a general rule that the virulence and duration of every disease are proportioned to the degree and the *contumacy* of the provocation—a retribution proportioned to the degree of the guilt, we should say, if Nature did not administer her code after the principle that ignorance of the law constitutes no excuse. The ignorant mother who, with the best intentions in the world, forces her child to sleep in an air-tight bedroom, incurs the penalties of an inexorable law as surely as the vicious father who tempts his child to a life of infamy.

In the aggregate, hygienic errors cause more mischief than hygienic recklessness; and, if we would know the most baneful of those errors, we must inquire after the cause of the most fatal disease. The alcohol-habit slays its thousands every year; but statistics prove that human life has a more terrible foe. The proportion of deaths from all diseases that can be ascribed to the effects of intemperance relates as three and a half to ten in Northern Europe, and as four to ten in the United States and Canada—to the mortality-rate of PULMONARY CONSUMPTION. Without counting acute pneumonia and other fatal lung-diseases, tubercular phthisis alone claims yearly one life out of 410 to 415; or an aggregate which, for the United States, has been estimated at 94,000; in Great Britain and Ireland, 110,000 (or one of every 300 inhabitants); in France, 80,000; in European Russia, 105,000; in Northern Germany (including the Polish provinces of Prussia), 82,000. And the quantum of the mischief is still aggravated by its quality. Consumption fulfills no scavenger's mission: the most voracious is, withal, the most fastidious disease, and selects its victims from the most industrious classes of the noblest nations; hard-working mechanics, devoted supporters of large families, bread-winning laborers and prize-winning students are its favorite victims. For the last fifty years its ravages have steadily increased; but the excess of the evil has finally revealed the means of deliverance, and the worst scourge of the human race has one redeeming feature: that its cause, and consequently its proper cure, have at last been determined with absolute certainty. Not more than fifty years ago the consumption-problem was still the *crux medicorum;* the disease seemed almost unaccountable and wholly incurable. Practical physicians had ascertained the value of certain secondary remedies, the prophylactic influence of fat and phosphates (cod-liver oil, etc.), and of chest-expanding gymnastics; but they had failed to recognize the great specific. Misled by the most prevalent of all popular delusions—the Cold-Air Fallacy*—they ascribed consumption to the influence of a low temperature, and tried to cure it by sending their wealthier patients to a warmer climate and the poorer to an air-tight sick-room. There were hospitals for consumptives where invalids were nursed with a care that would have insured recovery from almost every other disease, but here all calculations were defeated by the result of one wrong factor; the chief efficacy of the treatment was supposed to depend upon the exclusion of every draught of fresh air.

But statistics have at last exploded that delusion. It was ascertained that consumption is essentially a *house-disease.* North or south,

* "Dry and intensely cold air preserves decaying organic tissues by arresting decomposition, and it would be difficult to explain how the most effective remedy came to be suspected of being the cause of tuberculosis, unless we remember that, where fuel is accessible, the disciples of civilization rarely fail to take refuge from excessive cold in its opposite extreme—an overheated, artificial atmosphere, and thus come to connect severe winters with the idea of pectoral complaints. . . . They avoid cold instead of impurity, just as tipplers, on a warm day, imagine that they would 'catch their death' by a draught from a cool fountain, but never hesitate to swallow the monstrous mixtures of the liquor-venders" ("Physical Education," p. 80; compare pp. 85, 98, and 248).

east or west, the death-rate from lung-diseases was found to bear an exact proportion to the percentage of the inhabitants habitually engaged in sedentary and in-door occupations. Towns suffer more than the rural districts, cities more than country towns, manufacturing cities more than commercial and semi-agricultural cities, weaver-towns more than foundry-towns. "If a perfectly sound man is imprisoned for life," says Baron d'Arblay, the Belgian philanthropist, "his lungs, as a rule, will first show symptoms of disease, and shorten his misery by a hectic decline, unless he should commit suicide."

Moreover, it was shown that in non-manufacturing (uncivilized or pastoral) regions a low temperature seems to afford a protection against pulmonary disorders. Professor Jacoud found that, at an elevation of four thousand feet, the cold Alpine districts of Northern Savoy are almost free from lung-diseases. The medical statistics of the Austrian army have established the fact that recruits from the Tyrol, from Carinthia, and the Carpathians (Transylvania), i. e., from the highest, and consequently the coldest, provinces of the empire, enjoy a remarkable immunity from tubercular consumption. Dr. Hjaltelin, a resident of Iceland, states that among the inhabitants of that country pulmonary diseases are almost unknown.

But in the temperate zone consumption-statistics alone would enable us to infer the amount of dust-breathing and in-door work incidental to the pursuit of each trade. In the Italian cities that have largely engaged in the production of textile fabrics, consumption has become as frequent as in Lancashire. Irrespective of race-differences and special dietetic habits, the habitual breathing of vitiated air leads to the development of pulmonary scrofula. And science has furnished the *rationale* of that result. Physiology has demonstrated that air is gaseous food, and respiration a process of digestion. The atmosphere furnishes the raw material of the pulmonary pabulum ; at each inspiration the organism of the lungs imbibes the oxygenous or nutritive principle of the air-draught, and excretes the indigestible elements. By breathing the same air over and over again, the atmospheric aliment becomes azotized, i. e., depleted of its life-sustaining principle, and therefore unfit to supply the wants of the animal economy. The continued inhalation of such vitiated air fills the respiratory organs with indigestible elements, which gradually accumulate beyond the dislodging ability of the vital forces, and at last corrupt the tissue of the congested organ and favor the development of parasites. Consumption is one of the diseases that seem to confirm the tenets of the germ-theory. A tubercular diathesis is favored by stagnant impurities of the circulatory system, by a warm and humid climate, and counteracted by cold air and other antiseptics. Six years ago a German physician demonstrated that the progress of pulmonary scrofula can be arrested by a pectoral injection of carbolic acid ; and one of his countrymen lately ascertained that the tubercle-virus is alive with microscopic parasites, that multiply like the spores of a prolific mushroom. The first development of these lung-devourers would seem to amount to a sentence of speedy death; yet their fecundity hardly exceeds that of certain intestinal parasites, and the *vis vitæ* has methods of her own for dealing with such foes, and is ever ready to begin the battle for life, on the sole condition that we do not complicate the difficulties of the undertaking by counteracting her efforts or by perpetuating the influence of the original cause. Cease to feed the lungs with azotic gases, and Dr. Koch's animalcula will starve and disappear as surely as maw-worms will starve and disappear if we change a pork and sourcrout diet for bread and apples.

About the comparative advantages of a dry and cold or moist and tropical climate, opinions are divided, with a preponderance of arguments in favor of the former; but so much is certain, that in all latitudes of the temperate zone the disease known as pulmonary consumption is caused by the breathing of vitiated air and can be *subdued* by out-door exercise. In certain cases *cured* would be an ambiguous term. The respiration of vitiated (azotized and dust-impregnated) air results in the corruption of the pulmonary tissues, and finally in a process of disintegration that fills the structure of the lungs with ulcerous cavities. These cavities often cicatrize, but it is not probable that they can be entirely healed, i. e., that the wasted tissues can be reproduced. Yet in all but its last stages the *progress* of the disease can be arrested by out-door life alone. The voice of instinct adds its testimony to the teaching of science. In the language of our senses, every feeling of discomfort suggests its own remedy. If the proximity of a glowing stove begins to roast your shins, the alarmed nerves cry out—not for patent ointments, not for anti-caustic liniments and "pain-killers," but for a lower temperature. Nothing else will permanently appease them. Millions of prisoners, school-children, and factory-slaves, pine for lung-food as a starving man yearns for bread; and that hunger can not be stilled with cough-pills, but only with fresh air.

There are adjuvant remedies which will be noticed hereafter, but their co-operation is not indispensable. Without a sufficient supply of wholesome food, without warm clothes, without domestic comforts, under the disadvantage even of excessive hardships and protracted fasts, a three months' mountain-excursion, with or without tents, will cure all the symptoms of the disease with the exception of an accelerated pulse and a panting respiration during active exercise. Canadian trappers who leave their supply-camp with a bad cough, get rid of it on the fifth or sixth day "out." They may get foot-sore, and, if game is scarce, hipped and homesick, but the feeling of haleness about the chest continues. Night-frosts do not affect it. Fatigues rather improve it. They may wake up with a feeling of frost-cramp from their chilblained toes to their shivering knees, but the lungs are at ease: no cough, no asthmatic distress, no stitch-like pains, no night-fever.

An old campaigner would laugh at the idea of "colds" being taken in the open air. He knows that they germinate in close bedrooms and flourish in musty beer-shops, but vanish in the prairie-wind. If he is a government teamster and sells his meat-rations for brandy, he may know that sun-heat and fire-water are burning his candle at both ends; he may see trouble ahead, but he is sure that it will not come in the form of lung-trouble. Koch's lung-parasites do not thrive upon a fresh-air diet.

After the *tuberculous cachexy* has once been subdued, a moderate daily dose of Nature's specific will suffice to maintain, or even to fortify, the recovered vantage-ground. A foot-trip across the continent would regenerate the respiratory organs, but even a stroll across the next meadow will be booked to the credit of our health account. The human organism is a savings-bank for the elements of vital strength, and in the form of fresh air it accepts the smallest deposits. In stress of circumstances, an hour per day of active exercise will help to keep the lungs *catarrh-proof*, and that hour may even be subdivided. Buy a large umbrella, and make it a rule to walk on your way to market, to your place of business, or to church; or at least part of the way, if the distance is great and your time limited. In the evening take a large satchel and go a mile out of your way to patronize a good fruit-dealer or a vender of old books—or fill the satchel at home, and earn the blessings of a poor family in the factory-suburb. Street-rambles should have a proximate object; the regulation-walk on general principles is too apt to be shirked on very slight pretexts. If you have a garden of your own, fence off a digging corner and prospect for geological specimens. If you have a wood-shed, import an old stump-log (hickory preferred), and do not be too particular about keeping your axe sharp. Ventilate your office; keep a stove and an overcoat in your workshop, and open the windows every now and then. Open the dining-room windows in the forenoon and the kitchen-windows in the afternoon; no force-ventilator can compete with the effect of a direct influx of atmospheric air. If you teach a class or work in a warehouse or counting-house, prevail upon the managers to ventilate the place during the dinner-recess, or else try to do your work in the airiest corner, near a window or near the door of a vacant side-room or hall. In ill-ventilated rooms the azote miasma has its centers of density that can be avoided with a little management.

But at all events get rid of the *night-air superstition*, and enjoy the blessing of an airy bedroom—the luxury, I might add. A natural instinct may be suppressed, but needs but little encouragement to resume its normal functions, like a river returning to its ancient channel. Thus the fresh-air instinct. In families cursed with the night-air superstition, children are ofter fuddled with miasma till they prefer it to fresh air, and dislike to sleep near an open window. But, in a single month, that aversion can be changed into a decided predilection, till the cool breath of the night-wind becomes a chief condition of a good night's rest, and the closing of the bedroom windows creates a feeling of uneasiness not unlike the discomfort induced by an attempt to sleep with your head under the blankets. In the sleeping-dens of the French village-taverns, where, after September, the window-sashes are actually nailed down, the children of a hygienic home would pine for a draught of oxygen as a sweltering traveler thirsts after fresh water.

Besides open windows, Dio Lewis recommends an open fire-place and a good wood-fire all night ; but that is a matter of taste : an extra blanket will serve the same purpose, and the danger of damp bed-clothes* in winter has been as strangely exaggerated as have the perils of cold drinking-water in midsummer.

In stormy nights a half-closed "rain-shutter" (a window-blind with broad bars) will keep the room perfectly dry without excluding the air. If the mercury sinks below zero, close every window in the house. Intense cold is a disinfectant, that purifies even the air of the hide-covered dungeons where the natives of the polar regions pass the long winter nights. In the dog-days, on the other hand, do not be satisfied with anything less than a thorough draught ; open every window in and around the bedroom. Consumption has been recognized as a zymotic disease, and sultry heat favors the development of all morbific germs.

Where the prejudice against open windows has been cured, the cold-air superstition often lingers in the form of a repugnance to *out-door exercise in winter*. After the last of October thousands of convalescents suspend their morning rambles, and the hectic symptoms soon reappear. The aggravation of the disease may scare the patients into a warmer climate, but most of them would rather breathe sick-room miasma than the winter air of a high latitude. The truth is, that the prophylactic influence of the out-door atmosphere depends less upon its temperature than upon its purity, and for the open-air treatment of lung-diseases a cold, clear winter morning is more propitious than a dusty summer day. The contrast is shown in the effect. A single hour's exercise in the skating-ring or under a snow-covered wood-shed, a sleigh-ride, a brisk walk through an ice-glittering park, will ease the respiratory organs more effectually than a week of languid rambles through the dust and heat of an Italian *campagna*.

In larger cities, especially, a good frost defectates the lung-poisoning effluvia of the slum-alleys, while heat aggravates their offensiveness. In the cities of our Atlantic seaboard July is about the most unfragrant month in the year, and August the dustiest. Soon after the summer solstice wealthy invalids should, therefore, pack their

* "I shall not attempt to explain why damp clothes occasion cold, rather than wet ones, because I doubt the fact ; I imagine that neither the one nor the other contributes to that effect, and that the causes of 'colds' are totally independent of wet, and even of cold" (Benjamin Franklin's "Essays," p. 216).

camping-gear for the Alleghany highlands, and arrange for their return by the end of October. Patrons of a transatlantic passenger-line had better go a month sooner, to avoid the midsummer nightmares of a superheated cabin. European tourists can combine the useful with the agreeable by doing their sight-seeing afoot; but they should remember that Alpine morning breezes can not always neutralize the bedroom air of a South-German tavern, and that sultry heat aggravates the effects of mal-ventilation.* The German, Austrian, and Russian shepherds stay the whole summer with their flocks, but, as a class, are nevertheless remarkably subject to pulmonary diseases, and for the following reason: They pass the night in a *Schäfer-hütte*, a sort of ambulance-box, eight feet by four, and six feet high, without windows, but with a tight-fitting sliding-door. This door the ill-advised proprietor shuts after dark, and breathes all night the azotized air of his Black Hole of Calcutta on wheels. In the morning he awakens with a hacking cough, superadded to a profuse perspiration and a feeling of nausea. The air of the mountain meadows gradually relieves the other symptoms, but not the cough, which finally becomes chronic; and, with exquisite facilities for the attainment of a patriarchal longevity, the slave of the night-air superstition dies in the forenoon of his life.

Mal-nutrition, combined with a tubercular diathesis, hastens the macerative (or "hectic") stage of the disease. Air is gaseous food, and the body of an ill-fed man who stints his lungs in life-air is thus suffering under a compound system of starvation. Hence the occasional rapidity in the development of tubercular consumption, and its frightful ravages in the homes of the poor, and in the stuffy tenements of French dress-makers and Silesian weavers, where a perpetual air-famine aggravates the want of bread.

Fat is the best lung-food, and, among all fat-containing substances, fresh, sweet cream is about the best, and salt pork the worst. There is a close correlation between consumption and the various scrofulous affections; "pulmonary scrofula" is, indeed, sometimes used as a synonym of tuberculosis. The French physiologist Villemin found

* "The rate of life, and consequently the amount of disintegration, in any organized structure, depend in great measure upon the temperature at which it is maintained; and thus it happens that the production of carbonic acid from this source, at the ordinary rate of vital activity, is much more rapid in warm-blooded than in cold-blooded animals, and that the former suffer far more speedily than the latter from the privation of air. But, when the temperature of the reptile is raised by external heat to the level of that of the mammal, its need for respiration increases, owing to the augmented waste of its tissues. When, on the other hand, the warm-blooded mammal is reduced, in the state of hibernation, to the level of the cold-blooded reptile, the waste of its tissues diminishes to such an extent as to require but a very small exertion of the respiratory process to get rid of the carbonic acid, which is one of its chief products. And, in those animals which are capable of retaining their vitality when they are frozen, vital activity and disintegration are alike suspended, and consequently there is no carbonic acid to be set free" (Gurney Smith, "On Respiration").

that in Guinea-pigs, rabbits, and other animals, the symptoms of tuberculosis can be artificially produced by a repeated inoculation with scrofula virus; and in the children of scrofulous parents the inherited taint often leads to the development of a malignant form of tuberculosis. Consumptives should therefore avoid all scorbutific articles of diet: salt meat, pickles, indigestible made dishes, rancid fat, pungent spices, cheese, and all kinds of intoxicating liquors. A predilection for such diet is often encouraged by the circumstance that in the incipient stages of consumption it can be indulged without apparent inconvenience to the digestive organs. The victims of pulmonary disorders often enjoy an omnivorous appetite. But they should not forget that their diseased lungs act as an absorbent of all morbid matter, and that the immunities of the digestive apparatus are purchased at the expense of the respiratory organs.

Pathological conditions, involving an abnormal waste of tissue, require, indeed, an extra supply of nutritive aliments, and the patient may claim the right to indulge his appetite in regard to the quantity of his food, but he should earn that right by restricting himself in regard to the quality. His diet should be nutritious, non-stimulating, and slightly aperient; the regulation of the quantum may be trusted to the promptings of Nature. The first full meal, however, should not be taken before the morning exercise. Those who are in the habit of wasting the energy of the day's prime on the digestion of a massive breakfast may palliate their craving with a glass of sweet milk, or a piece of brown bread, dabbed with treacle or cream. Fresh cream, Graham bread, honey, beans baked with butter instead of pork, and a liberal dessert of such fruit as sweet grapes, pears, strawberries, or stewed prunes, at about 1 P. M. At six or seven a similar meal; for the sake of variety, perhaps buckwheat-cakes instead of bread, and apple-butter instead of honey. In point of quantity let the supper rival the dinner, with the proviso that the rules of the bedroom hygiene shall be duly observed, for, if the vigor of the digestive organs is aided by a liberal supply of oxygen, it is a fallacy to suppose that the night is an unfavorable time for the assimilation of a hearty meal. Animals rest after repletion, and some of them never sleep till they have a good meal to digest. There is no doubt that after meals neither mental nor muscular exertion is favorable to the performance of the organic functions which concur to effect the nutrition of the system. And, if the stomach can bear it, before going to bed an extra glass or two of sweetened cream may be taken—not as a food, but as a medicine. It is an established fact that *fat counteracts a tuberculous diathesis.* The inhabitants of the polar regions consume enormous quantities of non-nitrogenous food. Our negroes, to whom the climate of the United States must be semi-polar, lose no opportunity to gorge themselves with fat meat. The poor monkeys of our Northern menageries are ravenously fond of sweet milk and cream; instinct teaches them that fat stifles tubercles. The dairy-districts of the chilly Netherlands enjoy a remarkable immunity from pulmonary diseases. Sandor Czoma, the Hungarian traveler, who passed several years in the highlands of Thibet, states that the Thibetan (Buddhist) monks prolong the lives of consumptives by heroic doses of clarified butter.

The Æsculaps of the future will issue their almanacs with a list of household remedies. The knowledge of a few simple dietetic correctives would enable thousands to dispense with the use of costly patent medicines. Common sugar is an effective receipt for depurating the morbid secretions of the air-passages. It relieves hoarseness, and in bronchial affections alleviates the painful, dry cough, by loosening the phlegm and relaxing the stringency of the laryngeal muscles. Various kinds of sweet fruits share this property, and the most palatable form of the specific is perhaps the saccharine element of good layer-raisins. California raisins are now retailed at ten to twenty-five cents a pound, and half a pound of a medium quality can be warranted to afford as much relief as a dollar-bottle of the best cough-sirup. Besides, the demulcents of Nature induce no unpleasant after-effect, while repeated doses of medicated sirup soon become nauseating. A quart of cold water, either pure or slightly sweetened, taken just before going to bed, is a pulmonary febrifuge, and a reliable preventive of night-sweats. It also promotes the easy breathing which to far-gone consumptives comes otherwise only after hours of troubled sleep. Dyspnœa, or want of breath, like dyspeptic asthma, can be greatly alleviated by an aperient diet: water-melons and buttermilk in summer, and baked beans, peas, or lentils, in winter. Combined with out-door exercise, digestive correctives often afford permanent relief from the distress of asthmatic affections, for that dyspnœa does not necessarily indicate an irremediable waste of pulmonary tissue is proved by the fact that it often occurs and permanently disappears with the symptoms that characterize the transient affections of the upper air-passages.

Permanence of relief is the best criterion for the value of a remedial agent. The cathartics and alcoholic stimulants of the old-school practitioners suppressed the symptoms of the disease, but the supposed relief was nothing but an interruption of a reconstructive process. While the vital forces were fighting the battle of life against the chronic enemy, we obliged them to suspend their efforts in that direction, in order to meet a more imminent danger at another point; for Nature can fight only one disease at a time. If an asthmatic person is seized with a climatic fever, the respiratory trouble is temporarily suspended: Nature, as it were, postpones the asthma-case in order to give her undivided attention to the fever-affair. Fever and ague give way to small-pox, a drunken man can be "sobered up" by an heroic dose of arsenic, and intoxication relieves the pangs of neuralgia, gout, and rheumatism—for a day. But, at the end of the day, the mal-exorcised demon returns with seven accomplices, and Nature has to resume the original struggle with diminished chances of success—shorn of just as much strength as she had to expend in combating the additional enemy. The exorcist then repeats his dose, but finds that he has to increase the quantum: the exhausted system at last ceases to react against the provocation, and in order to obtain temporary relief the patient must resort to stronger and stronger stimulants.

There is a more excellent way: trust in the wisdom of Nature, and a careful husbanding of the vital forces—by CONTINENCE, for instance. Sexual excesses, combined with mal-nutrition, are such potent allies of pulmonary consumption that Dr. Zimmermann calls tubercles "*Thränen der Armuth und Reue nach innen geweint*" ("tears of poverty and repentance wept inward"). That dreadful disease known as "galloping consumption" often results from the co-operation of the three chief enemies of the human organism: impure air, intemperance, and incontinence. The causes of all violent (or painfully suppressed) MENTAL EMOTIONS should also be avoided. Give gambling-houses a wide berth. Deprecate quarrels, especially quarrels with superiors. Suppressed wrath has often resulted in fatal hæmorrhages. Consumptives need all the sleep they can get, and must abstain from night-work and nocturnal revels. They should also avoid crowded assemblies, not because of the excitement and the temptation to late hours only, but on account of the DANGER OF INFECTION. For consumption is a contagious disease, though not in the conventional sense of the word. The matter is this: the germs of tuberculosis have no direct effect on the respiratory organs of a healthy person, though cases are on record where the constant breathing of a tainted atmosphere has communicated the disease from husbands to wives, or from patients to nurses. But, after a tubercular diathesis has once been fairly developed, the diseased lungs become extremely sensitive to the *contagion* of all pulmonary diseases; the tubercle-seeds, as Dr. Koch's theory would explain it, fall upon a receptive soil—the sores of the half-healed *vomicæ*. Dr. Koch, of Breslau, traced the propagative principle of the tubercle-virus to the development of microscopic animalcula, and I predict that similar parasites will yet be discovered in the morbid secretions of the upper air-passages. This sensitiveness continues after the idiopathic symptoms of the disease have been brought well under control; and observation would show that a ten minutes' interview with a sufferer from catarrh, or a short visit to a reading-room, where swollen-faced children are hacking and coughing, suffices (often before the end of the first day) to prove the contagiousness of those affections.

But, if the danger is recognized in time, the virus can be *worked off* by out-door exercise. Catarrhs can thus be nipped in the bud. I speak from personal experience: I have tried the experiment at all times of the year, and always with the same result, even in one case where my plan of operation involved a ten hours' march across a snow-covered mountain-range. I reached the camp foot-sore and almost feverish with exhaustion; but the catarrh, too, had exhausted its resources, and the next morning I awakened with half-healed feet and wholly-cured *bronchi.* One day of pedestrian fatigues had saved me two weeks of pulmonary distress.

Next to fresh air, active exercise is the best prophylactic:

> "Dem Athleten wird vergeben
> Was der Schwächling theuer büsst."

By stimulating the action of the circulatory system, gymnastics promote the elimination of morbific matter; *disease-germs are removed before they have time to take root.* Every gymnastic apparatus is worth dozens of patent medicines; the beneficial effect of the "movement-cure" is permanent, as well as safe and prompt. The five gymnastic specifics for pulmonary disorders are dumb-bells, Indian-clubs, long-handled oars, spears, and a grapple-swing. *Ger-werfen*, or spear-throwing, is a popular pastime of the Turner-Hall. The missile is a javelin of some tough wood, about ten feet long and as thick as a common axe-handle. It terminates either in an iron lance-head, or in a brass knob, to keep the wood from splintering. A rough-hewed log-man, with a movable head, forms the target, and the problem is to decapitate the figure from a distance of about twenty paces for tyros and forty for veteran lancers. The shock of the throw expands the chest, and has a magical influence on the stitch-like pains of a lingering pleuritic affection. It is a mechanical anæsthetic for all kinds of pulmonary disorders. The grapple-swing consists of a pair of iron (leather-covered) rings, suspended at a height of about four feet from the floor, and affords opportunities—if not *facilities*—for a great variety of aerobatic exercises. The complex evolutions are somewhat arduous, but even the simplest use of the contrivance—swinging to and fro like a pendulum—exerts a mitigating influence on the strictures of the respiratory organs, dyspnœa, and asthmatic troubles. *Faute de mieux*, trundling a wheelbarrow, with a gradual increase of the load, chopping or sawing wood, or grubbing out stumps with a mattock, is worth ship-loads of cough-sirup, though it is doubtful in what degree the individual predilections of the patient might bias his choice.

But people of means and leisure can remove that doubt by making out-door exercise pleasant enough to be preferable to any drug; and the following plan would combine, under the most favorable conditions, the best atmospheric, gymnastic, and dietetic remedies for the disorders of the respiratory organs.*

* The treatise on consumption will be concluded in our next issue, as the first of a series of articles on the hygienic treatment of the prevalent disorders of the human organization, including dyspepsia, pulmonary diseases, the alcohol-habit, rheumatism, and climatic fevers.

[*To be concluded.*]

SCIENCE AND CONSCIENCE.

By Professor THOMAS SERGEANT PERRY.

WHENEVER we find men's thoughts concerning any one of the main questions of life inclining steadily in a certain direction, there is some probability that we shall not be far astray if we expect to find a similar tendency in the way in which other questions are regarded by the same persons. Our experience tells us that this is true of individuals : a radical in politics is likely to be a radical in religion, and what is true of individuals is true of the race. The more we study the past, the more we shall be convinced of the uniformity of thought at different periods of history. Thus, the general awakening of interest that we call the Renaissance was not confined to art and literature ; it became a reaction against every form of mediævalism. It aided the great movement of religious thought and produced the Reformation, as it also followed the new channels of scientific investigation. The decay of feudalism that accompanied these new interests was far from being an accidental coincidence.

The pedantic sequel of the Renaissance, the limitation of interest to what was called good sense, which distinguished the age of Louis XIV in France, and, to speak somewhat crudely, what we may call the literature of the last century in England, was far-reaching in its effects : government and religion, as well as letters, rested on conventionalities. They were all affected by the prevailing reaction in favor of authority. In government, this took the form of monarchism ; in literature, that of relying on Latin models, and abandoning all the national forms of composition. The French Revolution was more than a mere political outbreak : it was but one form of a wide-spread revolt against the narrow limits which pseudo-classicism and monarchism had imposed on intellectual and personal freedom. The very logical coherence of the French, which had made their chains more binding than the clumsy imitations which other countries forged for themselves, made the revolution, when it came, thorough and terrible. What was a smoldering discontent burst then into a flame of vengeance. Romanticism, again, was not simply a literary movement ; its roots lay deep in the recognition of the fact that all human beings, without regard to their social position, are equally objects of interest to literature and art. The discovery was made gradually and almost simultaneously in literature and politics, that the aristocracy had no monopoly of importance. In short, toward the end of the last century there was a Renaissance of humanity ; and aristocratic principles received a blow from which they can never wholly recover. The revolution is not yet complete, and its course hitherto has been uneven. Some of the leaders, who in their hatred of classicism discovered that civilization had a past, were so elated with their discovery that they stopped short to admire and make over again the past which they had painfully exhumed. There was a revival of mediævalism in art, in literature, in politics—modern imperialism is an instance of this—and that religion was not exempt is shown by ritualism in England. Yet the greater original movement has gone on, and in the realism that is beginning to affect art and literature, as in the spread of democracy, we see the natural growth of one inspiring thought.

If, then, we observe in the past the complex results of a single strong, animating influence, we may be justified in examining the life about us to see, so far as we may, how it is affected by contemporary thought. One of the most important influences now at work is doubtless that of science, which is of course as old as human curiosity, and is only new in its results. That the effect of the great advance in scientific thought has been to modify considerably most forms of religious belief can not be denied; and, in spite of the many attempted reconciliations of the two, it is not difficult to see that some of the leading dogmas of Christianity are doomed. Fortunately, one of the rewards of the freedom that is given to science is a lack of venom in its attack, and, on the other side, there is an absence of bitterness in those whose opinions it unavoidably alters. There are, of course, exceptions; modern science has not expelled arrogance from the world, and enlightenment has not wholly driven out bigotry. Yet, in the calmness with which the controversy is carried on, we see how wide-spread is the belief that dogmas are less essential than the truth which all men alike are seeking. As Professor Asa Gray puts it: "No sensible person now believes what the most sensible people believed formerly. Settled scientific belief must control religious belief." It is one of the time-honored jests which the late Lord Beaconsfield thrust into his last novel, that the religion of sensible people is what sensible people never tell. They may not, but their tolerance of new truths and the altered position of ecclesiasticism declare all that need be known.

The present interest in science is distinctly part of the revolutionary movement which demands, with restless curiosity, why everything should be as it is. This is the question that is put to every existing institution, and science often gives a serviceable answer. The answer is a leveling one to all conventionalities, because science concerns itself only about facts, and it is heard now because science can only exist where thought is free. Freedom of thought is a powerful solvent, and it is especially destructive to all the conventionalities which exist by means of the common agreement that they shall not be examined. We see that in politics the divine right of kings is called in question, and in the uniform tendency of modern times toward democracy the assumption of government by those who are governed. In social matters we perceive a similar movement toward the emancipation of the individual. All knowledge advances from vague generalities to the comprehension of particulars, and as human beings have succeeded in understanding themselves they have thrown aside the convenient habit of dividing the rest of the world into vast homogeneous classes, and have recognized the dignity and importance of each individual of the race. This is most vividly reflected in the literature of the present day. We find in the romantic movement an expression of the renewed interest in man and nature: this interest was mainly felt at first simply in their picturesqueness; modern realism shuns the picturesque, as one form of the romantic exaggeration, and endeavors to treat human life as the man of science treats the objects of his study.

It would be singular if religion remained untouched by these movements. There would be no precedent for its escape from the common fate of all branches of thought. The Reformation was a democratic revolution. That its original fervor died out, and was succeeded by imitation of the forms that it had bitterly fought, is well known. When, toward the end of the last century, the great outburst of Methodism startled the Church of England out of its lethargy, it was not so clear as it is now that religion was experiencing the same change that was making over politics and literature. The campaigns of the Salvation Army, so far as they have more than mere temporary importance, give proof that lower social circles are feeling the general excitement. Can we suppose that the most important subject of man's thought is disregarded at the present time? Far from it; we see in the modification of the demands it makes on society a great change in religious feeling. We may observe the general relaxation of formal bonds in the more liberal ground that is taken by even the more conservative sects, and in the fact that the others insist rather on righteous living than on rigid belief.

May not some of this spirit of toleration be due to the recognition of the fact that laxity of belief does not necessarily connote immorality? Are not society and theology tending toward a generally acceptable *modus vivendi?* Is not ecclesiasticism dwindling before the change which has made itself felt in politics and literature, that is, before the growing importance of the individual? If this phrase meant that the individual has simply grown in conceit, the result would be absolutely intolerable; but if it implies that there has been greater development in the notions of right and wrong, and a more general recognition of the rights of conscience rather than of an outside force, the change, if it exists, may not be for the worse. The examination of these questions is a difficult matter. Some will answer them, without delay, in accordance with their already fixed opinions; and any one who gives them any consideration must be ready to acknowledge the difficulty of judging the present in anything like a satisfactory way. Contemporary life obviously lacks the perspective which is necessary to set in their proper place what is important and what is merely trivial and ephemeral. Yet we have before us a certain amount of testimony which will be all that is left for posterity to judge from, and in consulting this we may find material from which to form a tolerably satisfactory conclusion.

It is an easy definition of the literature of the last century that its tone was didactic. From the "Spectator" to the "Rambler" it abounds with the soundest instruction in morality, yet it may be worth while to notice that this is generally about the very rudiments of decorum. The "Spectator," for example, defended matrimony from the ribald attacks of the comic writers; it preached sound views concerning education, and it by no means neglected minor matters, such as "that huddled economy of dress which passes under the general name of a mob, the bane of conjugal love, and one of the readiest means imaginable to alienate the affection of a husband, especially a fond one" (No. 302). Elsewhere mention is made of misbehavior at church; improper conversation in public vehicles is denounced: these are the domestic and somewhat rudimentary lessons inculcated amid a great deal of social instruction concerning witchcraft, the folly of dueling, the beauties of the arts, etc. The work of the "Spectator" was summed up not inaccurately in these lines of an admirer, which are given in Drake's "Essays," illustrative of the "Tatler," etc.:

"Improving youth, and hoary age,
Are bettered by thy matchless page,
And, what no mortal could devise,
Women, by reading thee, grow wise.
. . . wedlock by thy art is got
To be a soft and easy knot. . . .
The ladies, pleased with thee to dwell,
Aspire to write correct, and spell."

There is a certain anti-climax in this outburst of praise, but it has the merit of accuracy, and it is easy to see how great are the advances made since the beginning of the last century in what we may call social morality.

Richardson, too, was didactic; but no reader of "Pamela" can avoid seeing that the heroine clings to her virtue quite as much for the reward she expects to win in this world as from any higher motive. The dangers portrayed in "Clarissa Harlowe" are somewhat remote in this more decorous age; and Sir Charles Grandison is a curious combination of heroic romance and catlike domesticity. The life that Fielding draws seems to us all very remote. Miss Edgeworth, again, took charge of the education of her contemporaries by writing a series of novels, each one of which exhibited the evil effects of one minor vice and the advantages of the opposite virtue. In all her stories, clever though they are, there is a great deal of the teaching with which Frank was dosed.

When at length society was tamed, hospitality did not mean drinking with your guest till one or both of you fell under the table, and

Squire Western became as strange a type as Achilles; the discovery was made that family life, which had promised perfect peace, had yet its own trials, and that a very admirable person who always told the truth and shut the door after him, who was deaf to flattery and to gross temptation, might yet be an extremely disagreeable companion. We demand something more of those with whom we live than the certainty that they will not stab us or burn the roof over our heads, and it is not enough that they abstain from breaking the commandments. We require profound respect for one another's rights, and we perceive in selfishness, in all its intricate shapes, an evil that was overlooked, except in its more violent forms, by those who were eager in the contest against more heinous offenses. Society now busies itself with what we may call the statute law of ethics, the greater principles being generally observed by common agreement. Vice, to be sure, is not extinct, but intemperance, for example, is frowned upon by society rather than tolerated and sanctioned, as has been the case in the past. In the novels of the day, which are the most faithful records of contemporary life, the problems that are discussed are those that directly concern the individual conscience. George Eliot's work is full of such questions, and, like many great writers, she has set the standard before the reader ahead of what it is in fact, so that it is, as it were, a goal toward which we are striving with what strength we may have. In this respect she resembles Goethe, who pushed forward the outer lines of criticism to a point which the main body of his successors is only gradually reaching.

Compare, for example, Miss Edgeworth's chilly prudence with George Eliot's tender sympathy with suffering, and the advance that has been made becomes clear. What would Miss Edgeworth have thought of such a statement as this—"That element of tragedy, which lies in the very fact of frequency, has not yet wrought itself into the coarse emotion of mankind. . . . If we had a keener vision and feeling of all ordinary human life it would be hearing the grass grow and the squirrel's heart beat, and we should die of that roar which lies on the other side of silence"? Yet, of course, George Eliot is far from despising the minutiæ of domestic life; she makes it the setting of the most delicate ethical problems. It is character and not incidents that she studies; not the glowing crimes that make the fascination of the melodrama, but rather the corruption or weakness that gives them birth. She traces the growth of sin in the human heart with a vividness that is really appalling. Who has ever read "Romola" without feeling that his own vanity, boasting, and shuffling performances are branded in the chronicle of Tito's slow moral decay? In "The Mill on the Floss," again, we have a typical representation of a form of domestic tyranny that can be matched in every household that we know. In "Middlemarch" we follow the struggle of generosity and a high ideal against incompetence and corroding selfishness. In all her works the accidents of vice are carefully distinguished from the vileness of moral ruin; what tragedy there may be lies not in audacious crimes that make the fascination of the melodrama, but in the wrecked conscience of him who commits them. It is not long since fiction saw a hero in a murderer, who had at least the merit of boldness; now the analysis has been carried a step further, and novelists acknowledge, what we all know, that there may be evil-doers who are comparatively innocent, but that there is little to be said in behalf of a being sodden with selfishness, even if he do not offend against criminal law.

This distinction which the novelist draws between crime and wickedness is one that society itself is making, otherwise the novelist would not perceive it, and the growing interest in the discussion of the subject corresponds with the general increase in the value of the individual. Laws, we may perhaps say, concern masses; moral corruption is a personal matter that eludes the legislator. The ordinary citizen is law-abiding by nature and education; he does not consult the statute-book and trim his life in such a way as to avoid the grip of the constable; the policeman is his ally, not his foe. This alteration in men's way of modeling their lives has not been without effect on the position of the Church. Sermons are still preached that are remote from close connection with human interests, but there are many instances of the attempt that is making to save religion from the dry-rot of ecclesiasticism. Doctrinal exposition is giving place to simpler explanation of right and wrong, and to aid in the government of life.

What was once a hierarchy is becoming a democracy. We see a proof of this in the way in which books of casuistry are left stranded for the entertainment of the curious. Society has nothing more to do with those huge folios in which the leaders of the Church tormented themselves to devise possible sins for which they constructed ingenious reproofs. This treatment of the problems of sin reminds us of the barren and intricate exercises of the logicians who were contemporary with the casuists. Nowadays no one dreams of consulting a book to find out how wicked he has been, any more than an orator who wishes to influence his hearers practices with x, y, and z—the skeleton of the syllogism—to ascertain how he shall move the feelings of his audience. A man trusts to his conscience, to the sentiments of his neighbors, to tell him what his conduct shall be. The possession of the test of right and wrong has spread from a class to society at large. In the same way, with every year less stress is laid on the cosmogony of the Old Testament, and more on the ethics of the New. It is no longer demanded that we believe in the literal truth of Genesis, or in the ever-varying reconciliations, as they are called, with which theologians try not to be left behind by modern thought.

These modifications of ecclesiasticism—that is to say, the relaxation of dogmatism coincident with a general comprehension of morality—are part of the change which in matters of government is represented by the decay of aristocracy and the spread of democracy. "The theory of the Church," Mr. Stopford Brooke says ("Faith and Freedom," Boston, 1881, page 333), "is an aristocratic theory, and it has ministered to that imperialistic conception of God which in theology has done as much harm as despotism or caste system of any kind has done to society." In England the Church exists as a part of the general aristocratic system of a country in which non-conformity is detested mainly as a social stigma ; in America we see the clearest proofs of the altered circumstances, and these are visible on every side. The formal side of ecclesiasticism loses its force, while ethical teaching gives and receives fresh life. Dogmas linger a couple of centuries behind what people really believe, and even the most conservative are far more liberal than they try to be, or than they say they are. Even the most fervent Roman Catholic refuses to believe that his Protestant friend is doomed to eternal damnation.

If theology is willing to satisfy itself with furthering right living and right thinking, its future is bright ; if it demands assent to irreconcilable dogmas, it must in time disappear like everything which rests on sheer authority. Yet probably no age will ever be confronted with this direct question ; the present one has come near it, and, while a century ago the general discussion was tabooed by the cautious, lest the whole social system should be swept by the board, it is now seen more or less clearly that men can think variously about dogmas without relapsing into barbarism. In time this will be generally acknowledged—what we now feel in our hearts—that the eternal laws of right and wrong, of justice and injustice, of truth and falsehood, are safe from the bungling of copyists, the destruction of wars, and the confusion of commentators.

This, however, is taking us from the question immediately before us, which is the relation that religion bears to contemporary thought. We can judge of what may be in store in the future only from the past and the present. If we fail to detect any modification of older ways of thought, there is no firm ground for prophecy about what is yet to happen. Yet we have seen Christianity molded into a church by the force of the current Roman ideas ; we have seen feudalism triumphant in things terrestrial and things celestial ; we have seen new freedom come into religion as into the rest of the world with the Renaissance, and we have seen a renewed reaction into old ideas following this freedom, as we see mediævalism in the fantastic robes and many candles of the Church when, in its turn, it was affected by the Romantic movement. In the wider freedom that begets science we see new tolerance for freedom of thought, and this freedom of thought can not fail to undermine some of the artificial constructions of the past. That it will destroy the essential principles of religion need scarcely be feared, any more than that science will expel literature.

Only what has within it the seeds of mortality can be killed, and religion and imagination are outside of science ; but ecclesiasticism, which has been built by men, can be destroyed by men, just as literary conventions, which were the work of scholars, can be torn to shreds by scholars and writers.

PHYSICS IN GENERAL EDUCATION.*

By Professor T. C. MENDENHALL.

THIS is an "Association for the Advancement of Science." But the forces which have to do with aiding or retarding this advancement are so various that we are in danger of losing sight of some of them. We are mistaken if we suppose that science is advanced only through contributions which are the result of original research in our laboratories and libraries. Even if so narrow a view be taken, it will be admitted that the talent for research is fostered and encouraged, if not indeed created, by an atmosphere of recognition and appreciation. The existence of such an atmosphere is in itself a blessing, and its production is certainly worthy of our highest efforts.

To this end it is desirable and necessary to bring about a more general diffusion of accurate knowledge concerning the elementary principles and propositions of the science of physics, as well as some degree of familiarity with the methods of physical investigation. I do not refer, of course, to the demands or the necessities of those who expect to undergo a course of training for the purpose of becoming themselves physicists, but rather to the diffusion of this knowledge among the masses of educated people in general.

That this diffusion is not taking place to any great extent, and will not, according to natural laws alone, is patent to any observing physicist, who can not fail to have come in contact with prevailing and pernicious errors, which often carry the weight of repetition, and now and then of recognized authority.

I am aware that this is not an association of educators, and that pedagogics is not, as yet, one of the sciences specifically indicated as worthy of advancement at our hands ; but, if the growth of a tree is to be made healthy and permanent, it is not safe to neglect the soil into which its roots penetrate. Train it and prune it as you will, to grow into vigor and strength it must spring from a rich and generous earth which, though beneath it and below it, must be in harmony with it in order to supply the proper and necessary materials for its sustenance.

* Substance of a vice-presidential address delivered before the Section of Physics at the Montreal meeting of the American Association for the Advancement of Science, August, 1882.

It seems, therefore, not improper to raise the question, What can this Association do, or, more specifically, what can this section do, to increase the efficiency of instruction in physics?

I do this the more willingly for the reason that a considerable majority of the members of the section are engaged in this instruction during the greater portion of the year. In America a few only are privileged to devote themselves to original research. Here instruction and investigation, to a great extent, go hand in hand, and it is generally admitted that it is better so. The teacher does not reach his greatest efficiency, indeed he must fail completely, unless he continues a student, not of the works of men alone, but of Nature herself. On the other hand, some of the best and most fruitful inspirations of the investigator spring from his contact with those to whom he is communicating the finished products of his work. The history of science goes to show that many, perhaps most of those who have contributed to its advancement, have been great teachers. We neglect our duty, then, when we fail to give attention at proper times and under proper circumstances to the improvement of methods of instruction.

Perhaps in no other department of science has a greater change in these methods been wrought during the last ten years than in physics. And yet this change has been going on in an irregular, unmethodical sort of a way. There has been little or no concerted action among those interested and engaged in the work. Although all have had practically the same end in view, each individual has, in the main, worked out his own solution of the problem in accordance with his own views, modified and often largely controlled by the conditions and restrictions to which he was subjected.

It is not surprising, therefore, that results attained should in many cases be widely different and, on the whole, not entirely satisfactory.

In this new instruction many things have been attempted that could not be, and some things that ought not to be, accomplished. That overburdened and somewhat obnoxious word *practical* has found a place in our vocabulary, and we hear much of practical instruction in physics, whatever that may mean.

The subject, considered as a whole, naturally divides itself into two parts, pertaining respectively to higher instruction and elementary instruction: instruction in the colleges and instruction in the schools. Let us briefly consider each of these.

In referring to higher or collegiate instruction, it will be remembered that I do not include that of the post-graduate course in the university, properly so called, for which laboratories for research are equipped and maintained, and to which students are admitted only when thoroughly prepared by previous training. Fortunately for American students, a few such courses in physics are now open in this country, and it goes without saying that those who are conducting them do not need advice from us. It is for the large class of undergraduates who pursue the study of physics for a greater or less time that we may be concerned.

Contemporary with the recognition of the possibility of greatly improved methods of instruction was the recognition of the value of the more thorough study of physics as an element in what is called a liberal education.

These were alike the results of the tremendous strides made by physical science, beginning twenty-five or thirty years ago. Grand and beautiful generalizations commanded the admiration of men skilled in other departments of human knowledge, and equally wonderful applications of principles to practice touched our every-day existence upon so many sides as to draw forth applause from the millions who are without the "inner court." Physics thus found or forced its way upon the college curriculum to an extent much greater than had previously been thought possible or desirable.

A few keen-sighted men, combining in themselves, happily, the student and the teacher, recognized the fact that thorough instruction in physics implied and demanded the use of laboratory methods, such as had been utilized for some years in chemistry, and were rapidly coming into prominence in every other department of natural science.

Among these was, notably, Professor Pickering, whose establishment of a working physical laboratory for purposes of instruction, in the Institute of Technology at Boston, must be regarded as an epoch in the history of this progress; and with this also might be linked, although following at a little later date, the widely-known establishment made by Professor Mayer at Hoboken.

These were quickly followed by others in the East and in the West, and at the present time there are many institutions of learning in which the laboratory methods of instruction are in use, and whose equipment includes a so-called physical laboratory.

To all interested in the study of the present condition of this work I would especially recommend the very valuable "Report on the Teaching of Chemistry and Physics in the United States," prepared by Professor Clarke, of the University of Cincinnati, and issued about a year ago by the Bureau of Education. This report is full of facts of great value, and doubtless fairly represents the relative standing of collegiate instruction in these two important subjects at the present time.

Professor Clarke has classified the various courses of instruction in physics as follows:

1. Full course, including higher mathematical physics, advanced laboratory work, and research.

2. Full course, with mathematical physics and elementary laboratory work.

3. Course in general physics, involving a previous knowledge of trigonometry, and including laboratory work.

The other courses, up to ten in number, are elementary in their character, and do not concern the present investigation.

The report contains statistics gathered from nearly four hundred universities and colleges, agricultural colleges, and scientific schools. In nearly all of these the study of physics is pursued to a greater or less extent, although it appears that in some instances no report upon physics was forthcoming on account of ignorance as to what was meant by the word. Out of the whole number there were thirty-three institutions in which the instruction in physics fell within the limits established above. Of these there were four of the first rank, two of the second, and twenty-seven of the third.

In chemistry, however, laboratory instruction is to be found in at least one hundred and fifty institutions, the opportunities for instruction in this subject thus outnumbering those offered for similar instruction in physics in about the ratio of five to one. But it will be remembered that in this contest chemistry has many things in its favor, and that physics is handicapped by the great cost, relatively, of the first establishment, as well as by the lack of well-defined and systematic courses of instruction.

Taking it as a whole it will be admitted that there has been a rapid and, I believe, a permanent growth, and that the work has already become so extensive that it appears to be worth while to subject it to criticism, and to determine by conference and consultation what improvements, if any, might be suggested.

Admitting the necessity of the laboratory as a means of instruction in physics, two important questions present themselves: First, of the total amount of time given to the subject, what proportion should be spent in the laboratory? and, second, what should be the character of the work done there?

I shall not undertake to answer these questions, but will submit one or two conclusions which have been thrust upon me by observation and experience.

Concerning the first, something ought to be said. It will be remembered that the new instruction began at a time which was characterized not only by unusual scientific activity, but as well by what almost amounted to a revolution in educational processes. A great teacher had told us that we studied Nature in books, and when we met her face to face she passed unrecognized. There sprang up a new method, the essence of which was that the mysteries of Nature could not be known at second-hand; that a knowledge of things could only be obtained by a contact with things themselves. The use of the text-book fell into disrepute, and the student was encouraged to become his own authority. It was as if all men were to cast aside their maps, globes, histories, books of travel, etc., and start out to obtain a knowledge of the world by visiting its different portions.

But it was soon found that many never succeeded in getting far away from home. It is true that there were those who, untrammeled by tradition, precedent, or authority, made bold excursions into the regions of the unknown, and returned richly laden with spoils, but these were the few; the many were found to require guidance and support for some time before they became able to carry on explorations on their own account.

The underlying principle of the new method was correct and must survive, but it was a mistake to give it universal and unrestricted application. The earlier and indeed much of the later instruction in physical laboratories was tinctured with this error.

By many we were advised that the proper course to pursue was to put into the hands of the student who, in many instances, had little or no previous knowledge of the subject, a few pieces of simple apparatus and expect him to rediscover for himself principles of physical science which, although now commonplace, were at one time as completely surrounded by difficulties to the human mind as are now, for instance, the principles of the dissipation of energy and the vortex theory of atoms.

The result of the crude experiments of the student was often to disprove the law which he was expected to establish; for he lacked that knowledge and training which would enable him to take into consideration the influence of secondary causes and conditions, and to determine or properly interpret the errors of experiment. Something was gained, it is true, in the way of familiarity with the methods of manipulation, but very little in the acquisition of real knowledge.

Even if this method of instruction be made reasonably successful, the actual information concerning natural laws which the student obtains must be largely superficial, often erroneous, and the rate of acquisition extremely slow. Far better would it be for him to begin his so-called practical study of the subject after becoming tolerably familiar with its general outlines and prominent features through the study of some reliable text-book, and especially after having armed and equipped himself with such a training in mathematics as will enable him to discuss understandingly the results which he obtains, to consider the limitations to which they are subjected, and the influence which has been exerted upon them by errors of various kinds.

In this matter, as with most others, we are likely to fall into extreme views. Some of us maintain that experiment alone is the key, by the use of which Nature's mysteries are to be explored, and we fortify our belief by pointing to Faraday, the greatest experimental philosopher the world has yet produced. We forget that Faraday was ignorant only of the outward, conventional symbols of mathematical reasoning, and that one of the greatest works on mathematical physics, by one of the greatest mathematical physicists of modern times, is confessedly but little more than his interpretation.

Dazzled by the success of the leaders and representatives of another school, we proclaim that true success will depend on mathematical attainment, and that mathematical physics is the only physics worthy of the name. Here, again, the exceptionally brilliant few, who have succeeded under this training, stand as its exponents, and we fail to consider that, if adopted to the exclusion of the first, its results may be disastrous in the extreme. No better evidence of this need be furnished than is found in the remarks recently made by Mr. G. H. Darwin, concerning a contest for honors, in what is generally admitted to be the greatest school of mathematics and mathematical physics in existence. Mr. Darwin, who was one of the examiners, says: "The subject which exhibited the average weakness of grasp most flagrantly was thermo-dynamics. A great many men had read something of it, but very few really understood what they attempted to explain. Extraordinary muddle and confusion was sent up in answer to a question on the absolute scale of temperature. On another question, while the very elements of the subject were unknown to those who answered, the same men reproduced faultlessly the algebraic calculation of the thermo-dynamic function for a perfect gas."

Mr. Darwin also strongly recommends such a change in the style of questions as that half intelligence may be more stringently treated, and men induced to read less and master more, and to gain a comprehension of physical principles.

There can be little doubt but that the experimental and mathematical study of the subject should go on together, assuming, of course, a sufficient preliminary training in pure mathematics.

What seems desirable, therefore, at least in some instances, is less experimental work on the part of the student, and more thorough and exhaustive discussion and examination of what is done.

This leads at once to the consideration of what ought to be the nature of the work done in the laboratory. The limits to which I am confined will not allow me to enter into any lengthy discussion of this important question.

I will remark, however, that in my opinion there is much done which is neither desirable nor necessary. As a rule, quantitative work alone, and that the best possible under the circumstances, should occupy the time of the student. I would relegate to the lecture-table of the instructor all illustrative experiments and qualitative work necessary to a good understanding of the underlying principles of the subject, which every student should possess when he enters the laboratory. That which he gets which is of most worth in his course in a physical laboratory is not a familiarity with the principles of the science, but a training in the methods of investigation in use among physicists, including a knowledge of the use and abuse of experiment and the necessary limits of our knowledge derived therefrom. The study which he ought to make of errors, instrumental and accidental, will be of great value to him in other fields than this.

As an illustration of the lack of this sort of training, I may be allowed to mention a lecture to which I listened recently, delivered by the chief engineer of one of the leading railroads in the country. The subject was the "Great Pyramid," and in speaking of certain measurements taken in the interior he declared the results, which were given in feet, inches, and thousandths of an inch, to be *absolutely accurate*, taking especial care to disclaim anything in the nature of an approximation.

I need hardly explain that he was declaiming against the introduction and adoption of a system of metrology which has done and will continue to do much to increase the simplicity and accuracy of all measurements.

I have said that this quantitative work should be of the best quality possible. It is better for the laboratory to contain a few instruments of real precision than a large number of inferior performance and accuracy. It is not a matter of great importance upon which particular department of physics a student shall spend his time and strength. The underlying principles of this method of study are common to all, and it is a matter of experience that when a student has successfully accomplished a tolerably exhaustive investigation of one topic, involving, it may be, but a single instrument with its accessories, he is upon his feet for the remainder of the course.

To sum up, the course of study in physics for the undergraduate collegian, which I have tried to indicate, should include a sufficient training in mathematics to enable him to apply his knowledge with ease and facility to the more common physical problems ; a thorough and exacting course of text-book and lecture-work, in which the application of his mathematical knowledge would be made, and during which all illustrative experiments necessary to a complete understanding of the text should be exhibited by the instructor from the lecture-table ; and, finally, this to be supplemented by a course in the laboratory in which more attention is paid to the quality than to the quantity of work done ; during which every problem is discussed, as far as possible, both mathematically and experimentally, and especial attention is given to the discussion of the results of experiment, and of the more elementary portions of the theory of errors.

Considering the work as thus divided into three parts, I am unable to see which is the least essential.

I desire to say a few words in regard to instruction in physics in the school, about which we are, apparently, more remotely concerned. Even greater reform is demanded in this direction than in the other. Although there are numerous American text-books, I venture the remark that none have properly combined, in their making, the experience of the class-room with the critical knowledge of the scholar. We may import them from Europe, it is true, as we must also our more advanced text-books, but, although in the main vastly superior to our own, they are still not entirely suited to the wants of American schools and American pupils. These books, in the hands of teachers who know little or nothing outside of the books they use, and often falling far short of that, serve to put the instruction in elementary physics in this country in a condition over which no one can grow very enthusiastic; and this, in spite of the prominent place which has been given it and the considerable attention it has received. Unsound doctrines and absurd theories are promulgated because of an inability to distinguish the ring of genuine metal. These become so deeply rooted that it is difficult and often impossible in after-years to clear them away.

I believe it to be possible for this Association to exert a strong influence in favor of an improvement in the character of the instruction in physics in both elementary and higher institutions of learning in America. Much of it at present does us no credit, and must eventually do us much harm. At a meeting of this Association in Nashville, five years ago, a committee was appointed to report upon science-teaching in the public schools. At the Boston meeting, two years ago, this committee presented a report which embodied much thought upon the subject, and was replete with just and keen criticisms of present systems. It is greatly to be regretted that this report can not have found its way into the hands of those whom it would most benefit. A wide distribution ought to have been secured, and I am convinced that it is not yet too late to remedy this error.*

The same gentlemen were continued as a committee to report upon the "Best Method of Science-Teaching in Public Schools," and it is to be hoped that a scheme may be presented at no distant day. I will venture the opinion, however, that the best results will not be obtained until this, or a similar, committee shall work in co-operation with representatives of the public schools themselves, and I would suggest the feasibility of securing such co-operation through the National Educational Association.

No such difficulty is in the way of securing an improvement in the teaching of physics in colleges and universities, for those most interested are, in the main, a part of this Association and of this section.

I will not venture to suggest in what manner the Association might best make itself felt in this matter, although I think that would not be difficult to ascertain. I have only endeavored to direct attention to some of the salient features of the problem, and to ask its consideration at the hands of many members of the section who come in almost daily contact with it, and who will, I am convinced, sustain

* This report will appear in the next issue of "The Popular Science Monthly."

me in the belief that it is not unworthy to be brought before this body.

In preparing this discussion of the subject, I have not had access to such information as would have been desirable concerning the work which is being done in many institutions, nor have I been able to consult with others who are especially engaged in its management. Indeed, it was this very lack of accessible information, this very impossibility of personal consultation, with which I met in the outset, that convinced me of the importance of directing the attention of the section to the subject.

What the section *could* do in the direction indicated seems to be tolerably clear and certain. Whether it is wise or desirable that it should undertake to do anything is a matter which I willingly leave for it to determine.

MICROSCOPIC LIFE IN THE AIR.

By LOUIS OLIVIER.

ANCIENT Pantheism animated all nature. Gnomes in caverns, naiads in springs, sylphs in the air, represented life, pervading everything. Twenty centuries having passed, science has resuscitated these elementary genii under the form of organic germs; and we are forced to-day to recognize that the reality surpasses all the bold conceptions of the fable. From pole to pole the atmosphere transports myriads of microscopic animals and plants. They are counted by hundreds in each cubic metre of air that we breathe in Paris. Developing themselves in the organic infusions into which they fall, they soon determine their complete decomposition; and they play their parts in virulent diseases and in fermentations. No doubt is permissible on this point after the admirable labors of M. Pasteur; and every day a new workman brings his stone as a contribution to the grand edifice of which this illustrious physiologist has drafted the plan and himself laid the impregnable foundations.

A considerable work has just appeared on this subject. For several years, M. Miquel has pursued interesting researches upon the microbes of the air; and, in addition to the regular publication of his investigations in the "Annuaire" of the Observatory at Montsouris, he has just completed an important memoir, which includes valuable facts respecting these organisms. We propose to show here how this department of science has been developed, and what means of carrying out its objects it possesses. F. A. Pouchet devised the *aëroscope* that bears his name, for collecting dust from the air. It consists of a small cylinder connected with an aspirator; a disk of glass coated with glycerine, and placed at the bottom of the cylinder, receives the jet of air which is produced by the aspirator. The glycerine retains the corpuscles which are brought in by the current, and it is then easy to observe them. This apparatus has been modified in various ways,

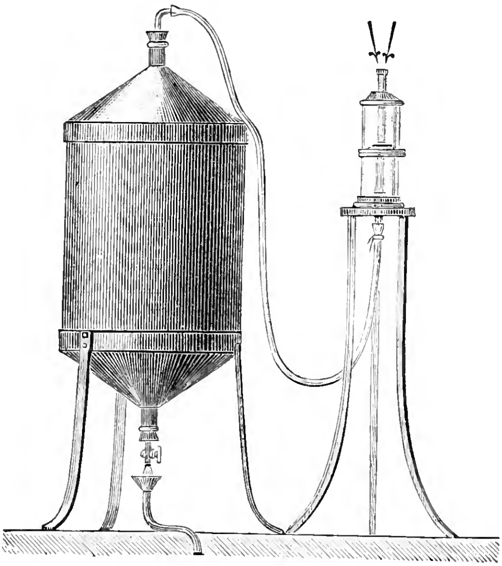

FIG. 1.—POUCHET'S AËROSCOPE.

but with it, or something like it, the earlier investigators, MM. Pasteur, F. Pouchet, Maddox, Douglas Cunningham, and others, have explored the atmosphere. It did not take long to discover that the air around us contains remnants of articles that we use existing in the condition of impalpable dust. Wool from our clothing, cotton, silk, starch, are floating in it, associated with fragments of various kinds—butterflies' scales, dried *tarsuses* of insects, feather-barbs, and skeletons of little worms. Pollens of the coniferæ and of numerous plants are abundant in it during the floral season. Particles of mineral matter are also found there, among them those curious spherules of meteoric air which have been described by M. Gaston Tissandier.*

Attention is, however, most strongly fixed upon the number and variety of spores of cryptogams of which the air operates as a vehicle of dissemination. Germs of the common molds, and the reproductive cells of the algæ that live on the roofs of houses, on walls, and on damp earth, are nearly always abundant. M. Miquel has tried to determine the laws that govern the appearance of these plants in the atmosphere. He first counted them, by disposing his aëroscopes so that they should register the volume of the air passing through them,

* See "Popular Science Monthly," July, 1880, article "Atmospheric Dust."

and estimating the spores deposited by those volumes, and from this deducing the number of spores contained in a cubic metre of air. Repeating these measurements every day and every hour for several years, and taking care to notice all the anterior or concomitant meteor-

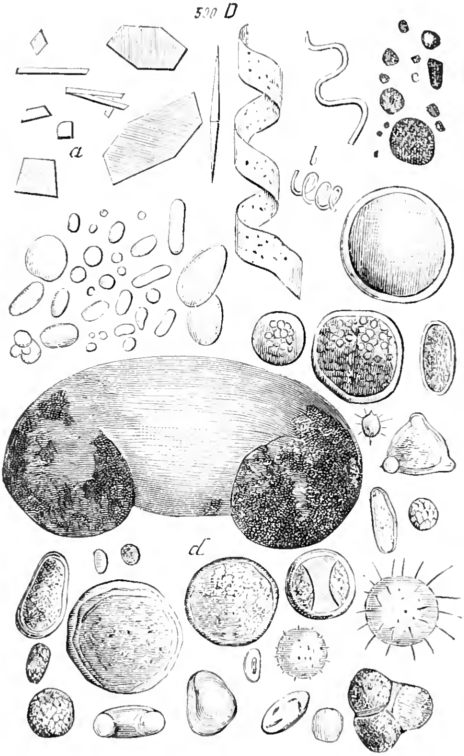

Fig. 2.—Pollen and Dust in the Atmosphere.

ological conditions, he succeeded in defining the influence of the seasons, and of temperature, dryness, and moisture in the progress of the phenomenon.

This method, applied at the Montsouris Observatory, shows that the number of mold-spores is weak in January and February, diminishes in March, and rises in April; the increase is very sensible in May, and the maximum is reached in June. The number then diminishes slowly till October, considerably in November, and reaches a minimum in December.

It may be said, generally, for the locality where the experiments were made, that a cubic metre of air contains on the average seven thousand mold-spores in December, January, and February; twelve thousand in May; thirty-five thousand in June; twenty-three thousand in August; fourteen thousand in October, and eight thousand in November. If, instead of considering the means of several years, we compare different periods of the same year, we shall not find the variations so regular. Sometimes the number of germs diminishes while the heat is increasing. In that case the effect of temperature is masked by the preponderance of another factor — the hygrometric condition of the air. This fact is explained by remembering that

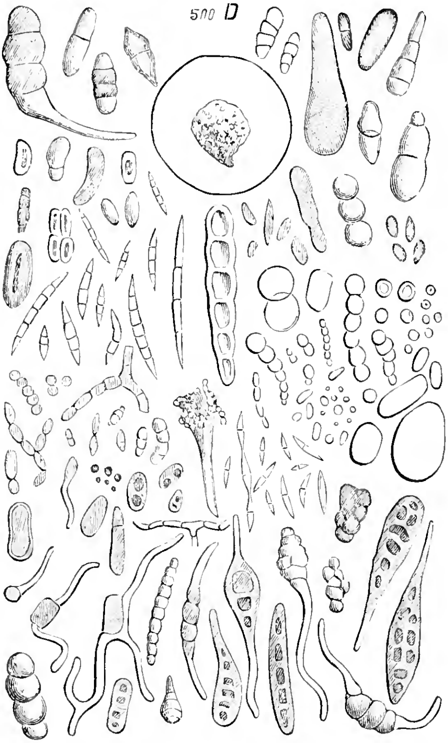

FIG. 3.—SPORES OF ALGÆ AND MOLDS IN THE ATMOSPHERE.

the development of molds is dependent upon both heat and moisture. The effect of moisture, however, varies according to the season, and with changes in temperature. Dry weather diminishes the number of germs in summer, and increases it in winter, while moist weather operates in an inverse manner.

Storms in the pleasant season are followed by a growth of cryptogamic vegetation, and purify the atmosphere for only a very short time. Fifteen or eighteen hours after a rain, says M. Miquel, "the spores appear to be five or ten times as numerous as before. On the other hand, mineral dusts and several kinds of microbes continue to be rare till the moisture which has caused them to adhere to the blades of grass and the moist soil of the surface has dried away."

These investigations, while they are profitable in a purely scientific aspect, are also destined to be of service in agriculture and hygiene.

As M. Miquel remarks, the use of aëroscopes will be of value for the discovery in the air of the germs of the molds which attack our cereals. Regarding the etiology of certain contagious affections, he continues: "It does not seem to be proved that the various spores introduced into our economy, to the number of 300,000 a day, or 100,000,000 a year, are perfectly innocuous. The appearance of thrush in the mouths of young children and in the respiratory canals of the dying seems to demonstrate also that the molds form a part of the class of parasites which are ready to take possession of our organism whenever it presents a vulnerable point or a point of weak resisting power."

M. Pasteur has long insisted on the utility of these researches. "I believe," he wrote in 1862, "that it would be of great advantage to multiply the studies on this subject, and to compare in the same place at different seasons, and in different places at the same time, the number of corpuscles disseminated in the atmosphere. Our knowledge of the phenomena of morbid contagion, especially during the prevalence of epidemics, would, it appears to me, gain from researches prosecuted in this direction."

Since M. Pasteur has established the parasitic character of zymotic diseases like the hen-cholera, sheep-rot, septicæmia, measles, etc., the micrographic statistics of the air has risen to a considerable importance. It has had, however, to concentrate its efforts chiefly upon a class of rudimentary organisms very different from the green algæ and the molds of which we have spoken. This group is the one to which the viruses belong. The plants composing it, and which are designated under the common denomination of bacteria, escape the process of numeration in use for the higher cryptogams. In consequence of their extreme minuteness and refractive power, they are

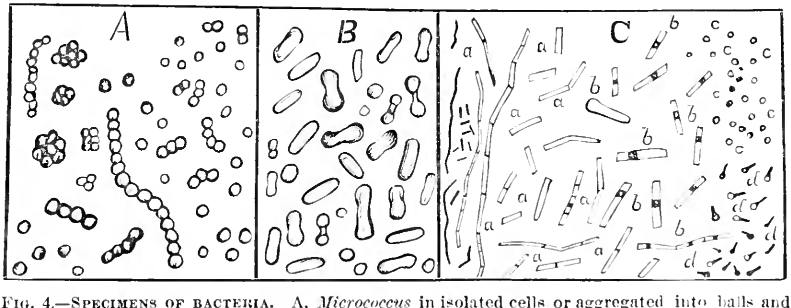

FIG. 4.—SPECIMENS OF BACTERIA. A, *Micrococcus* in isolated cells or aggregated into balls and strings; B, *Bacterium*; C, *Bacillus*; *a*, bâtonnets (adult bacilli); *b*, bâtonnets with spores; *c*, isolated spores; *d*, germinating spores.

invisible, and unrecognizable in the preparations of the aëroscopes. Their existence in the air was long denied, and the proof that they abound in it only dates from the experiments that were instituted by M. Pasteur for the solution of the question of heterogeny. The methods he devised are the ones that are still used to detect the presence of these plants in the atmosphere. Generally, these methods are founded on the fact that organic liquids become peopled with microphytes, or remain unchanged, according as the air comes to them charged with its normal quantity of germs, or after having been cleared of them by filtration. We can, therefore, examine the bacteria in the atmosphere by causing the air or the rain-water containing them to pass into liquors favorable to their nutrition, but previously free from them. Liquids for the culture of bacteria are easy to procure. Among them are the mineral solutions of Pasteur and of Cohn, infusions of hay and of turnips, neutral urine, broths of chicken or beef, and Liebig's extract. It is, however, very hard to obtain such liquids absolutely pure of every living being. Eminent physiologists have thought that all the germs could be killed by boiling them for a considerable time. Apparently the protoplasm, being an albuminoid substance, would be coagulated at a temperature of between 167° and 176° ; but very exact experiments have shown that while the protoplasms of different living beings belong to the same class of substances, they are not identical. Marked differences in this respect have been perceived even in the same beings. Thus, in the bacillus the protoplasm of the developed organism and that of the spore are not of the same quality. The former is in active life, the second in a state of life so low that it appears latent. A spore of this kind, as M. Chamberland has observed, will resist boiling water for hours, while the *bâtonnet* which is developed from it would perish rapidly in the same water at 122°.

M. Koch has conceived a method of discontinuous heating to sterilize liquids that are coagulable by heat. He raises his liquid to a temperature of not quite 158° to kill the adult bacteria ; then having cooled it, to give the spores time to germinate, he raises it again to about 158° ; and he believes that he can in this way destroy all the germs. M. Miquel makes a just criticism of this singular theory. We arrange that the spores of the microbes "must germinate in twelve or twenty-four hours, so that we may surely kill them if they go into the trap we set for them. But some of the germs may be obstinate or hardy, and we make a new trial, and for prudence a third and a fourth trial, after which we assume that all the bacteria have been destroyed. Unfortunately for the method of discontinuous heating, there are wary germs the development of which does not begin till after the fifth, the tenth, and even the twentieth day, and which, far from being stimulated in their growth by the successive heatings, at every repetition shut themselves up more closely in their latent seed-life. This method of sterilization can not, then, be depended upon."

A still more subtile cause of error must be guarded against. Cohn's mineral liquid will remain clear for an indefinite period after having been exposed to a heat of from 158° to 167°, without being free from germs; for, if we afterward add a quantity of broth which has been sterilized at 230°, the mixture of the two liquids, which, separate, would have continued perfectly limpid, will shortly swarm with bacilli and other organisms. Cohn's liquid can not be fully deprived of active germs till it has been boiled for four hours. If, continues M.

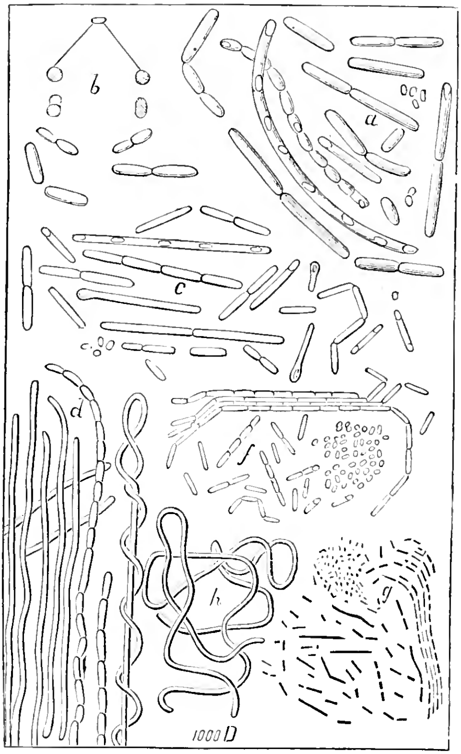

Fig. 5.—Bacillus of the Atmosphere magnified 1,000 diameters.

Miquel, we add sewer-water that has been heated for several hours in an hermetically sealed retort at 176° to Cohn's liquid which has been sterilized at 230°, and place the mixture in a hot bath, nothing will appear in it even after a month. Apparently it is perfectly free from living germs. But if a few drops of it are placed in a broth, also fully sterilized, the broth will in a day or two appear full of bacilli.

We must, then, unless we would expose ourselves to grave errors, distinguish between apparent and real sterilization. While beef-broth, neutralized with potash and heated to 230°, will remain sterile for an indefinite time, it is a good plan with other compositions and for particular bacteria to attain a temperature as high as 302°.

Heat, unfortunately, modifies the composition of organic liquids, and diminishes their nutritive properties. To obviate this, we must find means to sterilize the liquids without heating them. Filtration has been employed, and a number of adaptations of apparatus have been devised by means of which this object is accomplished satisfactorily.

In order to study the germs in the air, we must not only possess a sensitive and wholly pure liquid, but must have means of arranging it for the cultivation of the organisms, under such circumstances that we may be sure it shall contain no germs except those that are derived from the air we introduce for the experiment. MM. Chamberland and Miquel have employed simple apparatus which seem to effect this purpose perfectly.

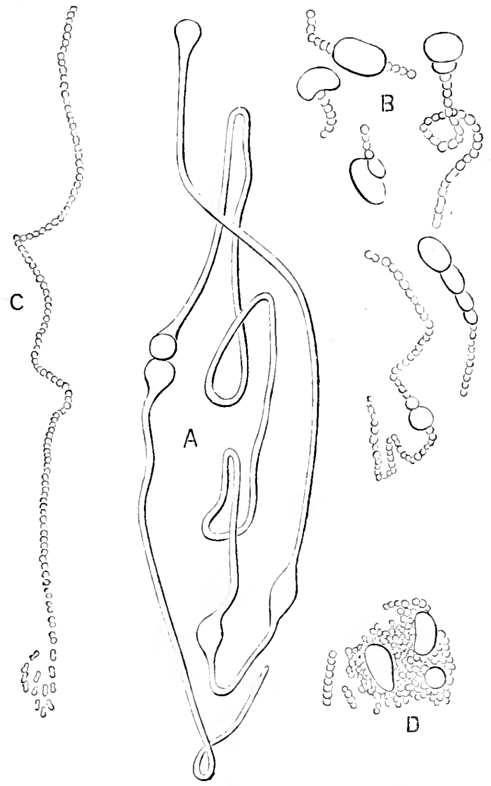

FIG. 6.—MICROCOCCUS BACILLIFORMIS (after M. Miquel). A, adult plant; B, examples of hypertrophied cells; C, chain at maturity; D, chain destroyed. Magnified 1,000 diameters.

If the experiments are made with rain-water, to ascertain the number of germs it collects in passing through the air, it may sometimes happen that, when a determined volume of water is evenly distributed in a considerable number of the cultivation-tubes, only a part of the tubes will become troubled. Generally, it may be said that if the water contains as the average one bacterium per cubic centimetre, nearly every tube that receives a centimetre of the water will become turbid; but, if the number of bacteria is only half as many, half the tubes will remain sterile. This rule, though inexact in theory, seems to prevail with an approach to exactness in practice. M. Miquel applied it to the estimation of the bacteria in rain-water, and found that at the beginning of storms the water of precipitation contained a considerable number, amounting sometimes to as many as fifteen per cubic centimetre, and that the number immediately began to diminish; but that, strange to say, "after two or three days of moist and rainy weather the meteoric water frequently contained more bacteria than at the beginning of the rain. As the atmosphere was then in a condition of extreme purity—a fact that was established simultaneously by the statistics of the germs in the air—it seemed to be shown that the bacteria could live and multiply in the very midst of the clouds, or, perhaps, that the clouds might in their course through space charge themselves with a very valuable contingent of germs."

In studying under the microscope the development of these little organisms, in the preparations of which they have taken possession, a very curious evolution of one of the microbes of the air is revealed. The organism is a bacterium, which presents at first sight the characteristics of a very long, filamentous *bacillus*. M. Miquel affirms that he has seen this organism afterward divide itself into segments of unequal size, in such a way as to form strings of micrococci. The observation deserves consideration, for, if it is confirmed, and the

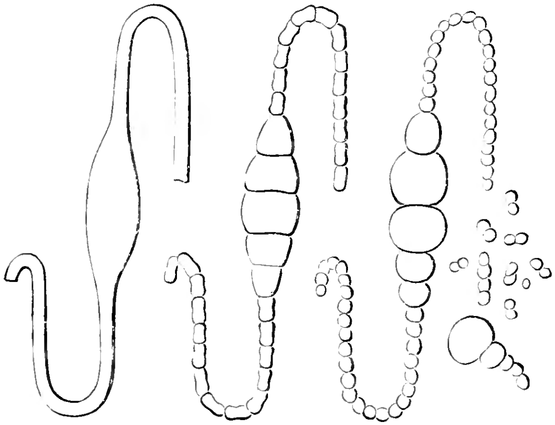

Fig. 7.—Successive Phases in the Transformation of the same Organism (after M. Miquel). Magnified 1,000 diameters.

habit is proved to be general, it will establish a line of union between the different types of the inferior algæ, which were believed to be fixed, but may be, after all, only transient genera.

It is important to have the microbes collected in the broth of the tubes sown in different kinds of liquors. Such treatment furnishes the only means of discovering the nature of the organisms, for characteristics deduced from their shape are of no significance. Most frequently they can be distinguished only by the fermentations they produce. Numerous experiments based on this principle will be required for the exact determination of the bacteria in the atmosphere. In the present condition of the science, we have to limit ourselves to the general statistics of the *Micrococci, Vibrios, Bacteria, Bacilli,* and *Cladothrices* that live in the air, without undertaking to classify in any precise way all the beings comprehended under each of these denominations.

The observations conducted at the Observatory of Montsouris show that there are on the average eighty bacteria in a cubic metre of air. The highest number was observed in the fall, the lowest in the winter. There were found fifty bacteria in December and January, only thirty-three in February, one hundred and five in May, fifty in June, and one hundred and seventy in October. The diagrams of daily observations

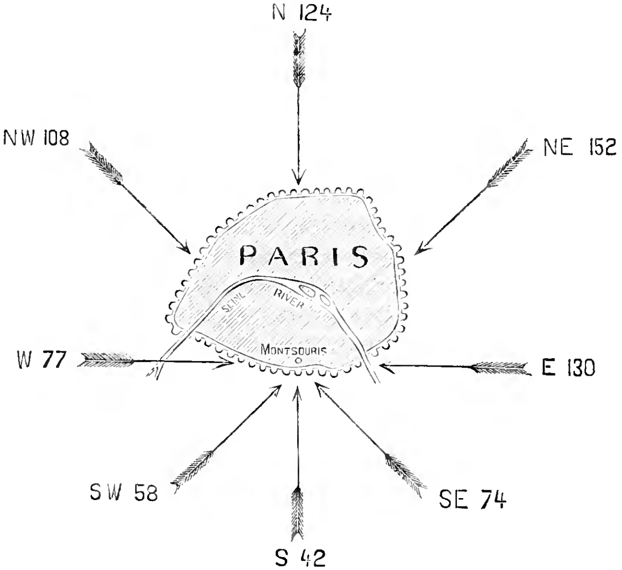

FIG. 8.—INFLUENCE OF THE DIRECTION OF THE WIND ON THE NUMBER OF AËRIAL MICROBES COLLECTED AT MONTSOURIS.

show that the number of spores of these algæ increases with the temperature. Inversely to what takes place in the case of the molds, the number of the schizophytes, small in rainy weather, rises when all the moisture has disappeared from the surface of the soil. The counteraction of moisture is stronger than the direct action of temperature; and this fact accounts for the rarity of the bacteria after the great rains of February, April, and June. Still a long period of dry weather does not appear to be favorable to the development of the plants.

The number rises at first during the hot season, but diminishes under the influence of a progressive desiccation toward the second or third week.

The diminution in hygrometric conditions manifested in September and October explains the recrudescence of the bacteria during these months. Some micrographers have suggested that the germs may be transported by the vapor of water; but M. Miquel's experiments invalidate this hypothesis, and indicate that the evaporation of water from the surface of the ground never carries any schizophytes with it. On the other hand, numerous tests have shown that dry dusts, especially those of hospitals, proceeding from substances in a state of putrefaction, sanious pus, and the dejections of the sick, are charged with microbes. Great agglomerations of men furnish the most of them. According to the measurements made in the Rue de Rivoli and Montsouris, the air in the interior of Paris is nine or ten times richer in bacteria than that in the neighborhood of the fortifications. At the observatory, the winds from the north bring many more than the winds from the south.

The vertical distribution of the microbes also shows that they come mostly from the dirt of our streets and houses. While a cubic metre of air at the top of the Pantheon contains only twenty-eight of them, the same quantity of air in the Park of Montsouris contains forty-five, and in the mairie of the fourth arrondissement, four hundred and sixty-two. These numbers are, however, insignificant in comparison with those furnished by the analyses of sewer-waters. We give a few specimens from M. Miquel's analyses, in which is shown the number of microbes found in a litre of water from each of the sources named: Condensed atmospheric vapor, 900; water from the drain of Asnières, 48,000; rain-water, 64,000; water of the Vanne (Montrouge basin), 248,000; water from the Seine (drawn at Bercy), 4,800,000; water from the Seine (drawn at Asnières), 12,800,000; sewer-water (drawn at Clichy), 80,000,000. These figures represent the minima. Left to stagnate, sewer-water putrefies in a very short time, through the multiplication of its germs, and the microbes become a thousand times as numerous as indicated in the summary.

Thus, we see, we are surrounded on every side by myriads of schizophytes. What proportion, among these minute inhabitants of the atmosphere and the waters, have a part in producing contagious maladies and the epidemics by which the populations of our large cities have been decimated at times? We do not know yet. The continuation of the statistical researches that have been begun at Montsouris, and the microscopic analysis of the air and of water, particularly of sewer-water, cultivation, botanical and physiological investigation, and inoculation with the resultant germs, will certainly conduct to the solution of the problem. Then only, having become acquainted with our enemies, shall we be able to destroy them. The precautions that we take against such evasive foes—working as we do in the dark—by using antiseptics, are evidently insufficient. A substance that kills one bacterium may not hinder the development of its neighbor, and our employment of antiseptics is always dependent upon their specific action. There exists no universal remedy against microbes. Science alone can teach us how to contend against them.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

HOW MUCH ANIMALS KNOW.

By F. A. FERNALD.

NO phenomena in nature are watched with more interest by all classes, young and old, ignorant and educated, than the displays of intelligence in the inferior animals. From the dog, which occupies a position of intelligent companionship with man, down through the less favored species even to the lowest groups of animal life, we see manifested all degrees of that wonderful attribute which in its highest perfection constitutes the human mind. It is not surprising that these various indications of something like a capacity for thought should be of universal interest, but it also has a deeper meaning, which it is the office of science and philosophy to explore, and which relates to the profound and mysterious problem of "mind in nature." Before philosophy can make much headway with this question, however, there must be a more critical scrutiny of the question as to what degrees of intelligence different grades of animals really possess. Dr. George J. Romanes, in his recent interesting book on "Animal Intelligence," engages with this subject as a scientific question of comparative psychology, and he has done a good deal toward winnowing away the fictions that have become current in relation to the mental manifestations of the lower tribes, and has given us probably the most trustworthy book extant upon the subject. We cull from his pages a series of representative instances of animal sagacity which the reader will find both entertaining and instructive.

It is common to quote the oyster as the lowest example of stupidity, or absence of anything mental, and, as it is a headless creature, the accusation might not seem wholly unfounded. Yet the oyster is not such a fool but that it can learn by experience, for Dicquemase asserts that, if it be taken from a depth never uncovered by the sea, it opens its shell, loses the water within, and perishes. But oysters taken from the same depth, if kept in reservoirs where they are occasionally left uncovered for a short time, learn to keep their shells closed, and then live for a much longer time when taken out of the water.

This fact is also stated by Bingley, and is now turned to practical account in the so-called "oyster-schools" of France. The distance from the coast to Paris being too great for the newly-dredged oysters to travel without opening their shells, they are first taught in the schools to bear a longer and longer exposure to the air without gaping, and when their education in this respect is completed, they are sent on their journey to the metropolis, where they arrive with closed shells and in a healthy condition.

The social life of ants has many parallels to that of the barbarous races of human beings. Thus, the habit of making slaves is said to obtain among at least three species of ant. A community attacks a nest of another species in a body; there is a great fight with much slaughter, and, if victorious, the slave-makers carry off the pupæ of the vanquished nest in order to hatch them out as slaves. When the pupæ hatch out in the nest of their captors, the young slaves begin their life of work, and seem to regard their masters' home as their own; for they never attempt to escape, and they fight no less keenly than their masters in defense of the nest. In the nests of *Formica sanguinea* the comparatively few captives are kept as household slaves. They never leave the nest, and so all the out-door work of foraging, slave-capturing, etc., is performed by the masters.

F. rufescens, on the other hand, assigns a much larger share of labor to the slaves. In this species the males and fertile females do no work of any kind, and the workers, or sterile females, though most energetic in capturing slaves, do no other kind of work. Therefore the whole community is absolutely dependent upon its slaves. Huber shut up thirty masters without a slave and with abundance of their favorite food, and also with their own larvæ and pupæ as a stimulus to work; but they could not feed even themselves, and many died of hunger. He then introduced a single slave, and she at once set to work, fed the surviving masters, attended to the larvæ, and made some cells.

A predatory expedition of ants for capturing slaves, or robbing the storehouse of another nest, marches out in a close column numbering from a few hundreds to several thousands. The army is guided to its destination, which may be an hour's march distant, by several ants who run from side to side with heads down, evidently finding their way by scent. A marauding excursion of the *F. rufescens*, or Amazons, against the *F. rufibarbis*, a sub-species of the *F. fusca*, or small black ants, took place as follows: The vanguard of the robber army found that it had reached the neighborhood of the hostile nest more quickly than it had expected; for it halted suddenly and decidedly, and sent a number of messengers which brought up the main body and the rear-guard with incredible speed. In less than thirty seconds the whole army had closed up, and hurled itself in a mass on the dome of the hostile nest. This was the more necessary, as the *rufibarbes* during the short halt had discovered the approach of the enemy, and had utilized the time to cover the dome with defenders. An indescribable struggle followed, but the superior numbers of the Amazons overcame, and they penetrated into the nest, while the defenders poured by thousands out of the same holes, with their larvæ and pupæ in their jaws, and escaped to the nearest plants and bushes, running over the heaps of their assailants. These looked on the matter as hopeless, and began to retreat. But the *rufibarbes*, furious at their proceedings, pursued them, and endeavored to get away from them the few pupæ they had obtained, by trying to seize the Amazons' legs and to snatch away the pupæ. The Amazon lets its jaws slip slowly along the captive pupa, as far as the head of its opponent, and pierces it, if it does not, as generally happens, draw back. But it often manages to seize the pupa at the instant at which the Amazon lets it go, and flees with it. This is managed the more easily when a comrade holds the robber by the legs, and compels it to loose its prey in order to guard itself against its assailant. The strength of the *rufibarbes* proved at last so great that the rear-guard of the retreating army was seriously pressed, and was obliged to give up its booty. A number of the Amazons also were overpowered and killed, but not without the *rufibarbes* also losing many people. Nevertheless, some individuals, as though desperate, rushed into the thickest hosts of the enemy, penetrated again into the nest, and carried off several pupæ by sheer audacity and skill. Ten minutes after the commencement of the retreat, all the Amazons had left the nest, and, being swifter than their opponents, they were only pursued for about half-way back. Their attack had failed on account of a short delay.

It seems to be a pretty general habit among many species of ants to dispose of the dead bodies of their comrades very carefully. The following especially notable account is given by an Australian observer:

"I saw a large number of ants surrounding the dead ones, and determined to watch their proceedings closely. I followed four or five that started off from the rest toward a hillock a short distance off, in which was an ants' nest. This they entered, and in about five minutes they reappeared, followed by others. All fell into rank, walking regularly and slowly two by two, until they arrived at the spot where lay the dead bodies of the soldier-ants. In a few minutes two of the ants advanced and took up the dead body of one of their comrades; then two others, and so on, until all were ready to march. First walked two ants bearing a body, then two without a burden; then two others with another dead ant, and so on, until the line was extended to about forty pairs, and the procession now moved slowly onward, followed by an irregular body of about two hundred ants. Occasionally the two laden ants stopped, and, laying down the dead ant, it was taken up by the two walking unburdened behind them, and thus, by occasionally relieving each other, they arrived at a sandy spot near the sea. The body of ants now commenced digging with their jaws a number of holes in the ground, into each of which a dead ant was laid, where they now labored on until they had filled up the ants' graves. This did not quite finish the remarkable circumstances attending this funeral of the ants. Some six or seven of the ants had attempted to run off without performing their share of the task of digging; these were caught and brought back, when they were at once attacked by the body of ants and killed. A single grave was quickly dug, and they were all dropped into it."

A remarkable acquaintance with mechanical principles is shown by spiders in building and attaching their webs. This ingenuity is perhaps most strikingly shown in making the repairs that some accident has necessitated. A web had been broken from one of its attachments during a storm and flapped violently in the wind. The spider let itself down to the ground, and crawled to a place where lay some splintered pieces of a wooden fence thrown down by the storm. It fastened a thread to one of the bits of wood, turned back with it, and hung it to the lower part of its nest, about five feet from the ground. The performance was a wonderful one, for the weight of the wood sufficed to keep the nest tolerably firm, while it was yet light enough to yield to the wind, and so prevent further injury. The piece of wood was about two and a half inches long, and as thick as a goose-quill. On the following day a careless servant knocked her head against the wood and it fell down. But in the course of a few hours the spider had found it and brought it back to its place. When the storm ceased the spider mended her web, broke the supporting thread, and let the wood fall to the ground!

The following interesting observation on the intelligence of snakes shows, not only that these animals are well able to distinguish persons, but also that they possess an intensity of amiable emotion scarcely to be expected in this class. A writer to the London "Times" thus describes the behavior of some pet snakes kept by a gentleman and lady of his acquaintance:

"Mr. M——, after we had talked for a little time, asked if I had any fear of snakes; and after a timid 'No, not very,' from me, he produced out of a cupboard a large boa-constrictor, a python, and several small snakes, which at once made themselves at home on the writing-table among pens, ink, and books. I was at first a good deal startled, especially when the two large snakes coiled round and round my friend, and began to notice me with their bright eyes and forked tongues; but soon finding how tame they were, I ceased to feel frightened. After a short time Mr. M—— expressed a wish to call Mrs. M——, and left me with the boa deposited on an arm-chair. I felt a little queer when the animal began gradually to come near, but the entrance of my host and hostess, followed by two charming little children, put me at my ease again. After the first interchange of civilities, she and the children went at once to the boa, and, calling it by the most endearing names, allowed it to twine itself most gracefully round about them. I sat talking for a long time, lost in wonder at the picture before me. Two beautiful little girls and their charming mother sat before me with a boa-constrictor (as thick as a small tree) twining playfully round the lady's waist and neck, and forming a kind of turban round her head, expecting to be petted and made much of like a kitten. The children, over and over again, took its head in their hands and kissed its mouth, pushing aside its forked tongue in doing so. The animal seemed much pleased, but kept turning its head continually toward me with a curious gaze, until I allowed it to nestle its head for a moment up my sleeve. Nothing could be prettier than to see this splendid serpent coiled all round Mrs. M—— while she moved about the room and when she stood to pour out our coffee. He seemed to adjust his weight so nicely, and every coil with its beautiful marking was relieved by the black velvet dress of the lady. It was long before I could make up my mind to end the visit."

Birds often show much ingenuity in attaining some desired end. Several stories are told of geese which show that they are by no means such scant-witted fowls as the common use of their name implies. Thus at Ardglass, county Down, Ireland, is a long tract of turf coming to the edge of the rocks overhanging the sea, where cattle and geese feed ; at a barn on this tract there was a low inclosure, with a door fastening by a hook and staple to the side-post : when the hook was out of the staple the door fell open by its own weight. One day a goose with a large troop of goslings was seen coming off the turf to this door, which was secured by the hook being in the staple. The goose waited for a minute or two as if for the door to be opened, and then turned round as if to go away, but what she did was to make a rush at the door, and making a dart with her beak at the point of the hook nearly threw it out of the staple ; she repeated this manœuvre, and succeeded at the third attempt, the door fell open, and the goose led her troop in with a sound of triumphant chuckling. How had the goose learned that the force of the rush was needful to give the hook a sufficient toss ?

The intelligence of crows is well attested by the following account contributed by a lady : "In the inn-garden I saw a dog eating a piece of carrion in the presence of several of these covetous birds. They evidently said a great deal to each other on the subject, and now and then one or two of them tried to pull the meat away from him, which he resented. At last a big strong crow succeeded in tearing off a piece, with which he returned to the pine where the others were congregated, and after much earnest speech they all surrounded the dog, and the leading bird dexterously dropped the small piece of meat within reach of his mouth, when he immediately snapped at it, letting go the big piece unwisely for a second, on which two of the crows flew away with it to the pine, and with much fluttering and hilarity they all ate, or rather gorged it, the deceived dog looking vacant and bewildered for a moment, after which he sat under the tree and barked at them inanely."

Crows have also been observed to hold general assemblies whose functions seem to be those of a criminal court. It often takes a day or two for the meeting to assemble; a palaver is then held, at the close of which the whole body sets upon two or three apparent culprits and kills them. No witness of such a scene can fail to be convinced that the accused have had a fair trial, and have not been put to death without cause.

The higher mental faculties are more developed in the elephant than in any other animal, except the dog and the monkey. The general fact that elephants are habitually employed in parts of India for storing timber, building, etc., shows a high level of docile intelligence. But perhaps in no labor in which they are employed do they display a more wonderful sagacity than in helping to catch wild elephants. A herd of wild elephants is driven into a corral, and two tame ones ridden in among them. The decoys will crowd up on either side of a wild one, and protect the nooser until a rope is fastened round the wild elephant's leg, when the tame one, to whose collar the other end of the rope is attached, will drag the captive out, and wind the rope round a tree, while the other decoy prevents any interference from the herd, and pushes the captive toward the tree, thus enabling the first one to take in the slack of the rope. The conduct of the tame ones during all these proceedings is truly wonderful. They display the most perfect conception of every movement, both of the object to be attained and of the means to accomplish it. On one occasion, in tying up a large elephant, he contrived, before he could be hauled close up to the tree, to walk once or twice round it, carrying the rope with him; the decoy, perceiving the advantage he had thus gained over the nooser, walked up of her own accord, and pushed him backward with her head, till she made him unwind himself again; upon which the rope was hauled tight and made fast.

One could almost fancy there was a display of dry humor in the manner in which the decoys thus play with the fears of the wild herd, and make light of their efforts at resistance. When reluctant they shove them forward, when violent they drive them back; when the wild ones throw themselves down, the tame ones butt them with head and shoulders and force them up again; and, when it is necessary to keep them down, they kneel upon them, and prevent them from rising, till the ropes are secured.

A remarkable degree of cunning was displayed by an elephant who had been chained to a tree, and whose driver had then made an oven at a short distance, into which he put some rice-cakes to bake. The man covered his cakes with stones and grass, and went away. When he was gone, the elephant with his trunk unfastened the chain round his foot, went to the oven and uncovered it, took out and ate the cakes, re-covered the oven with the stones and grass as before, and went back to his place. He could not fasten the chain again round his own foot, so he twisted it round and round it, in order to look the same, and when the driver returned the elephant was standing with his back to the oven. The driver went for his cakes, discovered the theft, and, looking round, caught the elephant's eye as he looked back over his shoulder out of the corner of it. Instantly he detected the culprit, and condign punishment followed.

The well-known intelligence of the dog is seldom more curiously manifested than in the cases of those who learn the use of money. A gentleman in Birmingham was acquainted with a small mongrel dog who, on being presented with a penny or a half-penny, would run with it in his mouth to a baker's, jump on to the top of the half-door leading into the shop, and ring the bell behind the door until the baker came forward and gave him a bun or a biscuit in exchange for the coin. The dog would accept any small biscuit for a half-penny, but nothing less than a bun would satisfy him for a penny. On one occasion the baker (being annoyed at the dog's too frequent visits), after receiving the coin, refused to give the dog anything in exchange, and on every future occasion the latter (who declined being *taken in* a second time) would put the coin on the floor, and not permit the baker to pick it up until he had received its equivalent.

In what may be called the chief pursuit of dogs—that of game—they often show great ingenuity in overcoming unusual obstacles. A little Skye terrier was once observed snuffing about on a wheat-stack which was in the course of being thrashed, when suddenly a very large rat bounced off, just from under her nose. It darted into a pit of water about a dozen yards from the stack, and tried to escape. The Skye, however, plunged after, and swam for some distance, but found she was being left behind. So she turned to the shore again, and ran round to the other side of the pit, and was ready and caught it just on landing.

Another dog, which had been sent to bring in a couple of wounded ducks from across a pretty wide stream, at first attempted to bring them both, but one always struggled out of his mouth; he then laid down one, intending to bring the other, but, whenever he attempted to cross, the bird left fluttered into the water; he immediately returned again, laid down the first on the shore, and recovered the other. The first now fluttered away, but he instantly secured it, and, standing over them both, seemed to cogitate for a moment; then, although on any other occasion he never ruffled a feather, he deliberately killed one, brought over the other, and then returned for the dead bird.

An instance of sagacity—indeed, amounting to reason—in a French poodle is told by Canon ——. Being a guest at luncheon with the dog's master, the canon fed the dog with pieces of beef. After lunch-con the beef was taken into the larder. The dog did not think he had his fair share. What did he do? Now, he had been taught to stand on his hind-legs, put his paw on a lady's wrist, and hand her into the dining-room. He adopted the same tactics with the canon, stood on his hind-legs, put his paw on his arm, and made for the door. To see what would follow, Canon —— suffered himself to be led, but the sagacious dog, instead of steering for the dining-room, led him in the direction of the larder, along a passage, down steps, etc., and did not halt till he brought him to the larder, and close to the shelf where the beef had been put. The dog had a small bit given him for his sagacity, and Canon —— returned to the drawing-room. But the dog was still not satisfied. He tried the same trick again, but this time fruitlessly. The canon was not going again with him to the larder. What was Mori to do? And here comes the instance of reason in the poodle: Finding he could not prevail on the visitor to make a second excursion to the larder, he went out into the hall, took in his teeth the canon's hat from off the hall-table, and carried it under the shelf in the larder where the coveted beef lay out of his reach. There he was found, waiting for the owner of the hat, and expecting another savory bit when he should come for it.

CHEMISTRY AND PHARMACY.*

By Professor IRA REMSEN.

CHEMISTRY owes a debt of gratitude to Pharmacy which she has for years been striving to repay. And when a disciple of the new science is called upon to address those who stand at the threshold of a career which will bind them to the old art, his thoughts naturally turn to the day when the occupations of the chemist and the pharmacist were united in one person—when all that was worth knowing of chemistry was mastered by the pharmacist, and the art of pharmacy was practiced by the chemist. We are far removed from that day now. Both the subjects once so intimately associated have developed to an enormous extent, and he would be a brave person who would attempt to make himself master of the lore of both pharmacy and chemistry. The term "chemist" has come to have a signification quite different from that which it once had, though it is used now, as of old, in two entirely distinct senses. There is, first, the chemist who makes use of facts already established for a variety of useful purposes, some of them of the greatest value to the human race. Such a one practices the *art of chemistry*. Then there is, in the second place, the chemist

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who establishes the facts which are to be made use of. He spends his time in delving in out-of-the-way corners, turning over this and that, and endeavoring to get at the principles which underlie what is called chemical action. Such a one is following the *science of chemistry.* Now you, gentlemen, are primarily chemists in the first sense—you are to practice to a limited extent the art of chemistry.

It has seemed to me that, during the short time to be devoted to my remarks, it might be both interesting and profitable to examine into the questions : What has Chemistry to thank Pharmacy for ? and what has Pharmacy to thank Chemistry for ?

As regards the former question, it may be answered that, in the first place, the desire to discover new substances for medical purposes originally formed a strong incentive to those engaged in chemical work, and undoubtedly a large number of valuable observations have been made by those who were working primarily to gain possession of substances which might be valuable to pharmacy. We know that the collection and the manufacture of drugs of many forms is one of the most ancient of occupations, and it seems to have been regarded as a very important one, as all who have ever been afflicted with the ills that flesh is heir to (and who has not ?) can easily appreciate. The alleviation of human suffering is a high object to strive for, and for this purpose the physician and pharmacist join hand to hand, and they had been working together for long ages before chemistry and chemists were ever heard of. While gaining experience which proved of direct value to them in their professions, they were also, though unconsciously, doing something toward laying the foundations of a science which has since been developed. They were helping to collect the material, the accurate scientific study of which was undertaken at a later date. Finally, there came the time when men began to study some of the substances which they gained possession of, with no other purpose in view than to learn something more with reference to their general properties, and their conduct under different circumstances. When that time came, the science of chemistry was born.

Again, in addition to the collection of much of the material which formed the basis of the first chemical study, indeed, as a consequence of this, we find that during a considerable period—from the middle of the seventeenth century—many of those who achieved the greatest distinction in chemical work were those who began as pharmacists. Among the earliest of these may be mentioned Kunkel, the discoverer of phosphorus ; Lemery, author of one of the most valuable of the text-books of chemistry ; Geoffroy, whose investigations on chemical affinity were of such great importance to chemistry ; Marggraf, the discoverer of alumina and of the composition of gypsum ; Scheele, the great discoverer of oxygen and of chlorine ; in France, Lefêvre, Glaser, and others ; and, finally, more recently, the most influential chemist of modern times, the great German, Liebig.

For a long time the only chemical laboratories known were the pharmacies, and of course all chemical work was then done by the pharmacists. If any one desired a knowledge of chemistry, his only way to acquire it was to enter a pharmacy, and this whether he desired to practice the art or not. It was not until between the twentieth and thirtieth year of the present century that there existed any laboratory in which a student could acquire a special knowledge of chemistry.

In another way we see the intimate connection which but a short time ago existed between chemistry and pharmacy. The principal chemical journal of the world, which was started in the year 1832 by Liebig, was called during a period of forty years the "Annals of Chemistry and Pharmacy," and only about ten years ago was its name changed to the "Annals of Chemistry"; and many other publications might be mentioned whose titles give clear indications of the close relationship existing between the two subjects.

The fact is, the interests of chemistry and pharmacy were identical during the period to which I have referred. What helped the one helped the other. But, beginning as a partial offspring of pharmacy, chemistry has attained to a position of great importance in the world, and has become gradually the foundation of more than one occupation. To-day not only pharmacists, but those of many other professions, have to look to chemistry for that knowledge of substances and of kinds of action which is necessary for their success. An extended examination of the subject would show us that pharmacy played a very important part in the founding, particularly of that field of chemistry which is usually designated by the name "organic chemistry"—a field in which many of the brilliant modern victories of chemists have been achieved. Without the fundamental work of pharmacists in extracting from plants their valuable constituents, organic chemistry would to-day be in its infancy, instead of being what it is—a giant of mighty strength, exerting a controlling influence upon a number of important occupations, including pharmacy. But what this subject is to-day is only a promise of what it is to be when the results, which we now see plainly foreshadowed, shall have been accomplished. I think it is clear, then, that Chemistry has much to thank Pharmacy for; but what has Chemistry done toward paying the debt she owes? Much, very much, directly and indirectly. It is impossible to enter into details this evening. I can only refer to a few features which seem to me worthy of special notice.

The accurate scientific study of chemical substances, whether these are of use to pharmacy or not, has led to the introduction of more accurate methods in pharmacy. The extraction and preparation of medicinal compounds were at first very crude and simple operations. These were gradually improved upon, of course, as time passed on, but they were only perfected when the science of chemistry began to exert its influence. The point to be particularly observed here is this, that it is rather the study of chemical action than the particular study of this or that substance as such that tends to improve the method of work. In this way many obscure substances have contributed largely to the improvement of chemistry, and consequently to the improvement of pharmacy. There is a not uncommon feeling that it is a waste of time to work for years endeavoring to unravel the secrets of some apparently insignificant substance. If the substance itself can not be used, and there is no prospect that it ever can be used, then, it is argued, it can not be important. To you, gentlemen, who have been under especially good instruction in these matters, this argument will not appear to be of much weight, but permit me to turn my attention for a moment to the larger audience before us, and to say a word in defense of those who spend their lives in what are commonly looked upon as unprofitable investigations.

Not long ago I heard this story, which may serve as a sort of overture to what I want to say: An excellent gentleman, on being informed that a certain scientific man was engaged in work upon frogs, replied, "Why spend his time in such trivial work, when there is the human soul to investigate?" The feeling which actuated the speaker is one which I repeat is not uncommon, and I may add it is quite natural, but it is certainly wrong in principle. If we analyze the underlying thought of those who cavil at ordinary scientific investigation, we shall find that there are two distinct ideas contained in it: First, that, in order that any investigation shall be of value or of importance, it must bear direct fruit. The substance discovered must be useful for some "practical" purpose, either as a medicine or as a dye-stuff, an explosive or a poison—no matter what, so that it can be used for something. A second idea is that, in order to solve the problems of nature, only those of the most evident importance should be attacked. Such questions as What is life? What is electricity? What is the attraction of gravitation? What is force? What is matter?—these are the ones which, in the opinion of many, should occupy investigators, to the exclusion of the less important.

As regards the latter idea, it may be said that there are a great many very strongly fortified citadels in nature. Scientific investigators have attacked these from time to time and have been repulsed. A good commander, having discovered that a stronghold is invulnerable from a given point, does not continue to attempt its capture from that side, but looks around him for other means of approach; he strengthens his forces, he collects more ammunition, and endeavors to keep his army in general in good condition, studying the surrounding country, and awaiting new revelations. There is, further, a great deal of insignificant camp-work to be done, and, if this is neglected, ultimate success can not be hoped for.

So, too, the scientific investigator finding that a certain problem of paramount importance can not be solved, turns his attention to others, the solution of which may in the end contribute to clearing up greater mysteries. There are hosts of minor questions to be answered, and these must be answered before the fundamental questions of nature can be. Through the insignificant lie the roads of advancement. A fallen leaf, a bit of stone, a tiny flower, a microscopic animal, may contain within themselves the answers to the most important questions. It is not the leaf, or the stone, or the animal that is specially investigated, but the principles involved in their existence. Explain these, if possible, and the explanations will serve for a thousand other things. Then, too, though the explanations sought for may not be found, the correct study of any fact or phenomenon of nature is of assistance to science as a whole. It strengthens her forces, it supplies her with ammunition. An enormous amount of camp-work must be done, or results of value can not be attained. Let the work upon the insignificant problems cease, and the world would sink into darkness. To fully understand the laws of the universe as a whole, we must first learn all we can in regard to the smallest subdivisions of the universe—the atoms.

As regards the idea that an investigation must bear direct fruit to be valuable, I would say that the reply to this is contained partly in what I have already said, but it can be refuted much more clearly and appropriately for our present purpose by the consideration of an example or two. As I remarked a few minutes since, when a new substance is discovered by a chemist, the first question asked by most persons is, What is it good for? what can it be used for? As I desire to show that pharmacy is much indebted to chemistry in recent times, it would seem that I ought first to show that many new substances have been discovered by chemists which are of use in pharmacy. This is, however, so obvious that I prefer to show how some of the most abstruse chemical investigations may ultimately yield fruit of much value to pharmacy. In an address which I had the honor to deliver a few years ago in this building, before the "Medical and Chirurgical Faculty of Maryland," I referred to the purely scientific investigations which led to the discovery of choral, and to a method for the manufacture of salicylic acid on the large scale. It can easily be shown that these discoveries were made, not because the discoverers were attempting to find substances gifted with the properties which these two are known to possess, but that they were made as the result of abstruse chemical investigation, undertaken simply with the object of adding to the possessions of science. I shall not repeat what I then said, for there are enough new examples, as well as old, to furnish us with interesting material.

Of comparatively recent discoveries, which may be classed among those which are of direct importance to pharmacy, is that of the artificial preparation of the oil of mustard. This substance is now made by a patented process entirely independently of the mustard-plant. I do not know that the artificial method can at present compete with the natural, but it will probably do so before long, if it does not now. Little did the discoverer dream of the result when he undertook his investigation. When glycerin and oxalic acid are mixed, and the mixture distilled, the chief product under ordinary circumstances is formic acid, a substance found in nature in the bodies of certain ants. Formic acid had been made by the method mentioned for a number of years before it was noticed that something else is formed at the same time. This observation was made about the year 1870, by Tollens, in a chemical factory. On looking into the matter more closely, it was found that the second substance is allyl alcohol, already well known. Now this allyl alcohol is closely related to the oil of mustard, but, up to the year 1870, no method was known by which it could be prepared easily and in large quantity. Now it can be made, thanks to the investigation of Tollens, in any desired quantity. Its transformation into the oil of mustard is a comparatively simple matter, and thus starting from the two common substances, glycerin and oxalic acid, it is now practical to pass to the valuable oil of mustard. You will observe that, in this case, the object of the discoverer of the method was not to get the oil of mustard, but simply to learn what else could be formed besides formic acid under the conditions above mentioned. The question which he proposed to answer was not a very elevated one, nor one the answering of which was at all likely to lead to results of practical value; but, nevertheless, a valuable result did follow.

At the present time there are several chemists engaged on investigations which promise eventually to be of the highest value to pharmacy. Let me attempt to give you some idea of these. For a long time it has been known that from many plants there can be extracted certain constituents which seem to concentrate the medicinal properties of the plants themselves. They form what are sometimes called the active principles of the plants. They are also, and more commonly, known as the alkaloids. Thus, from the white poppy cultivated in Asia Minor, Egypt, Hindostan, and elsewhere, is extracted opium, which in turn contains a number of alkaloids, as morphine, codeine, narcotine, etc.; from Peruvian bark are obtained the valuable alkaloids quinine, cinchonine, etc.; from the St. Ignatius bean comes strychnine; from tobacco, nicotine; from coffee, caffeine, etc. The great value of many of these alkaloids, especially of morphine and quinine for medicinal purposes, has, as we all know, long been recognized. They have, however, been but little understood by chemists, and this has been a just reproach to chemistry. They have been studied carefully, better and better methods have been devised for their extraction and purification, but scarcely anything has been done until within a year or two past to clear up their inner nature. Their relations to simple substances were not known, and it seemed quite impossible to conceive of any method by which our knowledge concerning them could be materially enlarged. Recently, however, a change has come over the scene, and now, in consequence of a very simple scientific observation, a large number of chemists have turned their attention to this field, and it looks as though the time is not far distant when the chemist will be able to produce artificially in the laboratory the alkaloids for which we have hitherto been entirely dependent upon nature. How did this come about? By carrying on investigations on insignificant substances, simply for scientific purposes, to learn more regarding these substances for the sake of increasing our knowledge.

In the year 1851 Anderson, a Scotch chemist, undertook the examination of the oil which is formed when bones are heated. We all know the extremely disagreeable properties of this oil. Its odor would be enough to prevent any but a bold man from undertaking its examination. It is a very complex substance also, and, at first, it seems almost impossible to get from it pure and definite substances. Anderson, recognizing the difficulties before him, went at the problem in a large way. He distilled about two hundred and fifty gallons, or more than a ton, of the disgusting bone-oil, and repeated this operation over and over again. He was finally rewarded by the discovery of some curious substances which he called pyridine, picoline, and lutidine. These substances have from time to time been met with since, but they have played a very subordinate part in chemistry until very recently. About two years ago a young chemist (and, as chance would have it, again a Scotchman) tried an experiment which gave him the startling result that from quinine there can easily be obtained a substance closely related to the pyridine of Anderson; and, indeed, by a further step pyridine itself was obtained. This gave the first hint as to the chemical nature of quinine, and chemists at once recognized the importance of the discovery. Immediately great activity showed itself in the further examination of bone-oil or animal-tar, and our knowledge of this substance was rapidly increased. At the same time it has been shown that not only quinine, but many other alkaloids, are related to pyridine and the other substances discovered by Anderson thirty years ago. Every month we receive reports of rapid advances, and it looks, indeed, as though we should not have long to wait before we hear it announced that quinine and morphine, and perhaps a host of other valuable alkaloids, have been made from the offensive oil which is given off when bones are heated. In view of many past achievements I do not think that this is too much to expect. Look at the unpromising coal-tar, at one time the bugbear of gas-manufacturers! It has become the source of many of the most valuable and interesting chemical substances. Nothing could less suggest the beautiful dye-stuffs, the delicious essences, which can be and are obtained from it in quantity. Surely, with the knowledge already in our possession we have a right to look forward to as brilliant a future for animal-tar as has been the past and is the present of coal-tar. Both substances, offensive as they are, are necessarily prepared in large quantities. The coal-tar is a result of the manufacture of gas; the animal-tar is produced in the manufacture of bone-black or animal-charcoal, which is used to such an enormous extent for the purification of sugar. Had it not been for the untiring and unselfish labors of scores of scientific investigators, who worked for no other object than to increase knowledge for the sake of knowledge, we would to-day be in ignorance of the beautiful and valuable possibilities of these two unattractive substances.

I might multiply examples indefinitely, but the time at my disposal is limited. I have endeavored to show, gentlemen, that while Pharmacy did a great deal to build up the science of Chemistry, Chemistry in her turn, when she reached maturity, began to pay back the debt she owed and pay it back with interest. It is to the science of Chemistry that Pharmacy must look for future advancement, and even the most obscure and most unintelligible of the many chemical investigations which are being carried on at present may eventually prove to be important steps in some line of reasoning which will have the enriching of pharmacy as its result. Nothing in science is too insignificant for notice. We can not tell what the simplest observation may lead to, and it behooves every one whose daily occupation brings him in contact with chemical substances to be ever on the alert and, in true scientific spirit, to follow up, independently of any direct practical result, the slightest observations. Many of you, gentlemen, will have the opportunity to add materially to human knowledge. You will have laboratories at your disposal, and you have been well instructed in chemistry. If you have the desire, you may do much to help your profession. Your chances of success will be better, if you keep yourselves interested in the scientific as well as in the purely practical side of your calling. There is enough work to be done. In certain directions chemistry has only just begun to advance, and there are vast regions still entirely unexplored. Many an arctic sea of chemistry, with its fascinating north pole, awaits the first expedition. An eminent mathematician once said that a new problem in mathematics might easily be furnished for every man, woman, and child in this vast country, and there would then be plenty left for foreigners. A similar remark might be made concerning chemistry. As I have, then, attempted to show that you must look to science for the advance of your calling, I desire above all to leave upon your minds the impression that each of you, if you will, can do something for the common cause. If, in after-years, it shall be my privilege to hear that one among you has really been led to enrich the domains of science, I shall look back upon my part in this evening's proceedings with feelings of great satisfaction.

POSITION AND STROKE IN SWIMMING.

By RICHARD LAMB, C. E.

PERHAPS there has been no science—at least none of equal importance—that has been less developed theoretically than swimming. The essay of Franklin upon the subject, although an answer to the inquiry of "how to swim," is merely an article with advice as to when and how long to bathe, and the narration of anecdotes of his experience in swimming. In the literature of the subject we fail to find any practical directions that could assist a novice in learning to swim; for this reason we propose briefly to analyze one or two important points, which, if put into practice, will make it an easy matter to acquire the art.

It has been the writer's experience, in teaching beginners, that the great difficulty lies, not in the inability on the part of the scholars to master the correct stroke, but in the fact that while using the correct stroke, for a certain reason, they find it difficult to keep their heads above water. Some of the scholars did not lack in determination or bravery, and yet their efforts were fruitless. They would apply the correct stroke with great force, and yet eventually their heads would sink. Finally, the complaint of one of the scholars, to the effect that the effort seemed to tire the neck more than any other part of the body, led to a contemplation of the cause of the fact.

While investigating the facts in the case, it was observed that a beginner throws himself upon the water in a stiff and straight position, not allowing the body or back to bend at all, but merely bending the neck. He kicks his legs in a vertical direction, tending to raise the back to the surface of the water, and thus places himself in a position parallel to the line of the surface. It is easily seen that he must bend his neck nearly perpendicular to this line of direction in order to keep his head above water (see Fig. 1). We have merely to try this

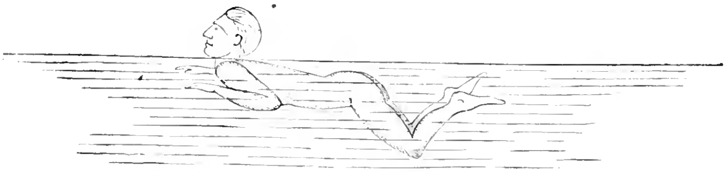


Fig. 1.

position on land, to experience its difficulty and disagreeableness. The muscles of the throat are greatly strained, while the air-tube is nearly closed, causing difficult respiration.

It is not to be wondered at that the learner soon relaxes this unnatural position of the head, and gives up the effort to keep his face above water. But, when the correct position is once mastered, this difficulty disappears, and swimming is made as natural and easy a function of the body as running or walking.

Fig. 2, showing the correct position of the body while swimming, has been drawn from empirical analysis, and is as plausible in theory as in practice. All of the propulsory exertions should be given so as to have but one tendency—that of advancing the body directly forward. (The proper method for accomplishing this end will be spoken of further on.) Now, admitting that the whole tendency of the stroke is to force the body in the direction of the component, *c*, if the body be so bent that the chest and part of the abdomen will form a resistance, making an angle with the direction of the force—as *a*, *b*, *c*—the tendency of that resistance will be to form a resultant in the direction

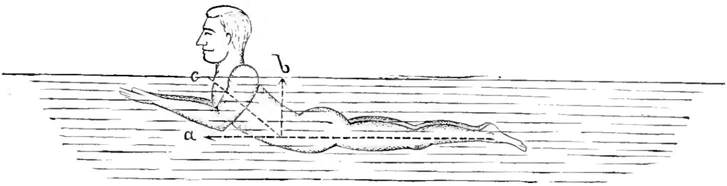


FIG. 2.

of *b*, which forms, with the natural buoyancy of the body, the force that keeps the head above water.

A concomitant advantage in the position under discussion is, that the neck and head are free to take their natural positions, and hence the avoidance of the evil referred to in speaking of the position of the head assumed by beginners.

The greatest difficulty to the beginner is to learn to keep the proper position of the body after attaining it. This difficulty can only be overcome by using the proper stroke after having placed the body in the correct position.

In the use of the arms, the only direction that can be given is to remember that, when the arms are thrust forward at the beginning of the stroke, such position of the elbows and hands should be taken as will make the least resistance to the water. To accomplish this, the hands should be placed palm to palm, and the elbows made to come quite close together, starting them from under the chest, as in the cut. In making the effective part of the stroke, our object is to get a forward motion only. The arms and hands should be so placed as to produce the greatest resistance upon the water. To accomplish this, the palms of the hands should be thrown outward, and the plane of the direction of the stroke of the arms made parallel to the surface of the water.

The most important and the most often defective point in swimming is the mode of using the legs. It would be well for a beginner to observe the swimming of a frog, for undoubtedly the same method of using the legs should be adopted by man as is displayed in the model swimming of that amphibian.

In analyzing the stroke of the frog, we notice that there is no vertical motion; the whole direction of the force is in a plane exactly horizontal, and is accomplished by virtually opening and closing the space between the knees—offering the sole of the foot as a resistance while kicking, and placing the feet in a position of least resistance while recovering.

In accomplishing the first of these conditions—the opening and closing of the space between the knees—the knees should be thrown out, and the contraction of the legs made slowly, in order to cause as little resistance as possible to the headway already attained.

It will be found that, if we alternate the stroke of the arms and legs by giving propulsion with one while recovering with the other, a more constant buoyancy will be attained, and, for long swims, it will be found far less fatiguing.

HOW THE ANCIENT FORESTS BECAME COAL.*

By M. G. De Saporta.

THE carboniferous formation represents the most wonderful episode in the history of our globe. It gives us an impression comparable in strangeness to that produced by those wonderful civilizations which blossomed out so suddenly and so splendidly in the infancy of mankind. Only a rare concurrence of circumstances could have brought on the expansion of plant-growth which characterized its epoch. The world of plants was still young and imperfect. Vegetation was characterized by the abundance of green parts susceptible of rapid growth, and of an almost indefinite development. It was, however, destitute of two characters which have been acquired by the later plants: those of the periodical and gradual increase of parts destined to endure, and of an absolute specialization of the reproductive apparatus. The vegetable kingdom was the first factor in the production of coal, but not the only one; and two other factors must be taken into account in studying its genesis. One of these related to the conditions of the environment, the climate, and the temperature; the other to the situations in which the plants that were converted into coal were placed. Had either of these conditions been essentially different or left out, we would have had no coal. The influence of situation is shown by the fact that the coal-beds are always intermittent; that they are limited in extent, and pass laterally into shales

* Translated and condensed for "The Popular Science Monthly" from the "Revue des Deux Mondes."

and sandstones, so as to show that there was nothing universal in the phenomenon, and that it was liable to interruption by physical changes. It is also easy to conceive that the formation of coal could not have gone on unless the vegetation was adapted to the process, and the conditions of the climate were suitable. The coal-plants could never have grown and flourished as they did in the present climates of the North; and our hard-wood trees, with their firm foundations in the ground, and their slow, periodical growth, could never by decaying in the open air have produced the peculiar and rich combinations we find in the coal-beds. The nature and bearing of these three concurrent factors have been carefully studied out by M. L. Grand' Eury, who has for that purpose spent many years in personal inspection of various mines and their surroundings, and has presented, in his "Mémoire sur la formation de la houille" ("Memoir on the Formation of Coal," Paris, 1882), a complete theory on the subject, including a review of the details of the process as taught by his observations of the phenomena.

The plants of the coal-measures, so far as their nature has been revealed to us by their remains, were great ferns, gigantic lycopodiums, called by the geologists lepidodendrons, and calamites and asterophyllites, allied to existing *Equisetaceæ*; all referable to the class of cryptogams. Besides these was another group, the character of which was long problematical, composed of the sigillarias and stigmarias. It now appears to be established that the stigmarias were a kind of rhizoma which had the faculty of persisting for a long time under the mud unchanged, growing and multiplying by stolons, but incapable in that condition of producing sexual organs; while under favorable circumstances they formed enormous buds whence shot up to the height of a hundred or a hundred and fifty feet the huge leaf-clad stems whose fossils, marked with the beautiful scars representing the leaf-attachments, have been called sigillarias. Gymnosperms were also quite plentiful, of one class of which, the cordaites, M. Grand' Eury has made some happy restorations. He has found their leaves and seeds in considerable abundance at Saint-Étienne, and he has observed at the same place visible traces of their carbonized trunks, still standing erect and traversing the sandstone strata of some of the quarries.

A peculiar feature of these plants was the extraordinary predominance of the cellular or succulent tissues in them, and the corresponding rarity of the hard or fibro-ligneous parts, which appear reduced to insignificant cylinders. It was certainly not the destiny of these parts to increase with time, after the manner of the wood of our trees; and, in examining the mature stems of the ancient plants, we never find any more than an extremely thin ring of real wood. The rest is all pith, and even the bark, except on the outside, frequently presents an open or spongy texture. Such structure is similar to that of the aquatic plants of the present time, which can not exist at all in the air, and wither as soon as they are taken out of the water. An atmosphere saturated with moisture was therefore essential to their vigor; and in such an atmosphere, according to M. Grand' Eury, they grew continually, without interruption by changes of season, without rest or alternations, to exhaustion; then to fall to the ground, and give place to other similar growths. So luxuriant a vegetation could only have been produced by the combination of an ultra-tropical heat with an excessive humidity, under no other changes of seasons than those distinguished by intervals of relative calm and of torrential rains. At the same time, the superabundance of green parts, which characterized even the trunks of the trees, presupposes a considerable intensity of light; and all the phenomena point to a strong diffused light, the direct rays of the sun being tempered by the interposed veil of vapors, as that under the influence of which these growths were produced.

The third element of the problem, that of the material disposition of the places in which the coal was formed, is the one that has offered the most difficulties. Two theories have been held on this subject. One is, that the materials were carried by ocean-currents or rivers from considerable distances to the places of deposit. Naturalists, however, who have applied themselves specially to the study of the carboniferous flora, have not been able to reconcile the orderly arrangement of the fragments, in which the specimens are so delicately posed, mingled without confusion, and often distributed uniformly in collections of leaves of the same species, with the confused drifts which are the almost invariable results of such a method of transportation. Moreover, in all coal-regions, recognizable trunks of calamites, tree-ferns, sigillarias, and other types of the carboniferous flora are found in the neighborhood of the coal, vertically crossing the strata of sandstone that accompany and separate the coal-beds in such a manner as to show that they grew over the ground of the whole region, and to indicate that their transformation was dependent upon some special or local phenomenon which may have been quite simple, or at least natural, and were probably resultant from the physical conditions of the land at that epoch. The other theory, that coal originated in the decomposition of trees and plants that grew on the spot, is insufficient to account for all the phenomena and circumstances, and raises new difficulties.

M. Grand' Eury, in whose theory transportation, but of a different character from that presumed in the first of these two theories, forms an important element, has been enabled, through his investigations at Saint-Étienne, to form a clear idea of the nature of coal and the processes to which we owe it, and also to enter into the details of the matter, to go back to the true causes of the processes, and to describe with remarkable precision how they must have taken place. The land of the carboniferous formations appears, after an intelligent examination of the stratigraphy, to have been frequently covered by the sea, and therefore in its immediate neighborhood. The coal-beds themselves were an essentially terrestrial formation, peculiar to the recently emerged land of the period. In Belgium and England they rest upon a marine deposit, which forms their floor, and which reappears in the course of the formation, alternating several times with the strata of land-growth. We learn from this that the sea was retiring from these spots before the extension of the continental area, leaving a broader strip of land after each fitful inundation, and that the carboniferous vegetation was developed on the ground which the marine waters had just abandoned. This phenomenon acquires great force with its frequent recurrence and repetition in various places.

None of the carboniferous plants except the stigmarias, whose peculiarities we have noticed, appear to have been especially aquatic; but they could all endure the immediate neighborhood and occasional contact of water without being hurt by it, and could live and grow, even when partially inundated. They grew around the borders and on the slopes of the lagoons with which the shore was studded, the smaller ones thickly matted under the cover of the larger trees, in groups characterized by the predominance of single species, as is shown by the distribution of the fossils. The coal was deposited in the lacustrine beds at the center of these forest-covered depressions; and the extent of the deposits is measured by the area of the basins that were fitted to receive them. One condition was essential, without which no seam of combustible matter could have been formed. It was, that the water flowing over the ground should bring with it and leave in the bottom of the basin where the carboniferous matter was destined to accumulate, only the remains of plants, to the exclusion of every other form of sediment. This condition may have been more easily realized in the Carboniferous epoch than at any other time, because the flora was more abundant and its extension more favored by the climate. It is conceivable also that, after having been once established, it might have been liable to interruption at any time; for a slight oscillation of the ground, a change in the direction of the currents, the washing down of a bluff, or the removal of some impediment, may have been enough to furnish an opportunity for the introduction of sand, mud, or rock-dust, into the deposits. We may also affirm as essential that there should be no real affluent coming down to the place of deposit, or current of running water, for that would bring down mud, and leave in the bed some other sediment than one of coal. The flow of water must have been a gentle trickling over the soil, bathing it without washing it, but strong enough to carry along the vegetable matter which it finally deposited. Whenever the flow became more violent, the formation of coal was interrupted to give place to deposits of shale or sandstone, according to the character of the mineral elements brought down, or, if they were in relatively small proportion to the vegetable fragments, of schistose laminæ marked with impressions of plants.

Such formations are of frequent occurrence in the coal-measures, in alternation with the seams of coal and the marine deposits left by the overflow of the sea, and this was doubtless their origin. The fossil forests which have been discovered in the same regions may be similarly accounted for. The trees growing around the perimeters of the lagoons would be partially submerged by the overflowing water, and the sections of them buried in its muddy deposit would be left to decay and fossilize in it. The persistent root-stocks of the sigillarias and calamites, unharmed by the flood, would send up new aërial stems; and most of the other plants, having the power of sending out adventitious roots from their trunks, would be able to live and continue to grow by that means, leaving their old lower parts to die, while they lifted themselves, as it were, bodily up with the ascensional movement of the soil. Several examples of such successive emissions of roots are figured in the "Mémoire." M. Grand' Eury has assumed that the concurrence of two principal circumstances, acting coincidently and in combination with each other, contributed essentially to the formation of coal. One was the transportation by water for short distances of all the vegetable matter of a region to be spread out flat and stratified at the bottom of the lagoon destined to receive it; the other was the exposure of the matter, previous to this process, in the open air to a certain amount of decay, of the nature and effects of which he has made a patient analysis. From these principles he has deduced a theory which may be summarized thus: The water which served as the vehicle for the vegetable matter, which must have been perfectly clean, because it was free from all mud, strong enough to carry along its drift, and plentiful enough to sweep all the points of the wooded region, could not have been any other than rain-water shed upon slopes pronounced enough to make it easy for it to run and carry the vegetable residues along with it, yet level enough not to allow the ground to be cut up. The land over which the water flowed must have been covered with a mass of plants and accumulated fragments abundant enough to furnish much flotsam matter, and matted enough to prevent its eroding the subjacent soil. The water must have been intermittent, else the fallen trunks of trees and the fragments of every kind which lay scattered over the ground would not have had time to undergo the partial decomposition and disaggregation of their tissues which necessarily preceded complete submersion. There must have been, then, if not real seasons, intervals of relative calm, in which the decomposition could have taken place, to be succeeded by times of protracted and extremely violent precipitation. The fact that a transportation and deposition of the parts took place is attested by the stratified structure of the coal. In both the coal and the schisto-carbonaceous laminæ, all of the fragments, down to the most delicate isolated organs, are always, with only the rarest exceptions, spread out flat, and cemented one over another, lying together like the leaves of a book. A close examination of coal and its texture under the microscope will show that only water could have taken all the fragments of such different sizes and consistencies and arranged them in this way. The disposition is the same as is always shown when leaves and fragments of plants, having become thoroughly soaked, sink and form stratifications at the bottom of ponds. In the coal, the elements continue visible, and their arrangement in superposed laminæ is evident, while the interstices between the planes of junction appear to have been filled up in the course of the formation of the beds. These facts, with the perfect condition of the organization of many of the fragments; their agglomeration in an amorphous pulp, the resultant of the previous maceration of a host of fragments; and the reduction of the whole mass by compression to half of its primitive thickness—all parts of one and the same phenomenon—point to the action and weight of the bed of water at the bottom of which the stratification took place. The perfect uniformity which reigned over the formation of coal has given it generally a schistous structure, in thin leaves disposed in a parallel fashion and fissile in the direction of the plane of deposition. It is also found, on attentive examination, to be somewhat varied in constituency, according to the varying character of the elements of which it is composed, and the different stages of freshness and maturity in which they were deposited. One kind, which M. Grand' Eury calls "fusaine," from its resemblance to a stick-charcoal, comes from the decomposition of stems from which the anatomical structure has disappeared while they preserve their form. The green parts appear as crystalline laminæ, or scales, or black particles in the amorphous mass. This mass, the result of the maceration of wholly decomposed particles, constitutes the amorphous coal in which, besides "fusaine," we can always discover some remains of vegetable structure testifying to the common origin of all the coal products. Within these differences of type are innumerable variations passing from one to another, the existence of which prevents our establishing a clear distinction between the coals most homogeneous in appearance and those which show the multifarious and manifest traces of hardly altered organized elements.

M. Grand' Eury's sketches introduce us to the depths of the carboniferous forests, into regions of dense moisture, at the feet of gentle slopes where are accumulating in stagnant ponds immense drifts of the remains of constantly active, exuberant, and quickly exhausted vegetation. Masses of this kind may even now be observed in the midst of the virgin forests of hot countries; how much more might we have expected to find them in ancient epochs, when the trees made no wood, but sent up spontaneous, ungainly shoots, sudden growths in green columns, the function of which was as ephemeral as their texture was weak! Most of the carboniferous stems, hollow or filled with pith only, fell by the sheer exaggeration of their growth; the tree-ferns were crowned with fronds of marvelous dimensions; the stems of the sigillarias shed their leaves rapidly; and the remains of all these rank growths were incessantly accumulating in a sultry shade on a water-soaked soil. We can conceive the enormous production of humus. Decomposition was accelerated by every rain, and the whole mass was reduced, down to the very bottom, to a black pulp; and this is why, notwithstanding we have such abundant materials, we meet so many difficulties in reconstructing the types. The fallen trunks seldom remained whole, but swelled and burst. The soft and porous parts gave way first, then the dense and fibrous parts were detached from the cortical mass; that, more tenacious and firm, spread out and resisted longer than the rest. Nothing remained of the fern-stems but the peripheric sheath or the disaggregated interior fibers; of the cordaites, sigillarias, and lepidodendrons only the cortical regions. The detached leaves formed other accumulations; and all these heaps, standing as obstructions in different places, were waiting for the arrival and passage of the water to yield to it innumerable fragments in very unequal degrees of decomposition. When the great rains came on, the waters, filtering in from every side, trickling down all the slopes, gathered here and there in temporary lakes, and finally overcame all the dams of organic matter they met—an immense mass of *détritus* going down to the lacustrine center. With these old and disorganized residues, the rains, which we must imagine to have been torrential, brought down also everything that would yield to their impulsion—tree-trunks, leaves, young shoots, and at times entire plants. It is these remains, so fresh in condition, these leaves so delicate, and clearly defined, these organs so whole which we see in our collections distinguishable in their slightest details, and lying spread out in the leaves of the great herbarium of which it is our privilege to turn the pages.

M. Grand' Eury's theory does not appear to offer anything that is discordant either with ancient phenomena or with those of more recent periods. It possibly has its place marked even now among the grand scenes of contemporary nature. We read in the narratives of the travelers who have ascended the great rivers of the interior of Africa, the Nile, for example, how their boats have been stopped for days at a time by submerged remains and the accumulations of plants hiding the river on which they were floating. In the face of such pictures, which show us sedges, water-lilies, and immense colonies of floating plants, under which the river has disappeared, while its eddies, its lagoons, and its deep basins are temporarily flooded after having been dry for months, we can not escape being carried back in mind to the phenomena, doubtlessly not quite parallel, but assuredly of the same order, to which was due the formation of the coals and lignites in ancient epochs. These were certainly not accidental or episodical phenomena, produced by circumstances which, once realized, were never to appear again, but occurred in the course of a series of analogous combinations of conditions which may have been frequently repeated, and involve nothing incompatible with what is going on on the surface of the globe in our own day. In speaking thus, we do not regard Europe, but the interior of tropical countries, and the parts of those lands where water, heat, and an exuberant vegetation are combined upon a ground the configuration of which is agreeable to the material conditions that have been postulated in this sketch.

A SUPERSTITIOUS DOG.

By EUGENE N. S. RINGUEBERG.

THAT many of the higher animals are possessed of reason does not, in the light of modern science and recorded facts, need any argument ; only the question of degree remains to be determined in the future.

It is among domesticated species that we have the best opportunities for studying the mental phenomena of the lower animals, but here they are often greatly modified by contact with man ; and, as these abnormal modifications are the ones that we can most readily interpret, they must necessarily form the major portion of our data.

Observation of their habits can not fail to convince us that many individuals, if not all of the brute creation, are possessed of a considerable degree of imaginative faculty. Every one has watched a dog in dream-land : his feet will go through the motion of running ; occasionally a few smothered barks will be heard, showing his eagerness in the imagined chase in which he is engaged ; or his tail will wag rapidly, probably indicating a meeting with a pleasant acquaintance. He may even start up, and then, awakened by his energetic action, his countenance will show plainly, as he turns to lie down again, how sheepish he feels about the exhibition that he has involuntarily made of himself.

In the fall of 1879 an eccentric pointer came into my possession, or rather he adopted me for his master. He was a genuine canine tramp, with all the peculiarities of the human variety ; stealing his food or lodging whenever he had a chance, or deferentially begging it when that method would answer his purpose better. He had been in the habit, as we afterward found out, of roaming about from place to place in the town, selecting first one home and then another. He was something over two years old when he came to me ; his color was coal-black, and he soon learned to answer to the cognomen of Pluto.

After he had been with me a few months, certain peculiar mental traits began to manifest themselves. He became subject to attacks of apparent mental derangement, lasting from a few minutes to several hours, which increased in frequency and violence up to the time when we disposed of him, two years later. These paroxysms would, at times, gain such complete control of his mind as to either paralyze or pervert all his physical senses.

The first one that I observed was brought on by the falling of a stick in the stove, back of which he was sleeping. Whereupon he started up, and commenced barking violently at a small leaf that was lying on the floor, every now and then making a dash toward it, after which he would retreat in the greatest terror. Then he would crawl slowly toward it again, and when he came within reach would strike at it with one of his fore-paws, drawing the paw back quickly with a little yelp, and then carefully looking it over as if to find an imagined injury, and licking it.

While the leaf was in the room he appeared to be entirely insensible to feeling or sound. Severe blows were administered with a stout stick, but they produced no more impression than if they had fallen upon the floor. He did not shrink, nor even by the slightest tremor give any indication that pain accompanied their infliction. Neither would he pay any attention to commands that were given in a loud voice close to his ear, although he had always shown himself obedient to any commands that he could understand; nor would any other sound, no matter how loud, cause him to make the slightest motion indicating that he had heard it.

After this his peculiar mental condition became more noticeable; the most trivial circumstance would sometimes be sufficient to destroy his mental equilibrium. A slight noise might bring on one of his paroxysms; but, singularly, it would generally have no effect unless it proceeded from the kitchen, which seemed to be to him a haunted chamber. Often in passing through the room he would cringe and put his tail between his legs.

At other times he would fix his eyes upon a spot on the ceiling or in a corner, or upon a towel hung up to dry, and would retreat from the object upon which his gaze was fixed, with dilated pupils and every other sign of intense fear of the imaginary "ghost." At these times his senses, instead of being simply deadened, were generally active, but in a perverted condition. If he was struck by a person behind him, instead of shrinking away, he would give a start toward the person who had struck him. Likewise a sudden noise, as the stamping of a foot, no matter from what part of the room it came, would invariably cause him to retreat violently from the imaginary object of his terror. He was apparently so prepossessed by one idea for the time being that, to his perverted senses, every noise was made and every blow was struck by the object which had excited him.

Sometimes he would stand on his hind legs and, directing his attention to the middle of the ceiling, would retreat backward, barking violently all the while. Then, seeming to be entirely mastered by his terror, he would drop on all-fours and run out of the house at full speed, with his tail between his legs. It would be some time before he could be induced to enter the house again, and even then he would tremble violently.

Certainly in the case of this dog the mental phenomena exhibited can safely be termed superstition, and, whether it was normal or superinduced by momentary insanity, it was plain that for the time being he actually saw "ghosts." For this reason the case is a very interesting one, as it furnishes additional evidence of the similarity existing between the mental actions of man and those of the lower animals.

FROM BUTTERCUPS TO MONK'S-HOOD.

By Professor GRANT ALLEN.

TO look at these queer, irregular blue flowers, growing on a long and handsome spike in the old-fashioned garden border, nobody would ever dream of saying that they were in reality altered and modified buttercups. And yet that is just what they really are, with all the marks of their curious pedigree still clearly impressed upon their very form. Pull one of the blue blossoms off, and pick it carefully to pieces, and you will see how strangely and profoundly it has been distorted by insect selection. Monk's-hood is most essentially a bee-flower, and in examining it we see the results of bee action plainly set forth in every organ. If we pick a common meadow buttercup for comparison with it, we shall be able to see exactly wherein the two flowers differ, as well as why the one has gained an advantage in the struggle for existence over the other.

The outside whorl of the buttercup consists, of course, of five separate greenish sepals, which together make up its calyx. Inside the sepals come the five golden petals composing the cup-shaped corolla; and inside the petals, again, come the numerous stamens, and the equally numerous carpels or unripe fruits, each containing a single solitary little seed. Moreover, all these parts are regularly and symmetrically arranged round a common center, so as to form a series of concentric whorls. But when we look at the monk's-hood we see no such simple and orderly arrangement in its architectural plan. At first sight, we recognize no distinct sepals or petals: and the colored organs that take their place are very irregular in shape, and disposed in an unsymmetrical fashion—or rather, to speak more correctly, their symmetry is not radial, but bilateral. When we begin to pull our blue blossom to pieces, however, we gradually recognize the various parts of which it is composed. First of all come five sepals, not greenish as in the buttercup, but bright blue; and not all alike, but specially modified to fulfill their separate functions. The uppermost sepal of all is helmet-shaped, and it forms the curious cowl which gained the plant its suggestive name from our mediæval ancestors. The two side sepals, to right and left, are flatter and straighter, but very broad, while the two lowest of all are comparatively small and narrow. The whole five are bright blue in color. Pull off these petal-like sepals, and you come to the real petals beneath them. At first you can hardly find them at all; you see only two long blue horns, covered till now by the helmet-shaped upper sepal or cowl, and each with a queer cup-like sac at its extremity, containing a small drop of clear fluid. That fluid is honey, but I should advise you to be careful in tasting it not to bite off any of the flower, for monk's-hood is the plant from which we get the now famous poison, aconitine; and a very little of it goes a long way. Unlike as they are to the familiar yellow petals of the buttercup, one can still gather from their position that the two long horns are really petals. But where are the three others? Well, you must look rather close to find them, and perhaps even then you won't succeed after all; for sometimes the three lower petals have disappeared altogether, being suppressed by the plant as of no further use to it. In this particular specimen, however, they still survive as mere relics or rudiments, three little narrow blue blades, not nearly as big as a gnat's wing, placed alternately to the lower sepals. As for the stamens, they are still present about as numerously as in the buttercup; whereas the carpels, or fruit-pieces, are reduced to three only, which in the ripe seed-vessels here on the lower and older part of the spike grow into long pods or follicles, each containing several seeds.

Thus, then, the flower of monk's-hood agrees fundamentally with the flower of the buttercup; while, at the same time, it has undergone some very singular and suggestive modifications. In both there are five sepals; but in the buttercup all five are alike, and all five are greenish; whereas in the monk's-hood they have acquired different shapes, exactly fitting them to the bee's body, and they have become blue, because blue is the favorite color of bees. Again, in both there are five petals; but in the buttercup all five are similar and yellow, and all five secrete a drop of honey at the base; whereas in the monk's-hood two of them have become long and narrow specialized nectaries, while the other three, being no longer needed, have grown obsolete or nearly so. Once more, the stamens remain the same; but the carpels have been immensely reduced in number, at the same time that the complement of seeds in each has been greatly increased by way of compensation.

Well, how are we to account for these peculiar modifications? Entirely by the action of the fertilizing bees. The secret of the monk's-hood depends, in the first place, upon the fact that its flowers are clustered into a spike, instead of growing in solitary isolation at the end of the stem, as in the common buttercups. Now, Mr. Herbert Spencer has pointed out that solitary terminal flowers are always radially symmetrical, and never one-sided, because the conditions are the same all round, and the visiting insects can light upon them equally from every side. But flowers which grow sideways from a spike are very apt to become bilaterally symmetrical; indeed, whenever they are not so, one can always give an easy explanation of their deviation from the rule. Probably the blossoms of the monk's-hood began by arranging themselves in a long and handsome spike, so as more readily to attract the eyes of insects; and that was the real starting-point of all their subsequent modifications. Or, to put the same thing more literally, those monk's-hoods which happened to grow spike-wise succeeded best in attracting the bees, and therefore were most often fertilized in the proper manner. Next, we may suppose, the large green sepals, being much exposed to view, began to acquire a bluish tinge, as all the upper parts of highly developed plants are apt to do; and the bluer they became, the more conspicuous they looked, and therefore the better they got on in competition with their neighbors, especially since bees are particularly fond of blue. As each bee would necessarily light on the middle or lower portion of the flower, he would begin by extracting the honey from the two upper petals; but it would be rather awkward for him to turn round head downward, and suck the nectaries of the three bottom ones. Hence, in course of time, especially after the flower began to acquire its present shape, the two top petals became specialized as nectaries, while the three lower ones gradually atrophied, since the colored sepals had practically usurped their attractive function. But as the flower can only succeed by being fertilized, all these changes must have been really subordinate to the great change which was simultaneously going on in the mechanism for insuring fertilization. Slowly the blossoms altered to the bilateral shape—they adapted themselves by the bee's unconscious selection to the insect's form. The uppermost sepal grew into the hood, so arranged that the bee must get under it in order to reach the long nectaries containing their copious store of honey. At the same time the bee must brush against the stamens, and cover his breast with a stock of adhesive pollen-grains. When he flies away to the next flower he carries the pollen with him; and, as he rifles the nectaries in the second blossom, he both deposits pollen from the last plant upon the sensitive surface of the carpels in this, and also collects a fresh lot of pollen to fertilize whatever other flower he may next favor with a call. The increased certainty of fertilization thus obtained enables the plant to dispense with some of the extra carpels which its buttercup ancestors once possessed; and, by lessening the number to three, it manages to get the whole set impregnated at a single visit. But, as three seeds would be a small number to depend upon in a world of overstocked markets and adverse chances, it makes up for the diminution of its carpels by largely increasing the stock of seeds in each.

Thus the whole shape and arrangement of the monk's-hood bear distinct reference to the habits and tastes of the fertilizing bees. It is a mountain plant by origin, belonging to a tribe which took its rise among the great central chains of Europe and Asia, and these Alpine races are usually highly developed in adaptation to insect fertilization, because they depend more absolutely upon a few upland species than do the eclectic flowers of the plains, which may be impregnated haphazard by a dozen different flies, or moths, or beetles. We can still dimly trace many of the links which connect it with very simple and primitive buttercups, if not directly, at least by the analogy of other plants. For all the buttercup tribe show us regular gradations in the same direction. The simplest kinds are round, yellow, and many-carpeled, like the buttercups. Then those species which display their sepals largely have dwarfed petals, like hellebore and globe-flower, or have lost them altogether, like marsh-marigold, which trusts entirely for color display to its big golden calyx. The still higher anemones have the sepals white, red, or blue; and the very advanced columbine has all the petals spurred, and developed into nectaries, like those of monk's-hood. But columbine still keeps to single terminal flowers, so that here the five petals remain regular and circularly symmetrical, though the carpels are reduced to five. Fancy a number of such columbine-flowers crowded together on a spike, however, and you can readily picture to yourself by rough analogy the origin of monk's-hood. The sepals would now become the most conspicuous part; the two upper petals would alone be useful in insuring fertilization, and the lower ones would soon shrivel away from pure disuse. The development of the hood and the lengthening of the upper petals would easily follow by insect selection. It is a significant fact that our only other spiked buttercup, the larkspur, has equally irregular and bilateral flowers, though its honey is concealed in a long spur formed by the petals, and accessible to but one English insect, the humble-bee.—*Knowledge.*

ON THE COLORS OF WATER.

By M. W. SPRING,

OF THE UNIVERSITY OF LIÉGE.

VIEWED in relatively shallow masses, clear water appears wholly colorless. In our daily dealings with the liquid we seldom have occasion to observe it in great depths; hence it has been generally believed that water is quite destitute of color. The ancients were accustomed to explain the transparency of some bodies by assuming that they partook of the nature of water; and we now speak of a diamond as of the first water, to emphasize its perfect transparency and colorlessness. If, however, we regard the larger masses of water in nature—the seas, lakes, and rivers—we shall receive a different impression. In these, the water not only appears colored, but of various colors, and of a rich diversity of shades. The Mediterranean is of a beautiful indigo, the ocean is sky-blue, the Lake of Geneva is celebrated for its lovely and transparent azure waters ; the Lake of Constance and the Rhine, the Lake of Zurich and the Lake of Lucerne, have waters quite as transparent, but rather green than blue ; and the green waters of the little Lake of Kloenthal, near Glaris, can hardly be distinguished from the surrounding meadows. Other waters are of a darker color, like those of the Lake of Staffel, at the foot of the Bavarian Alps, which was quite black the day I saw it, though clear in shallow places.

These facts start the questions whether water, after all, has not a color ; if it has, what the color is, and what causes the varied tints under which it is seen. The solution of these questions has long occupied the minds of scientific inquirers, and it can not yet be said that they have been answered. Disagreement still prevails respecting them.

M. Durocher, in his "Studies of the Glaciers of Northern and Central Europe," has expressed the opinion that the blue color of some waters is of glacial origin, and that it is so peculiar to water from snow-fields and glaciers as to constitute a mark by which to distinguish whence it has proceeded. "If the color of water is really blue," he adds, "the substitution for it of gray or greenish tints proceeds in the majority of cases from organic substances, chiefly vegetable rather than animal."

M. Durocher's view is disputed by M. Th. Martins, who points to the snow-fed Lakes of Sioron and the Bachalpsee, as one azure blue, the other yellowish green, and the Lake of Brienz, whose yellowish-green waters, after crossing the Isthmus of Interlachen, become blue in the Lake of Thun.

Bunsen was the first one to deny, with any real knowledge, the absence of color in water. Struck with the green-blue color of the hot water of the Icelandic geysers, he examined pure water in a tube, found it blue, and concluded that that was the true color of the liquid, while other colors observed were derived from foreign matters or by reflection from a colored bottom.

Tyndall, Soret, and Hagenbach took up the question about twenty years after Bunsen. Tyndall found by experiments on polarization that the blue of the atmosphere was caused by reflection of the shorter blue light-waves at the expense of the longer waves, from particles of aqueous vapor in an extreme state of division, which he called nascent cloud. If the particles were larger, longer waves would be reflected, and the color would approach white. Soret, seeking to learn if the blue color of the Lake of Geneva had not an analogous origin, applied the polarization experiments to it, and concluded that it contained minute particles similar to those found by Tyndall in the atmosphere. Hagenbach repeated the experiments, with like results, in the Lake of Lucerne; and Tyndall, a year later, with water of the Mediterranean and the Lake of Geneva, sent to him in London. Mr. Hayes examined the water of the Lake of Geneva, to see if it did not contain a coloring substance, and found none.

The later of these experiments indicate that, contrary to Bunsen's belief, water by itself may be colorless, but nothing is less certain. M. Soret says that the lake was still blue in cloudy weather, when he could not get a trace of polarization effects. Is this not enough to prove that reflection is not the only cause of color in water? Moreover, if the blue in water were wholly of the same origin as that of the sky, the light transmitted by water should be crimson, as that which is shown on the tops of high mountains, or which is transmitted through the clouds at the rising and setting of the sun; but nothing of the kind is the case. Professor Tyndall states this, and Father Secchi has established the absence of the red and yellow from the absorption spectrum of water. It is also well known to those who have had occasion to make submarine excursions, or who have visited the glacial grottoes in Switzerland, that the transmitted light has a blue tone, and the red is so weak that the figures have a livid aspect.

These facts show that the question is still waiting a definite solution. We now turn to the explanations which have been offered of the diversities in the colors of natural waters.

According to Arago, water has two colors, "a color of transmission and a color of reflection, wholly different from the other. It appears blue by reflection, and its transmitted color is green." This supposition can not be reconciled with optical laws, but Arago used it to explain the variations of tint in the water of a shallow, white-bottomed sea. "When the sea is deep, light is reflected from the water and appears blue; but, if it is not very deep, the sand at the bottom receives the light through a stratum of water. The light then reaches the bottom, already green, and, in returning from the sand to the air, the green color is deepened, frequently so much as to predominate, on coming out, over the blue. This, probably, is the whole secret of those shades which are in calm weather the sure and valuable index to the experienced sailor of the depth of the bottom. This explanation fails when it is applied to other quarters than those for which Arago conceived it. The Swiss lakes are green, or blue, independently of their depth. Arago suggests, after Davy, that the change from blue to green may be caused by the presence of vegetable, M. Durocher of colored, matters. These suppositions are gratuitous, and supported by no evidence. H. Sainte-Claire Deville, in 1848, analyzed a number of natural waters, and found that the blue ones gave hardly perceptible colored residues, while the green ones yielded such considerable quantities of organic matter that the soluble salts became yellow after evaporation. According to this, green waters, and, *a fortiori*, yellow or brown waters, owe their color to the presence of a small quantity of yellow mud. If pure water is really blue, the presence of a small quantity of yellow matter would be enough to turn its color to green or yellow. The same idea was advanced some time ago by M. Wiltsthein, who believed he had proved, by analyses of the waters of a number of Bavarian streams and lakes, that brown and yellow waters contained more organic matter than green ones, and that they were less hard than the latter. He thought that mineral substances of themselves had no effect on the color of the water, but that organic substances, naturally brown, existing in it as humic acids, were held in solution through the presence of alkaline matters with them, and that they made the water, according to their abundance, green, yellow, brown, or black. His views are not supported by the results of my analyses, which indicated that the colors of different waters on which they were made bore no relation to the quantity either of organic matter or of alkalies held in them. I have also not been able to find any relation between the color of water and its hardness or softness. It is, however, probable that very dark water may owe its color to dark organic matter dissolved in it.

M. Schleinitz attributes the diversities in the color of sea-water to variations in the quantity of salt dissolved in it. During a voyage in the Gazelle, from Ascension to the Congo, he observed that the blue water had a higher specific gravity than that which was of a greenish tinge. This observation leads to an erroneous conclusion, but affords a confirmation of some results which I have reached.

M. J. Brun has noticed in the water and the ice of the Lake of Neufchâtel an alga which is green, orange, red, or brown, according to the stage of growth it has reached, and black after it is dead. Its presence would not be without influence on the color of the lake.

This review shows that the problem of the color of water still calls for more investigation. It may be useful to speak of a few researches that I have made. My object was to determine the color of pure water, and to observe the variations in color produced by the presence of different substances. I used glass tubes, five metres long and four centimetres in interior diameter, closed at the end with glass plates, and passing through a black sheathing that intercepted the side-light. They abutted against a ground-glass pane in the window of my laboratory, so as to receive diffused light in the direction of their axes.

M. V. Meyer, who used a similar arrangement, found the color of distilled water to be a blue-green. I found it pure blue. In my first experiment, I also found distilled water of a blue-green color, like that of a diluted solution of ferric sulphate. A second experiment, with freshly distilled water, gave a pure sky-blue, which in the course of seventy hours became blue-green like the former water, without losing any of its transparency. This indicated that the distilled water of laboratories is not perfectly pure, but that it contains substances that will change in time. These substances might be mineral or organic, or even living organisms. Wishing to ascertain whether the last was the case, I added to the water in one of the tubes $\frac{1}{10000}$ of bichloride of mercury, while I left that in the other tube unchanged. The small quantity of bichloride did not at all affect the color of the water to which it was added. In the course of six days the water which had been left alone became blue-green, while that to which bichloride of mercury had been added preserved a fixed blue, and exhibited no sign of change for three weeks; but, when the salt was put into the water that had turned blue-green, that began slowly to turn blue again, and this process continued for nine days, when it stopped, without the blue color having been quite restored. Inasmuch as the bichloride of mercury is extremely deadly to minute organisms, we have a right to conclude that life exists in the distilled water of laboratories, and that such water contains also the aliments required for its development. How can organic germs exist in water that has just passed through the process of distillation? Tyndall has shown the possibility of vapor taking up germs as it passes through the air. M. Stas has proved that distilled water may contain volatile organic matters which after a little while become spontaneously fixed. We may, then, conclude that our distilled water continued blue as long as the organic matters contained in it continued volatile, but that it turned green as they became fixed.

It was necessary to obtain distilled water certainly free from organic matter. I did this by an adaptation of M. Stas's process of distilling spring-water over a mixture of manganate and permanganate of potash into a cooling-vessel of platinum. The resultant water, which met every test of its purity, when placed in the tubes, displayed a color to which only the clearest blue of the sky, as seen from a mountain-top on a perfect day, can be compared, the hue of which was not changed after it had been left in the tubes for two weeks. The color was evidently not due to reflection from minute particles, for it was a color of transmission and had not a tinge of red in it; moreover, if it was due to the presence of foreign particles, all liquids under the same conditions ought to have a bluish tinge. But amylic alcohol, distilled under circumstances favorable to the absorption of fine particles, was colorless, while acetic acid and ethylic alcohol were yellow, when seen through a thickness of five metres; and, though the color was effaced as the thickness of the masses was reduced, no trace of green or blue appeared in the liquids. It seemed proved to me that water, as pure as we can get it, has a blue color, which proceeds, not from reflection, but from an absorption of the yellow.

To perfectly clear lime-water I added enough of a solution of carbonic anhydride to cause the formation of a barely visible precipitate, and then poured the liquid into one of my tubes of observation. The liquid was entirely opaque, as much so as if it had been ink I had put into the tube. I then took the mixture from the tube, diluted it to a suitable degree with pure water, and introduced a current of carbonic anhydride sufficient to precipitate the lime as a carbonate, and finally to dissolve the carbonate as an acid carbonate of lime. The current of carbonic anhydride was interrupted from time to time, and the liquid was clarified and examined in the tube, and, as I did so, I could see the opacity slowly disappear, letting in first a brown light, then clear brown, then yellow, then green, and at last, after eighteen hours of circulation of the carbonic anhydride, the liquid had again become blue, but with a tendency to green. Thus, by the combined action of carbonic anhydride and carbonate of lime, it is possible to produce all the colors of natural waters, from opacity to greenish-blue. I reversed the process, and from a green saturated solution of bicarbonate of lime and carbonic acid, by gradually expelling the carbonic acid, obtained a succession of colors, in inverse order, to complete opacity. Similar processes with solutions of other salts gave results agreeing with these.

My experiments enabled me to verify several facts. First, we find that not all of a luminous ray can pass through a considerable mass of a liquid holding foreign bodies in suspension, even when the latter are transparent or colorless. Further, it is not necessary that the body in suspension be in the solid state. The important point is, that it be competent to reflect light. Then the light-rays of feebler intensity suffer extinction, one after another, according to the thickness of the medium, till the yellow rays, the brightest to our eyes, are the last to survive the struggle. It is not essential to the production of this phenomenon that the medium be liquid. It may be observed in our atmosphere, where the shadow of a cloud of smoke will appear yellow or brown according to the thickness of the smoke. It may be that the reflecting particles can be dispensed with, and we may say generally that, when light passes through an optically resistant medium, the yellow rays are the last to be extinguished.

Other experiments have satisfied me that the yellow tint exists not only when the liquids contain matter in suspension, but also when they contain it in solution to the point of saturation, or when precipitation is about to begin, at which point there still remains enough of this color to form with the natural blue of the water a green. This condition may be called, in analogy with the nascent cloud of Tyndall, that of nascent precipitation. We now come to another view, which is supported by a small number of experiments I have made with reference to it, that the obstruction of light, inducing the yellowish tint, which is produced by any salt, depends less on the quantity of the salt present than on its being near the stage of precipitation. Small quantities of a feebly soluble salt produce the same effect as large quantities of a more soluble salt. The variety in the colors of natural waters may, then, be thus explained: Absolutely pure water, viewed in masses of sufficient thickness, is of a beautiful blue color. If it holds in complete solution colorless salts in small mass, its color is not changed; but, in proportion as it may contain matter on the verge of precipitation, the light traversing it will be of a yellow or darker color, until a stage is reached when the liquid will let no light through, and becomes opaque or black. The yellow light will combine with the blue light of the water, and thus will be produced green-blue, bluish-green, and green tints, according to the strength of the yellow. If the latter is very strong, the dark blue will be wholly smothered, and the water will appear yellow, brown, or of a still darker color.

In nature, generally, the feebly soluble substances contained in natural waters, and appearing, perhaps, in the state of nascent precipitation, are carbonate of lime or magnesia, silica, silicate of aluminum, and alumina. A blue water should contain carbonate of lime more completely dissolved in proportion as it is more distinctly blue, and should consequently have in it enough carbonic anhydride to produce the acid carbonate of lime. A green water, on the other hand, should contain carbonate of lime in less complete solution, as would be the case if there were a less relative proportion of carbonic anhydride in it. The blue waters of the Rhône and the green waters of the Rhine, as analyzed by Sainte-Claire Deville, illustrate and confirm this rule. It may also be presumed that a blue water, containing limestone in full solution, should become green when lime is added to it. This is illustrated on the north shore of the Lake of Achen, where the blue waters of the deep lake become chrome-green when they break over the limestone pebbles of the strand, and, generally, in the greener color of the bottom and shore waters of seas and lakes. Other substances than lime, particularly silica and alumina, may produce the same effects, but their action is more complicated. These substances, without being really soluble in water, are pseudo-soluble, or form an emulsion with it; and water which has taken them up from the ground over which it flows does not become perfectly clear on standing. If, however, it meets a solution of chloride of sodium, alumina, or silicate of alumina, it is precipitated rapidly; and this is what takes place at the mouths of rivers, and is the immediate cause of the deposits out of which deltas are built up. The changes in the color of the sea-water observed by M. Schleinitz, on board the Gazelle, may be accounted for by reference to this fact.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

A WONDER FROM THE DEEP-SEA.*

By M. L. VAILLANT.

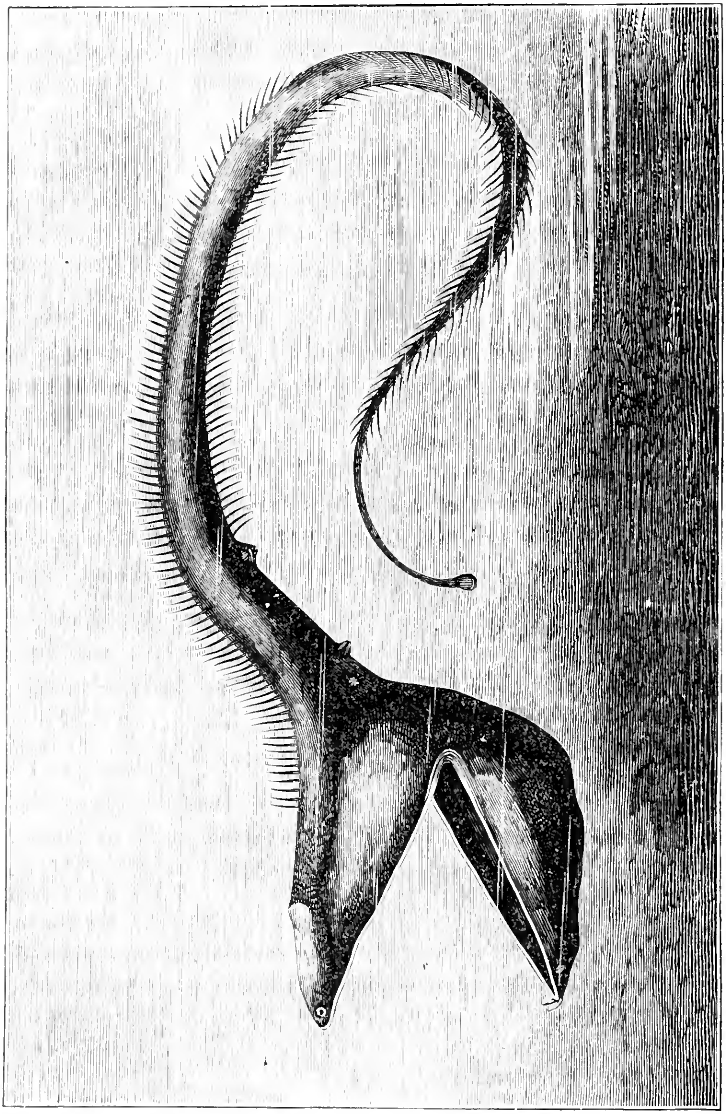
DURING the last voyage of the French deep-sea dredging-ship Travailleur, a fish was found, off the coast of Morocco, at the depth of about 7,500 feet, which may certainly be regarded as one of the most singular beings yet brought to light in any of these investigations. It is about eighteen inches long, and three quarters of an inch thick at the thickest place, and is deep black. Its body, the form of which is marked in front by an enormous mouth, somewhat resembles that of a macrouran, and tapers regularly from near the anterior quarter, where the external branchial orifice may be seen, till it terminates in a point at the caudal extremity.

A most singular appearance is given to the fish by the disposition of the jaws and the conformation of the mouth. While the head is very short, being less than an inch and a fifth in length, the jaws and the suspensorium are excessively long, the latter measuring more than three inches and three quarters. Hence the angle of the joint is put very far back, at a distance from the end of the snout about three and a half times the length of the cephalic portion. The suspensorium is probably composed of two pieces, one basilar, analogous to the temporal, the other external, and doubtless representing a tympano-jugal. The upper jaw is constituted of a long and slender stylet, the situation of which nearly corresponds with that of the intermaxillary, while the maxillary is wanting, unless we assume that the two bones are confounded. Slight, tooth-like granulations may be felt on both jaws, and two teeth, about two millimetres long, may be seen at the end of the mandible. The buccal orifice is, in consequence of this disposition, enormous, and is the introduction to a cavity of still more astonishing dimensions. The upper jaw is, in fact, united to the sides of the head and the fore part of the body by an extensible fold of the skin, which permits a considerable separation. Between the branches of the mandibles is extended an analogous but more dilatable membrane, containing, as is shown by histological examination, a great number of elastic fibers, in bundles, which may be compared to the pouch of the pelican. In consequence of the divergence of the jaws and the extensibility of the membranes, the mouth, with the pharynx, forms in the fresh animal a vast tunnel, of which the body of the fish seems to be a drawn-out continuation. It is presumed that food was accumulated, and partly digested, in this pouch.

The organs of locomotion are most rudimentary. The swimming-fins are reduced to two little appendages, situated near where the pec-

* From a paper read before the French Academy of Sciences.

toral fins should be; the ventral fins are wanting. A dorsal fin, which is prolonged to nearly the whole length of the back, without quite reaching the tail, begins at about the length of the head back of the occiput; the anal fin begins a short distance back of the anus, and



THE DEEP-SEA FISH EURYPHARYNX PELECANOIDES.

ends at the same point as the other. The extremity of the body is wrapped in a little membranous fold, a kind of caudal fin. The slender and flexible rays of these singular fins are not articulated, nor, so far as can be judged from the preserved specimen of the animal in liquor, are they connected by a membrane. Without engaging in a technical description of the organs of respiration, which are so far unique among bony fishes, or of the organs contained within the abdominal cavity, it is important to take notice of the complete absence of the swimming-bladder. This fish offers in certain features resemblances to the *Anacanthini*, to the *Scopelidæ*, the *Stomiadæ*, and to certain apodes, but has also characteristics which separate it distinctly from them. It must be regarded as the type of a new family, of which, unless it may be found to be related to the malacosteus, it is the only representative. I propose for it the name *Eurypharynx pelecanoides.*

GYMNASTICS.*

By ALFRED WORCESTER, A. M.

THE very name carries our thoughts back to the ancient Greeks, who provided for their children the most complete physical training that the world has ever known. Men and women alike took pains and pride in the development of perfect bodies, and their success, recorded in inimitable statues, affords models of human beauty and strength. In examining their system we discover much that is foreign to our civilization. We can not find the time for daily anointing with oil, powdering with dust, and long exercising in the sunshine—hardly time, indeed, for even an abridgment of their luxurious bathing ; and yet, till after we do devote time and care to the development of our physical natures, need we hope for anything like the splendid equipoise of the faculties that characterizes the Greek excellence of manhood. Passing now to Rome, we find early in her history the vigor always characteristic of a new race. It matters not how impoverished their ancestry, colonists cut off from the sloth of old centers of population, forced to battle with the earth itself for their support, soon retake the vigorous manhood their fathers gradually lost. And the Romans, in their turn, driven under the yoke by a sturdier race, proved no exception to the general rule that, as ease of living rises above a certain line, people deteriorate physically. That there is no underlying law of nature necessitating this result is proved by the Grecian training which raised the body to a far higher than any barbarian standard. In the age of chivalry we can find something of a similar physical excellence, and again its plain dependence upon a high estimate of the value of a perfect body and upon great pains taken for its procurement. As this age gave way before gunpowder and the Church, as men discovered the uselessness of heavy armor, battle-axe, cross-bow, and lance,

* An essay read before the Boylston Medical Society of Harvard University, December 15, 1882.

and as they were taught the doctrine of the necessity of body-mortification in order to perfection of soul, there prevailed a total disregard of the physical conditions necessary to our well-being. Even bathing was held to be a vanity of worldly savor, and gymnastics would doubtless have been considered worse than folly. This state of darkness lasted in Europe till the beginning of the present century, when Ling, of Sweden, after most persistent effort, succeeded in introducing his "movement-cure." For every one of the five hundred muscles, and for every imaginable disease, this system provided some kind of exercise. Its distinctive feature was its adaptability to diseased conditions, and there can be no doubt of its usefulness. As a means of cure it is still somewhat in use, and would probably be still more used were it not in the hands of those who make for it altogether unreasonable claims. And still, for those in search of the proper movements for exercising any given set of muscles, Ling's system, as set forth by Dr. Roth and many other of the great gymnast's disciples, furnishes abundant and explicit instruction. Also in the early years of this century, a system of physical training was introduced in Prussia by Jahn, not for the cure of disease, but for the development of strong, serviceable bodies. Strangely as it now sounds, Jahn's system was opposed by the Government, on the ground that it made the people less manageable, and more intolerant of church and state. Could better evidence be offered both of the good effect of gymnastics and also of the fearful ignorance that then prevailed of the value to the Church and to the state of a vigorous, healthy people? In spite of royal opposition, however, gymnastics grew in German popularity. The annual meetings of the Turnvereine, like the old Olympic festivals, fostered an enthusiasm for body-training, which, in turn, so far proved its worth to the state that in 1853 it became a recognized branch of public instruction. Since then, it will be remembered, Prussia's advance has been uninterrupted. To her armies Denmark, Austria, and France have in turn succumbed. Is it not possible that her glory is due to the thorough physical training of her children?

Coming now to our own country, we find by the year 1825 gymnastics taught in a private school at Northampton, Massachusetts, by a Professor Beck, who a few years later published a translation of Jahn's system. The school seems to have attracted considerable attention, but we can easily imagine how silly such artificial exercise must have seemed to those whose backs ached from their daily work. Little prepared were our New England parents to understand that, by this kind of exercise, backs and limbs could be developed that would easily carry burdens which untrained muscles would groan under. This same popular ignorance exists to-day. The majority still believe that hard manual labor affords better exercise than can any system of artificial gymnastics; whereas, instead of the equally developed elastic body resulting from gymnasium-training, we have in the laborers a stiff-jointed, clumsy, ill-proportioned body. In the fifty years since the introduction into this country of systematic body-training, there, nevertheless, has been great gain in the popular estimation of its advantages, as is shown by the almost countless systems that have received ephemeral patronage. Witness the innumerable pieces of gymnasium apparatus that have been advertised, and widely believed, to prevent or to cure all manner of woes and ills. At one time it is the spirometer, which, if blown into daily, will prevent consumption ; then it is a patent kind of lifting-machine by which a man may soon learn to lift a ton ; or rubber bands which deluded purchasers would surely find it easier to stretch as the rubber grew older. This long list of nostrums it is important for us to notice as in great measure accounting for the distrust many intelligent people have of the whole subject of gymnastics. In their ignorance they have believed the quacks, and, having suffered at least in purse, they now are shy of the subject in general. The fact is plain that their distrust is because more good has been claimed, and has been temporarily believed, to result from the use of one especial kind of exercise than could reasonably be expected from all kinds together. Honest efforts have meantime been made to introduce systematic exercise. Dio Lewis twenty years ago carried on in Boston a normal school of gymnastics. Several hundred teachers were graduated, and for a time were in considerable demand. Later, Dr. Lewis had a great girls' school in Lexington, where, in Bloomer dress and broad-soled boots, girls were certainly taught to walk long distances. The new system, as he called it, contained this principal innovation : Exercise was to be by couples holding rings or wands, and with music the doctor enthusiastically believed that he had borrowed all the charm of the dance, but it was found that, unlike dancing, in his evolutions all the fun was in learning how, and now his system is quite forgotten. In bringing our history of gymnastics down to date, it is necessary to mention the gymnasia of city clubs and colleges. Till within a few years a typical gymnasium of this sort was a medley collection of apparatus under the care of a janitor, who possibly knew something of the art of boxing. It was the fashion for the would-be gymnast to work at this or that according to fancy, always taking care, however, to exercise only his best-developed muscles. If a good vaulter, he spent his hour in vaulting ; if strong-armed, his exhibitions were on the swings and bar. These gymnasia would have been even less patronized except for the training in them of the sporting-men, who by general opinion were obliged to work diligently at some kind of machine if the next summer they were to beat other clubs and colleges on the field and river. Of their training and violent exercise little need be said, because they were so few, except that the wide-spread fear of harmful results from excessive exertion in these sports seems in the light of recent careful investigation to have been greatly exaggerated. The poverty in the results of these gymnasia was generally so disappointing that they were fast becoming unpopular, when happily the present successful system came in to supersede them. In order thoroughly to understand this new system one must experience its sure beneficent effects, which depend not upon newly-devised apparatus, although great improvements have been made in this respect, but upon the application of scientific principles in the employment of old methods, thereby combining all the possible advantages of every other system. Its main features are: First, a thorough physical examination of the person in comparison with the normal type, proper allowances being made for race, age, sex, and temperament. Second, carefully prescribed exercise to correct deformities and deficiencies, and to induce symmetrical development. Third, special directions as to proper times for exercise, and for care of the body after exercise. It will readily be understood that such a system requires professional oversight and direction. Before discussing the opportunities for profitable introduction of this system, let us consider its theoretical advantages and its practical results.

If, as may naturally be supposed, the human body is designed to meet the physical activity of life in simplest conditions, where all the muscles find necessary employment in procuring food and protection, then, in conditions of life where such necessity does not exist, it follows either that the body has unlimited power of adaptability, or that sooner or later in the deviation from primitive conditions the body will not naturally attain its maximum of possible vigor. The latter is, of course, our only conclusion; and it needs but to be pointed out that, in our present complicated civilization, where the demands upon nervous and mental force are so disproportionally great, this deviation is excessive and increasing, in order to emphasize the need of supplying artificially the lost conditions of maximum body strength. Our subject naturally divides, according to purposes, into exercise designed for the preservation, and into exercise designed for the development, of health and strength. Of the two subjects the latter is the more important. Once given a well-developed body in fine condition, and obedience to certain definite rules will keep it so; while, on the other hand, to bring about this condition is often impossible, and always demands skill and painstaking. No time may safely be wasted: the earlier the start and the more constant the care, the better are the possible results. A month's work in correcting a child's deficiencies or deformities may be worth years of such labor later on, when the skeleton is thoroughly ossified. And yet, although the plastic stage of youth is so much the more favorable time for such work, there is still such a willing response on Nature's part, that almost at any age our efforts in this direction are liberally rewarded.

In considering the results that may be expected from exercise directed to certain ends, let us take first the body framework. The shape of the bones most concerns us. When we remember the pliant condition of young bone and the manner of its growth at the epiphyses, how easy it is to imagine the advantage of regularly stretching the cartilage in the lines of the most serviceable shape and position of the future bone! We know how easily the thorax-walls, for instance, become misshapen from abnormal pressure within or without, even from lazy slouching; and we know too how quick and lasting is the "setting-up" of the West-Pointers. Their splendid carriage is due simply to the stretching of ligaments and cartilage, maintained till the natural equilibrium of muscular force is regained in the new position. Merely for æsthetic reasons this result is well worth the cost. Of far greater importance are the increase of chest-room and the greater resistance to fatigue thus gained.

In passing now to the theoretical advantages of regularly exercising the voluntary muscles, little consideration need be paid to the supposed advantage of increase in size. Muscles readily respond to increased demands by rapid growth in size, and, for those whose duties do not require large muscles, it is questionable if they are any better off with them. A blacksmith's arm may be considered rather as a superfluity if on a parson. For some sets of muscles the blacksmith and the parson, and in fact all people, have equal need, and, in order to be equally vigorous in their respective stations, the development that the blacksmith gains naturally must, by others leading a sedentary life, be obtained artificially. Of prime importance to all are both the voluntary and the involuntary muscles of respiration. So directly does our physical health depend upon their continued vigor, that nothing short of their highest possible development should satisfy us. Especially is this true of the abdominal muscles, which should give not only most valuable assistance in the mechanism of breathing, but also a support of exceeding value to the viscera. No other set of muscles has suffered more in the change from active to sedentary life. Corsets are proof of this. Fashion is by no means wholly responsible for their almost universal use. They do not come and go, but, in spite of all efforts at dress reform, corsets hold their sway, because their wearers feel better in them. This will continue to be the case until the muscles whose office they partially supply are developed by exercise designed to take the place of what is no longer naturally obtained.

It is not sufficient to have merely large muscles. Like raw troops, their usefulness depends upon constant discipline. This widely-recognized fact is often wrongly explained, as, for instance, by the theory that our nerves need exercising. In this age, nerves need no such stimulus. A much more probable theory is given by Maclaren, of Oxford, namely, that the potential energy of body-substance depends upon its *newness*, which may be explained by the facts that the potential energy of combustible material is directly proportional, and its chemical stability is inversely proportional, to its molecular complexity. There can be no doubt that this complexity, if not immediately, is then gradually, lessened in the animal economy. There are probably countless stages in the oxidation into urea of each particle of nitrogenous tissue, be it cell-wall or cell-protoplasm, and at each stage of the process the particle will have consequently less potential energy and greater chemical stability ; that is, less usefulness for the exhibition of vital phenomena. It is therefore impossible to lay up a permanent stock of physical vigor. Even if we should keep motionless as statues, our stock would steadily disappear. Not in size, but in quality, would come the great depreciation. Nature's own tendency to replace lost organic material with new teaches us how this depreciation may be avoided. In the body there is at best only a sluggish tendency to replace poor with better material, but by destroying that poor stuff we can arouse the organism into active efforts for its replacement. This is the philosophy of the advantage to muscles of regular exercise.

The full development and the continued vigorous condition of the circulatory system are of far more importance to the general health than are similar states of the voluntary muscles and the skeleton, whose importance is mainly in relation to the respiratory and circulatory systems. If we desire to possess maximum vigor, we must have large lung capacity, and, most of all, a stout heart and elastic arteries. In two great ways are the latter needs procured by physical exercise : First, in response to unusual demands there is an accelerated destruction of degenerating substance in the involuntary muscles of the heart and arterial walls, which, as we have seen, is requisite to the substitution of newer and more useful substance in them. Second, by the increased blood-tension, the coronary arteries and the vasa vasorum, in the intervals of dilatation, will carry more nourishment to the heart and arterial walls. It is hardly conceivable that a person, accustomed to regular physical exercise, should ever suffer from a fatty degenerated heart. And, with regard to this increased blood-tension gained in exercise, it is probable that it is productive of many other valuable results. For instance, the blood is drained from the overcharged brain, not merely as might be effected by venesection, thereby requiring an increased production, but by diverting its course into previously only half-dilated channels, whose sluggish currents now become swift streams of lively blood. And, again, in consequence of this heightened blood-tension, both the secretions and the excretions are increased, thereby developing the capacity of the glandular organs, and also directly aiding the body, both in the riddance of waste material and in the production of the necessary fluids. Of especial advantage, then, would be this increased blood-tension in aiding digestion. The circulation of the blood is, of course, directly aided during physical exercise by the rhythmical pressure of the muscles upon the veins, whose valves allow the blood to be driven only in the right direction.

In considering the effect of exercise upon the respiratory system, it is well understood that, in order faster to rid the body of waste gases and to obtain the needed oxygen, the respirations are increased in amount and frequency. Merely from this increased work the lung-tissue would be expected to increase; and there is still further influence to this end, from the pressure of air within the lungs, induced by forcibly holding the breath for a moment, as is naturally done at the inception of muscular exertion. This pressure must tend to dilate the alveoli to their full extent, and it also serves to aid the passage of oxygen through the membranes, and its solution by the blood.

Such, then, are some of the theoretical advantages of physical exercise. Let us now examine the results. Unfortunately, exact records of gymnasiums are as yet rare. Although indefinite reports are of comparatively little value, still it is possible to appeal to the personal experience of many to substantiate the claims made for systematic artificial exercise. And, indeed, it is only by this personal testimony that we can get at the indirect, yet perhaps the most valuable, results. No tabulations can represent the after-glow, and the consciousness of increased strength, purified blood, and cleared brain, which delightfully reward such exercise. Equally difficult would it be to describe the body alacrity so acquired, which, without stopping to discuss its origin, is a very valuable result, and never otherwise attainable. We are, however, not entirely dependent upon our own limited experience, nor upon indefinite statements of results. Though strangely few, we still have some unquestionable records of not slight deformities and deficiencies corrected. In searching for measurements that will even approximately represent the vigor of the body, we can not depend upon measurements of muscles, which can never be accurate, and, even if they were so, are no sure guide. The weight and height are also alone useless; but all these measurements taken into account, together with the muscular strength and the general character of the flesh, give a tolerably fair idea of the person's condition. If to these measurements be added the girth and expansive power of the chest, and the lung capacity, a far more accurate idea will be obtained; and the gain in these measurements, after regular terms of exercise, may fairly be assumed to represent its advantages. Taking now the most important measurements, we find reported from various gymnasiums an increase of two inches in passive girth of chest, of four inches in expansive power, and of fifty cubic inches in lung capacity. These gains have been obtained in six months' time, not only in college students, army officers, and school-boys, but also in city girls. Who can properly estimate the advantages of such increased breathing power? In enabling the fortunate gainer more easily to meet the wear and tear of daily duties, or the possible onslaught of acute disease, what invaluable assistance would be rendered by these fifty cubic inches of lung capacity!

As a preventive of disease, there can be no question of the advantageous results of exercise, and in this connection may be quoted the reports from Amherst College, which show a remarkable decrease in sickness since the introduction of compulsory gymnastics, and a decrease in the proportion of three sick in the freshman year to one sick in the senior year, as a result of four years' training. Another most excellent result mentioned in the same reports, which can not be too greatly emphasized, is the increase of the person's own regard for his body. After realizing the cost of physical strength, one is far less likely to waste it wantonly.

What has been said of the advantages of physical exercise in developing the body applies even more forcibly in regaining a vigorous condition after debilitating disease. For, while in growth we have natural tendencies toward excellent development, on the other hand in the convalescence of adults the only stimulus is that of needed strength; only by exertion can this stimulus be gained. To bring a convalescent fully up to par, more is needed than tonics and a nutritious diet. And if doctors oftener prescribed and required definite daily amounts of exercise, their patients' recoveries would be hastened, and the striking change for the better, now so often immediately following the doctors' dismissal, would then be less noticeable.

Especially applicable would such practice be in hospitals where patients are under stricter surveillance, but surrounded with less inducements to exercise themselves; comfortably cared for, with no necessity for exertion, it is often no easy job to rouse them to active recovery of strength. The added expense of a suitable gymnasium under competent supervision would, doubtless, be saved by the patient's shorter stay in the convalescent condition.

In the case of physical exercise, no exception will be found to the general rule that the efficacy depends upon the accuracy of the prescription.

Good results are not to be expected from careless following of careless advice. Those whose need is greatest are often the most loath to undertake any exercise, and hence such will be sure not to avail themselves of any indefinite instructions in this respect; while, on the other hand, some, out of over-conscientiousness or enthusiasm and in lack of explicit directions, are liable by overdoing to receive injury instead of benefit. It should be borne in mind that it is the physician's duty to teach his patients that they may so far as possible live intelligently as regards their own peculiar conditions. If in his trained observation there is on his patient's part a need for greater lung development, then every means should be taken to gain the patient's intelligent co-operation in securing this result.

If a well-appointed gymnasium is at hand, the physician should be as well able to prescribe the exact use of its different apparatus as he is to write for doses from the adjoining drug-store. Nor is it safer to depend upon the skill of the average gymnasium director, than it is upon the druggist, for particular instructions. It is as likely that one as the other would be able to recognize, for instance, the difference between functional and organic heart-murmurs, which would call for such fundamentally different treatment. If no gymnasium is at hand, the doctor should still be as well able to advise about the use of extemporized apparatus and the various forms of exercise without appatus as about the use of other domestic remedies. His prescriptions must be both intelligent and intelligible.

The opportunities for giving this advice are far greater than for giving any drug or all drugs put together. For long before and for long after there is any drug indication, there exists the plain, imperative need of physical exercise, even for those in perfect health who desire to keep that blessing. Either physicians must recognize the growing demands for professional advice as to such means of maintaining health or a new profession will arise to keep people out of the doctors' hands. Even now doctors are called upon for this advice, and it is a great mistake to suppose that the call demands little attention.

The grandest opportunity for the introduction of this new system of gymnastics is in the schools, where succeeding generations are molded. According to statistics, in only three in a thousand of the public schools of this country is any attention paid to physical training. Even a casual inspection of these schools, where entire attention is paid to mental development, reveals sufficient reasons for the abounding deficiencies and deformities which make almost conspicuous any well-formed man or woman. To say nothing of the debilitating influence of their commonly wretched hygienic surroundings, their entire lack of physical exercise as a corrective for the unnatural sedentary life that is forced upon them is cause sufficient for their poor bodily development.

It is a popular fallacy that the short recesses and the after-school play-hours can make up for the long school-sessions, during which the children must sit still and too often in a necessarily cramped position. The school-yard is generally so small and crowded that only the bolder boys dare run in it ; the timid, weakly boys and the girls dawdle away the precious minutes. And even the common sports of childhood do not furnish the right sort of exercise. Like that of tramping up the long stair-flights, and of going to and from the school, the exercise is mainly of the lower limbs, which in the unnatural conditions of civilization suffer least from disuse, and therefore stand in least need of artificial development. Invaluable as the play-hours are in relief from mental strain, the exercise thus afforded needs to be supplemented by such as will give the child the best possible body. Such exercise can easily be provided in the schools, and will be provided when parents awake to the fact that children's bodies as well as minds suffer from neglect, and become serviceable according to the care taken in their development.

WHY ARE WE RIGHT-HANDED?

By W. C. CAHALL, M. D.

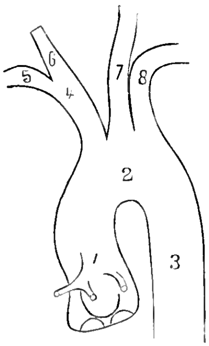
THE reader has no doubt often wondered why people almost invariably use their right hand in preference to the left. Is it not remarkable that, through all time and in all lands, man has been a right-handed being? The individual exceptions only prove the rule. What is the reason? It can not be simply imitation or heredity, for in those children who are disposed to use the left hand these influences will not avail in changing the inclination, even, in many instances, when supplemented by persuasion or force.

In my belief, there is a physical cause for this uniform habit—a cause that is demonstrable by anatomical and physiological facts. These, for the sake of brevity, are expressed in the following statements:

1. The brain (cerebrum) is divided into two hemispheres.

2. The nerve-force and nerve-fibers which produce muscular action on the one side of the body have their origin in the opposite hemisphere of the brain.

3. The left hemisphere, from the earliest period, is larger and heavier than its counterpart, and the convolutions of gray matter—the reservoirs of nervous energy—are more numerous on this side than on the right.



1, 2, 3, aorta.
1. Ascending part of aorta.
2. Transverse part and arch of aorta.
3. Descending part of aorta.
4. Innominate artery.
5. Right subclavian artery.
6. Right common carotid artery.
7. Left common carotid artery.
8. Left subclavian artery.

4. This superior development of the left hemisphere as to weight, size, and richness of convolutions, may be attributed to a peculiar arrangement of the blood-vessels, by means of which a greater blood-supply is distributed to the brain-substance of this side.

5. The arrangement of the blood-vessels to which I refer is the manner of origin of the right and left common carotid arteries. The carotid artery is a branch of the innominate artery on the right side, while it springs direct from the aorta on the left.

This directness of communication, in addition to a larger caliber of the left carotid, gives the left hemisphere a decided advantage in the race of development.

To reverse these statements we would have: as a consequence of the greater capacity of the left carotid the left hemisphere of the brain has a greater blood-supply; as a consequence, there is a greater development of the left hemisphere as to weight, bulk, and number of convolutions; as a consequence, when there is need of muscular action, the child naturally uses those muscles which possess the more powerful nerve-supply, for muscles are only strong in proportion to their nerve-supply; as a consequence, the nervous energy is dispatched, in those cases where there can be a choice, from the left hemisphere; as a consequence, the right hand and right leg will be the more likely used, since this side of the body is innervated by the left hemisphere. Thus, predisposition primarily, and use afterward, influencing and strengthening each other, fix upon us a habit almost unchangeable—how firmly, let those who ever attempted to break the habit in a left-handed boy testify.

But this leads to another question. Why are there left-handed people? Before we answer this question we will again look at the diagram. We have seen that, as the aorta rises from the heart, it arches from right to left, and the first large artery it gives off is the innominate, which in turn is divided into the right common carotid and right subclavian arteries. Farther on, we find the left common carotid and the left subclavian arteries arising separately from the aorta. Now, in making their dissections, anatomists have found that in a certain proportion of their subjects the aorta arches from left to right, in which cases the innominate is on the left side, and the common carotid and subclavian separate on the right. This arrangement would favor the growth of the right hemisphere, and would predispose to the use of the left hand.

Unfortunately, there have been no *post-mortem* examinations made for the purpose of observing whether this arrangement of blood-vessels and the use of the left hand really do occur in the same individual, nor is it necessary that it should be found in every case, for there are other anomalies in vessel-branching which would favor the growth of the right hemisphere. Apropos of speaking of the preponderance of the right over the left hemisphere, it might not be amiss to mention here that recent investigations have shown this condition of the brain to be characteristic of certain forms of insanity. This does not prove, however, that because a person is left-handed he is necessarily in any degree insane, as some *dexterous* reader may superciliously infer. Now, if the reason of our choice of a hand is due to an organic cause, how unwise is it to fight against nature, unless we commence at the beginning, and trust that habit will overcome the predisposition to the use of the left hand! Undertaken later, the result is often to spoil the skill of the left hand, without training the right to do its work as well. In conclusion, from what we have seen above, in answer to the question, Why are we right-handed? it might be said, because we are left-headed.

LENGTHENING THE VISIBLE SPECTRUM.

By JOHANNES GÖTZ.

THE phenomena of refraction and dispersion teach us that a body in a state of intensest heat emits not alone powerful thermal rays, but also all possible sorts of light (luminous colors). Diffraction convinces us that radiation is a wave-motion of an extremely fine, elastic, fluid medium, ether, and at the same time it enables us to compute the wave-length of the single rays. As is known, our apparatus suffices for taking cognizance of from one hundred and sixty to seven hundred and ninety billion undulations of heat or light per second, while all the vibrations of the ether lying either below or above are withdrawn from our direct observation. It is the purpose of this article to show what ways and means have been found for rendering the latter rays at least partly visible to our eye.

We throw a spectrum upon a white screen by means of a prism. The rays of the inferior number of undulations (ultra-red) will lie beyond the red, the superior (ultra-violet) beyond the violet end of the spectrum. We will begin with the latter.

We replace the screen, generally covered with ordinary white paper, by another one, the covering of which is impregnated with silver chloride, a combination of the two elements, chlorine and silver.* When the light has for some time operated upon this preparation, we interrupt it, and examine the screen by the light of a candle. We find that the coating has become blackened ; that the blackening is insignificant at the place where we formerly had red light, but that it increases the nearer we approach toward the violet end ; that it finally attains its maximum beyond this place, and gradually grows weaker until, at a certain distance, it disappears from the violet end. Whence this blackening ? By the operation of the ether-waves, the combination of chlorine and silver was dissolved, the chlorine passed into the air in the form of vapor, while the silver was precipitated in microscopically fine pearls upon the paper. The coating became black, because silver is not metallically lustrous in such minute division, but simply constitutes a black powder.

This experiment convinces us that rays will still be found beyond the violet end of the spectrum, which, on account of their high number of undulations, are shrouded from our sight, and yet betray their presence by the decomposition of silver preparations. These rays have been called *actinic* or *chemical rays*, and their spectrum the *chemical spectrum*.

* This and most of the following experiments succeed well only with a very great power of light. It is necessary, therefore, to sustain the lamp by a battery of from sixty to eighty elements. In the present case, sixty-four large Bunsen elements were employed.

Our proposition is, "May not these rays, even if only partially, be rendered visible to the eye?" Let us, for this purpose, shut out all the other vividly luminous colors of the spectrum, so that they shall not interfere, by their excess of illumination, with the feeble effect of the ultra-violet rays. We interpose a black screen in their path, and cut off all except the extreme violet ones. The ultra-violet rays now become visible upon the white screen;* we see them of a feebly lustrous lavender-gray.

This method of rendering the ultra-violet rays visible is extremely primitive. Stokes, the successor of the great Newton in the professor's chair of the University of Cambridge, indicated a means by which our object is attained much more effectively. He introduced a piece of calcic fluoride into the ultra-violet part of the spectrum, and found that this crystal began to shine brightly with a blue light. Before we attempt to elucidate this peculiarity, however, let us consider the influence of the motion of ether upon a body.

When a ray arrives upon the surface of a body, three things may be imagined: The ray is either reflected, or it is transmitted, or absorbed. We describe the first two cases as reflection and refraction. In the third case, the ray is absorbed, and serves for heating the body, which itself emits again the arriving motion of ether in the form of calorific rays.† Besides these three cases, another, a fourth one, is possible, to wit, that, although the arriving rays are absorbed, they are not wholly employed in the heating of the body, but are partly altered into rays of another number of waves, and are emitted again under their changed form. Stokes, who first investigated this alteration more minutely, named it fluorescence.

Investigations demonstrate that, besides the calcic fluoride, there are an entire series of fluid substances possessing this property of conversion: for instance, petroleum; again, the solution of the highly esteemed febrifuge—quinine sulphate; esculine, an extract of the bark of the common horse-chestnut; leaf-green, or chlorophyl; eosine, frequently used in the manufacture of red ink; and, finally, in a high degree, the solution of a substance discovered by Bayer, of Munich, fluoresceine (resorcinphtaline).

Let us get better acquainted with these fluorescing substances. Best for this purpose is a narrow glass tube, filled with rarefied air—a so-called Geissler's tube, surrounded by an envelope, containing solutions of such substances in four divisions (Fig. 1).

By means of the electric current we bring the inclosed air to a red heat. It emits whitish-violet light, which penetrates into the fluorescing solutions, and is by them partly transmitted and partly absorbed.

* In this experiment, the screen, impregnated with silver chloride, was replaced by a white one.

† The name of calorescence would be far more applicable to this peculiarity than to the one mentioned further below.

We find the transmitted light to be colored differently by the different fluids, but that these latter themselves begin to shine in different colors—for instance, eosine, green; quinine sulphate, blue. By the former, the transmitted light is red; by the latter, almost white. In both cases, consequently, the rays emanating from the red-hot gas were screened as it were, and the retained part converted into rays of another number of undulations, to wit, into green with eosine, and blue with quinine.

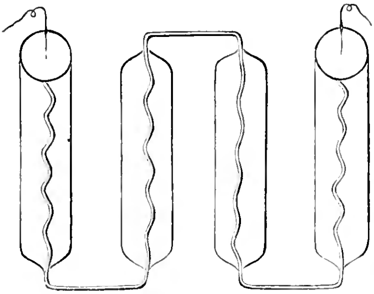


Fig. 1.

Far more intense and admirable in color become the appearances, when we make the powerful rays of the electric light parallel by means of a condensing lens, pass them through a square glass vessel filled with pure water, and to this add the substances by drops. We will begin with eosine. We pour a little of the solution into the water, and an admirable, vividly green-colored cloud at once spreads within the vessel. If we place a white screen behind the vessel, we find that the transmitted light appears red upon it. Eosine, consequently, possesses the property of only permitting the red rays to pass, and of altering them into green light, while absorbing all the others. We take fresh water, and repeat the experiment with fluoresceine. The green of the generated cloud now is far more vivid, while the transmitted light is yellow. We close the experiments with quinine sulphate. The cloud is colored delicately blue, but the transmitted light is pure white. Which rays were absorbed in this case? A later experiment will answer the question.

There is an occurrence very generally found in nature which is dissimilar in form, but analogous in essence, with the fluorescence. With fluorescent substances, the emission of light ceases as soon as illumination is interrupted. If light is thrown upon calcium preparations, a part of the rays is also absorbed, and altered into rays of another number of waves. But these preparations emit the absorbed rays partly only after the cessation of illumination. Owing to the weakness of the light emitted, it becomes visible only ofter the preparations have been placed in darkness. Since this peculiarity of subsequent illumination is analogous to the development of light occurring when a piece of phosphorus is rubbed in darkness, it has been called phosphorescence. Both the duration and intensity of this subsequent light depend upon the nature of the substances employed. There are those known, the light of which disappears very quickly after its emission, and again those by which the illumination lasts as long as eighteen hours—of course, while growing constantly feebler.

For the study of this phosphorescence we again make use of a

Geissler's tube, the exterior envelope of which contains four phosphorescent substances in four divisions (Fig. 2). By means of the electric current, we raise the temperature of the inclosed air to a glow-heat, and cause the emitted rays of light to operate for about a minute upon calcium salts.

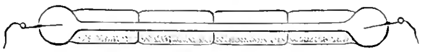


FIG. 2.

After interrupting the light, the salts appear in four different colors, to wit: orange, yellow, green, and blue. This property of phosphorescence is universally found in nature. I call to mind the glowing of decayed wood, that of fire-bugs, etc. Various inferior organisms are provided with special glands for secreting phosphorescent substance. During excitement this is exuded by the animal, and begins to emit light. The phosphorescent light of the tropical waters is produced by myriads of minute organisms, by which the substance is secreted.

An Englishman, Balmain, succeeded some time ago in manufacturing a substance of a fairly intense and durable phosphorescence. It is used for painting watch-dials, match-boxes, door-signs, etc., to make them self-illuminating. In tenor with the nature of things, these articles can discharge their functions only after they have previously been exposed to the light of day, or some other energetic source of light.

We have in this manner become acquainted with means of altering rays of one number of waves into those of another number, and we will employ these means of rendering the ultra-violet rays visible to the eye. For this purpose, we must seek for substances possessing the property of absorbing these ultra-red rays, in order to emit them as rays of an inferior number of undulations. Besides the calcic fluoride, the above-named solutions of quinine sulphate and of esculine will answer our purpose.

We again throw a spectrum in the above-described manner, and introduce a calcic fluoride crystal into the ultra-violet part. It begins at once to shine vividly with a blue light. A writing with cyanuret of barium and platinum upon white paper is invisible in ordinary white light, but, as soon as we expose it in the ultra-violet end of the spectrum, it emits greenish-blue light. Finally, if we throw the spectrum upon a screen, the paper covering of which is saturated with quinine sulphate, we shall at once observe that it extends largely beyond the violet end. The ultra-violet rays now begin to appear with a pale-blue color. By the operation upon the quinine sulphate, therefore, the invisible rays have been converted into visible, illuminating ones.

Deeply violet-colored glass possesses the property of transmitting only the extreme violet and ultra-violet rays, and absorbing all the others. We cause a pencil of white luminous rays to emanate from the incandescent carbon-points of an electric light, which, rendered parallel through a condensing lens, passes through a square glass vessel containing clear water. We introduce a pane of violet glass into its path. The illuminating radiation is cut off by it, and only a few violet rays are transmitted. The ultra-violet ones, however, are represented much more abundantly in the now invisible pencil. Their existence is revealed at once when we add a few drops of the quinine solution to the water. Bright blue-colored clouds now move within the vessel, generated by the quinine absorbing the ultra-violet rays and changing them into blue light. The appearance becomes still brighter by substituting the more energetic fluorescent esculine in place of the quinine.

If we draw a sketch * upon yellow paper with an esculine solution, it is invisible in daylight as well as by electric light. But if we insert the violet glass into the pencil-cone, the single parts of the picture begin to shine vividly with a blue light. The sketch flames up at once in the obscurity before our eye, and we might imagine that we have been transported into Fairy-land.

We have until now had our attention engaged with the ultra-violet rays ; it remains to speak of their practical adaptation. On account of their chemical effect upon the salts of silver, they constitute the basis of an important branch of industry—photography. As we have seen above, the red rays have almost no influence upon such preparations, while the effect of the yellow and green ones, when compared to that of the blue, violet, and ultra-violet, is not very great. Many mysteries of photography, incomprehensible to the layman, are explained hereby. A red and a black dress, for instance, are exactly alike upon a photograph, while blue and white, in their effect, approach nearer to white.

We now turn to the opposite end of the spectrum—the ultra-red rays. Our proposition is, "Are we able to render perceptible to the eye, the organ of sight, those rays that operate upon our sense of feeling simply as conveyers of heat?" We can attain our purpose only by augmenting the number of vibrations the thermal rays, by their influence upon suitable bodies, in such a manner that they are rendered perceptible to the visual organ. We provide the electric lamp with a parabolic reflector, A B, silvered and polished within, with incandescent carbon-points in its focus. The intense rays of the lamp are made parallel by the reflector, and pass through the room as a bright horizontal column. We recognize their course by the illuminated dust-particles of the air. We interpose another spherical reflector, C D, also silvered and polished, in the course of the rays. According to the law of reflection, all the rays falling upon the latter unite into one point, the focus (Fig. 3). It is easily recognized, since it brightly illuminates the dust-particles of the air. But not

* The one employed by Mr. W. Fried, of Augsburg, represents a Renaissance ornamentation, of about sixty centimetres in diameter.

alone the luminous, but also the thermal rays, are united at this point. We become convinced of this fact by holding a cigar at the focus: it is at once ignited, begins to smoke, and bursts into flame. In consequence of the concentration of the caloric rays, the most varied inflammable bodies may be ignited at this luminous point. Paper is perforated and charred in a moment, zinc consumes with a bright violet flame. Very thin, blackened platinum is brought to a white heat, and emits an intense white light. We place a test-tube filled with water within the focus; it begins at once to burst into bubbles, and commences to boil. Are these observed occurrences effected by the rays of heat or of light, emanating from the incandescent carbon-points? We answer this question by placing a body in the course of the rays, which, although it transmits the luminous rays, absorbs the thermal ones. Such a one is a concentrated solution of alum in water. We place a glass vessel, filled with this perfectly transparent solution, between the two reflectors, and in this manner sift the rays emanating from the carbon-points. The luminous focus is still there, but the ebullition of the water in the test-tube ceases at once. We remove the vessel, and ebullition is resumed with violence. Those rays, therefore, that caused the boiling were absorbed by the alum solution. This had meanwhile been raised in temperature, and, if left sufficiently long, it would begin to boil. We return the solution into the path of the rays, and place white paper within the focus. It is illumined brightly, but not consumed. We repeat the experiment with gun-cotton wrapped in white paper. It might lie there for a hundred years without exploding. We remove the vessel, and explosion occurs at once. We continue the experiment with black paper, by bringing it into the focus of the rays sifted through the solution, when it is at once perforated and ignited. Gun-cotton wrapped in black paper explodes almost instantly. Why is it that the same rays that left white paper intact at once ignite black? The luminous radiation transmitted by the solution is not absorbed, but reflected, by the white paper. It is brightly illumined, but not heated. Black paper, however, absorbs these rays, is heated thereby, and ignites.

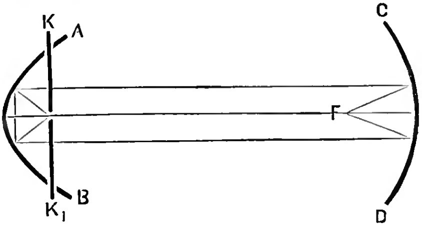


FIG. 3.

The preceding experiments convince us that the combustion and heating of bodies in the focus are solely caused by the dark rays emitted by the carbon-points. We confirm this conviction by introducing into the path of the rays a body transmitting the dark radiation with the greatest facility, while completely absorbing the luminous one. According to Tyndall's experiments, this condition is complied with to a very high degree by a solution of iodine in carbonic disulphide.

We introduce a very thin-walled glass cell, filled with such a solution, between the reflectors. Light is now cut off, but heat passes through freely. The focus is absolutely dark, but it still contains heat, of which fact we can soon convince ourselves by introducing a cigar into it: it is ignited and bursts into flame. White as well as black paper is charred and ignites in it. A piece of platinum-foil is raised to white heat in the dark focus. If we examine the incandescent platinum with a prism, we find that it emits again all colors, from the most extreme red to the most extreme violet; consequently, we have here the counterpart of fluorescence. The dark rays, by the augmentation of the number of vibrations, are converted into luminous ones, influencing the eye. Tyndall, who first observed and examined this appearance, called the conversion calorescence.

We have thus passed through a domain of physics, the more exact knowledge of which we mainly owe to the researches of our century, more especially to very recent times. That part of radiation perceptible to our organs of sense was extended far beyond the violet end of the spectrum, in investigating the chemical effects of light and fluorescence. We succeeded at the same time in rendering visible that part simply felt by the eye. It can not for a moment be supposed that there are no more rapid or slow rays, besides those already known to us, and ranging in the number of vibrations from one hundred and sixty to two thousand billions. Their existence can just as little be doubted as that of the ultra-violet. Whether we shall ever succeed in rendering them perceptible to our organs of sense remains a task for the investigations of the future.—*Westermann's Monatshefte.*

THE BOUNDARIES OF ASTRONOMY.

I.

IS GRAVITATION UNIVERSAL?

By ROBERT S. BALL,
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IT is proposed in this and the following paper to trace some parts of the boundary-line which divides the truths which have been established in astronomy from those parts of the science which must be regarded as more or less hypothetical. It will be obvious that only a small part of so wide a subject can be discussed, or even alluded to, in the limits proposed. We intend, therefore, to select certain prominent questions, and to discuss those questions with such fullness as the circumstances will admit.

It will be desirable to commence with that great doctrine in astronomy which is often regarded as almost universally established.

The doctrine to which we refer is known as the law of universal gravitation. It is customary to enunciate this law in the proposition that every particle of matter attracts every other particle with a force which varies directly as the product of the masses and inversely as the square of their distance. It is no doubt convenient to enunciate the great law in this very simple manner. It might seem awkward to have to specify all the qualifications which would be necessary if that enunciation is to assert no more than what we absolutely know. Perhaps many people believe, or think they believe, the law to be true in its general form ; yet the assertion that the law of gravitation is *universally* true is an enormous, indeed, an infinite, exaggeration of the actual extent of our information.

To make this clear, let us contrast the law of gravitation as generally stated with the proposition which asserts that the earth rotates on its axis. No one who is capable of understanding the evidence on the question can doubt that the earth really does rotate upon its axis. I purposely set aside any difficulties of a quasi-metaphysical character, and speak merely of words in their ordinary acceptation. In stating that the earth rotates upon its axis, we assert merely a definite proposition as regards one body, all the facts which the assertion involves are present to our minds, and we know that the assertion must be true. Equally conclusive is the evidence for the statement that the earth revolves around the sun. Concrete truths of this kind could be multiplied indefinitely. We can make similar assertions with regard to the planets. We can assert that the planets rotate upon their axes, and that the planets revolve around the sun. But the law of gravitation is a proposition of quite a different nature. Let us examine briefly the evidence by which this law has been established.

The science of dynamics is founded upon certain principles known as the laws of motion. The simplest of these principles asserts that a body, once set moving in a straight line, will continue to move on uniformly forever in the same straight line, unless some force be permitted to act upon that body. For nature as we know it, this law seems to be fully proved. It has been tested in every way that we have been able to devise. All these tests have tended to confirm that law. The law is therefore believed to be true, at all events throughout the regions of space accessible to us and to our telescopes. Assuming this law and the other principles analogous to it, we can apply them to the case of the revolution of the earth around the sun. As the earth is not moving in a straight line, it must be acted upon by some force. It can be shown that this force must be directed toward the sun. It will further appear that the intensity of this force will vary inversely as the square of the distance between the earth and the sun. The movements of the planets can be made to yield the same conclusions. All these movements can be accounted for on the supposition that each planet is attracted by the sun with a force which varies directly as the product of the masses, and inversely as the square of the distance between the two bodies. When more careful observations are introduced, it is seen that the planets exhibit some slight deviations from the movements which they would have were each planet only acted upon by the attraction of the sun. These deviations do not invalidate the principle of attraction. They have been shown to arise from the mutual attractions of the planets themselves. Each of the planets is thus seen to attract each of the other planets. The intensity of this attraction between any pair of the planets is proportional to the masses of these planets, and varies inversely as the square of the distance between them. We may use similar language with regard to the satellites by which so many of the planets are attended. Each satellite revolves around its primary. The movements of each satellite are mainly due to the preponderating attraction of the primary. Irregularities in the movements of the satellites are well known to astronomers, but these irregularities can be accounted for by the attraction of other bodies of the system. The law of attraction thus seems to prevail among the small bodies of the system as well as among the large bodies. It is true that there are still a few outstanding discrepancies which can not yet be said to have been completely accounted for by the principle of gravitation. This is probably due to the difficulties of the subject. The calculations which are involved are among the most difficult on which the mind of man has ever been engaged. We may practically assume that the law of gravitation is universal between the sun, the planets, and the satellites; and we may suppose that the few difficulties still outstanding will be finally cleared away, as has been the case with so many other seeming discrepancies. But even when these admissions have been made, are we in a position to assert that the law of gravitation is universal throughout the solar system? We are here confronted with a very celebrated difficulty. Do those erratic objects known as comets acknowledge the law of gravitation? There can be no doubt that in one sense the comets do obey the law of gravitation in a most signal and emphatic manner. A comet usually moves in an orbit of very great eccentricity; and it is one of the most remarkable triumphs of Newton's discovery, that we were by its means able to render account of how the movements of a comet could be produced by the attraction of the sun. As a whole, the comet is very amenable to gravitation, but what are we to say as to the tails of comets, which certainly do not appear to follow the law of universal attraction? The tails of comets, so far from being attracted toward the sun, seem actually to be repelled from the sun. Nor is even this an adequate statement of the case. The repulsive force by which the tails of the comets are driven from the sun is sometimes a very much more intense force than the attraction of gravitation.

I have no intention to discuss here the vexed question as to the origin of the tails of comets. I do not now inquire whether the repulsion by which the tail is produced be due to the intense radiation from the sun, or to electricity, or to some other agent. It is sufficient for our present purpose to note that, even if the tails of comets do gravitate toward the sun, the attraction is obscured by a more powerful repulsive force.

The solar system is a very small object when viewed in comparison with the dimensions of the sidereal system. The planets form a group nestled up closely around the sun. This little group is separated from its nearest visible neighbors in space by the most appalling distances. A vessel in the middle of the Atlantic Ocean is not more completely isolated from the shores of Europe and America than is our solar system from the stars and other bodies which surround it in space. Our knowledge of gravitation has been most entirely obtained from the study of the bodies in the solar system. Let us inquire what can be ascertained as to the existence of this law in other parts of the universe. Newton knew nothing of the existence of the law of gravitation beyond the confines of the solar system. A little more is known now.

Our actual knowledge of the existence of gravitation in the celestial spaces outside the solar system depends entirely upon those very interesting objects known as binary stars. There are in the heavens many cases of two stars occurring quite close together. A well-known instance is presented in the star Epsilon Lyræ, where two stars are so close together that it is a fair test of good vision to be able to separate them. But there are many cases in which the two stars are so close together that they can not be seen separately without the aid of a telescope. We may take, for instance, the very celebrated double star Castor, well known as one of the Twins. Viewed by the unaided eye, the two stars look like a single star, but in a moderately good telescope it is seen that the object is really two separate stars quite close together. The question now comes as to whether the propinquity of the two stars is apparent or real. It might be explained by the supposition that the two stars were indeed close together compared with the distance by which they are separated ; or it could be equally explained by supposing that the two stars, though really far apart, yet appeared so nearly in the same line of vision that when projected on the surface of the heavens they seemed close together. It can not be doubted that in the case of many of the double stars, especially those in which the components appear tolerably distant, the propinquity is only apparent, and arises from the two stars being near the same line of vision. But it is, also, undoubtedly true that in the case of very many of the double stars, especially among those belonging to the class which includes Castor, the two stars are really at about the same distance from us, and, therefore, as compared with that distance, they are really close together.

Among the splendid achievements of Sir William Herschel, one of the greatest was his discovery of the movements of the binary stars. It was shown by Herschel that in some of the double stars one star of the pair was moving around the other, and that their apparent distances were changing. The discoveries inaugurated by Herschel have been widely extended by other astronomers. One of the more rapidly moving of the double stars lies in the constellation of Coma Berenices. The revolution of one component around the other requires a period of 25·7 years. The two components of this star are exceedingly close together, the greatest distance being about one second of arc. There is very great difficulty in making accurate measurements of a double star of which the components are so close. More reliance may consequently be placed upon the determination of the orbits of other binary stars of which the components are farther apart. Among these we may mention the remarkable binary star ξ Ursæ Majoris. The distance between the two components of this star varies from one second of arc to three seconds. The first recorded measurement of this object was by Sir William Herschel, in 1781, and since that date it has been repeatedly observed. From a comparison of all the measurements which have been made it appears that the periodic time of the revolution of one of these components about the other is about sixty years. This star has thus been followed through more than one entire revolution. The importance of these discoveries became manifest when an attempt was made to explain the movements. It was soon shown that the movements of the stars were such as could be explained if the two stars attracted each other in conformity with the law of gravitation. It would, however, be hardly correct to assert that the discovery of the binary stars proved that the two stars attracted each other with a force which varies inversely as the square of their distance. Even under the most favorable circumstances the observations are very difficult; they can not be made with the same accuracy as is attained in observing the movements of the planets; they have not even the value which antiquity will often confer on an observation which has not much else in its favor. There are probably many different suppositions which would explain all that has yet been observed as to the motions of the binary stars. Gravitation is but one of those suppositions. Gravitation will no doubt carry with it the prestige acquired by its success in explaining phenomena in the solar system. I do not know that any one has ever seriously put forward any other explanation except gravitation to account for the movements of the binary stars, nor is any one likely to do so while gravitation can continue to render an account of the observed facts; but all this is very different from saying that the discovery of the binary stars has *proved* that the law of gravitation extends to the stellar regions.

Except for what the binary stars tell us, we would know nothing as to the existence or the non-existence of the law of gravitation beyond the confines of the solar system. Does Sirius, for instance, attract the pole-star? We really do not know. Nor can we ever expect to know. If Sirius and the pole-star do attract each other, and if the law of their attraction be the same as the law of attraction in the solar system, it will then be easy to show that the effect of this attraction is so minute that it would be entirely outside the range of our instruments even to detect it. Observation is hopeless on such a matter. If we can not detect any attraction between a star in one constellation and a star in another, no more can we detect any attraction between our sun and the stars. Such attractions may exist, or they may not exist: we have no means of knowing. Should any one assert that there is absolutely no gravitation between two bodies more than a billion miles apart, we know no facts by which he can be contradicted.

If we know so little about the existence of gravitation in the space accessible to our telescopes, what are we to say of those distant regions of space to which our view can never penetrate? Let a vast sphere be described of such mighty dimensions that it embraces not only all the objects visible to the unaided eye, not only all the objects visible in our most powerful telescopes, but even every object that the most fertile imagination can conceive, what relation must this stupendous sphere bear to the whole of space? The mighty sphere can only be an infinitely small part of space. It must bear to the whole of space a ratio infinitely less than the water in a single dew-drop bears to the water in the Atlantic Ocean. Are we then entitled to assert that every particle in the universe attracts every other particle with a force which is proportional to the product of their masses, and which varies inversely as the square of their distance? We have, indeed, but a slender basis of fact on which to rest a proposition so universal. Let us attempt to enunciate the law of gravitation so as to commit ourselves to no assertion not absolutely proved. The statement would then run somewhat as follows:

Of the whole contents of space we know nothing except within that infinitely small region which contains the bodies visible in our telescopes. Nor can we assert that gravitation pervades the entire of even this infinitely small region. It is true that in one very minute part of this infinitely small region the law of gravitation appears to reign supreme. This minute part is of course the solar system. There are also a few binary stars in this infinitely small region whose movements would admit of being explained by gravitation, though as yet they can hardly be held to absolutely prove its existence.

It must then be admitted that, when the law of gravitation is spoken of as being universal, we are using language infinitely more general than the facts absolutely warrant. At the present moment we only know that gravitation exists to a very small extent in a certain indefinitely small portion of space. Our knowledge would have to be enormously extended before we can assert that gravitation extended entirely through this very limited region; and, even when we have proved this, we should have only made an infinitesimal advance to a proof that gravitation is absolutely universal.

I do not for a moment assert that our ordinary statement of the law of gravitation is untrue. I merely say that it has not been proved, and we may also add that it does not seem as if it ever could be proved. Most people who have considered the matter will probably believe that gravitation is universal. Nor is this belief unnatural. If we set aside comets' tails, and perhaps one or two other slightly doubtful matters, we may assert that we always find the law of gravitation to be true whenever we have an opportunity of testing it. These opportunities are very limited, so that we have but very slender supports for the induction that gravitation is universal. But it must be admitted that an hypothesis which has practically borne every test which can be applied has very strong grounds for our acceptance: such, then, are the claims of the law of gravitation to be admitted to a place among the laws of Nature.

The wondrous series of spectroscopic researches by which Mr. Huggins has so vastly extended our knowledge should also be here referred to. Mr. Huggins has shown that many of the substances most abundant on the earth are widely spread through the universe. Take, for instance, the metal iron and the gas hydrogen. We can detect the existence of these elements in objects enormously distant. Both iron and hydrogen exist in many stars, and hydrogen has been shown, in all probability, to be an important constituent of the nebulæ. That the rest of the sidereal system should thus be composed of materials known to be to a large extent identical with the materials in the solar system is a presumption in favor of the universality of gravitation.

In what has hitherto been said, we have attempted to give an outline of the facts so far as they are certainly known to us. Into mere speculations we have no desire to enter. We may, however, sketch out a brief chapter in modern sidereal astronomy, which seems to throw a ray of light into the constituents of the vast abyss of space which lies beyond the scope of our telescopes. The ray of light is no doubt but a feeble one, but we must take whatever information we can obtain, even though it may fall far short of that which an intellectual curiosity will desire. The question now before us may be simply stated: Are we entitled to suppose that the part of the universe accessible to our telescopes is fairly typical of the other parts of the universe; or are we to believe that the system we know is altogether exceptional; that there are stars in other parts quite unlike our stars, composed of different materials, acted upon by different laws, of which we have no conception? The presumption is, that the materials of which our system is composed are representative of the materials elsewhere. This presumption is strengthened by the very important considerations now to be adduced.

In the first place, let us distinctly understand what is meant by our sidereal system. We have already dwelt on the isolated position of the sun and the attendant planets. The grandest truth in the whole of astronomy is that which asserts that our sun is only a star separated by the most gigantic distances from the other stars around. Our sun, indeed, appears to be but one of the vast host of stars which form the milky way. We need not here enter into the often-discussed question as to whether the nebulæ are, generally speaking, at distances of the same order as the stars. There seems to be no doubt that some of the nebulæ are quite as near to us as some of the stars. At all events, for our present purpose, we may group the milky way, the nebulæ, the stars, and the clusters, all into one whole which we call our sidereal system. Is this sidereal system as thus defined an isolated object in space? are its members all so bound together by the law of universal gravitation that each body, whatever be its movements, can only describe a certain path such that it can never depart finally from the system? This is a question of no small importance. It presents features analogous to certain very interesting problems in biology which the labors of Mr. Wallace have done so much to elucidate. We are told that the fauna and flora of an oceanic island, cut off from the perpetual immigration of new forms, often assumes a very remarkable type. The evolution of life under such circumstances proceeds in a very different manner to the corresponding evolution in an equal area of land which is connected with the great continental masses. Is our sidereal system to be regarded as an oceanic island in space, or is it in such connection with the systems in other parts of space as might lead us to infer that the various systems had a common character?

The evidence seems to show that the stars in our system are probably not permanently associated together, but that in the course of time some stars enter our system and other stars leave it, in such a manner as to suggest that the bodies visible to us are fairly typical of the general contents of the universe. The strongest evidence that can be presented on this subject is met with in the peculiar circumstances of one particular star. The star in question is known as No. 1830 of Groombridge's catalogue. It is a small star, not to be seen without the aid of a telescope. This star is endowed with a very large proper motion. It would not be correct to say that its proper motion exceeds that of any other known star, but it certainly has the largest visible proper motion of any star of which the distance is known. The proper motion of 1830 Groombridge amounts to over seven seconds annually. It would take between two and three centuries to move over a distance in the heavens equal to the apparent diameter of the moon. The distance of this star is much greater than might have been anticipated from its very large proper motion. The estimates of the distance present some irregularities, but we shall probably be quite correct in assuming that the distance is not less than two hundred billions of miles. This star is, indeed, ten times as far from us as *α* Centauri, which is generally considered to be the sun's nearest neighbor in our sidereal system. The proper motion and the distance of 1830 Groombridge being both assumed, it is easy to calculate the velocity with which that star must be moving. The velocity is indeed stupendous and worthy of a majestic sun; it is no less than 200 miles a second. It would seem that the velocity may even be much larger than this. The proper motion of the star which we see is merely the true proper motion of the star foreshortened by projection on the surface of the heavens. In adopting 200 miles a second as the velocity of 1830 Groombridge, we therefore make a most moderate assumption, which may and probably does fall considerably short of the truth. But, even with this very moderate assumption, it will be easy to show that 1830 Groombridge seems in all probability to be merely traveling through our system, and not permanently attached thereto.

The star sweeps along through our system with this stupendous velocity. Now, there can be no doubt that if the star were permanently to retain this velocity, it would in the course of time travel right across our system, and, after leaving our system, would retreat into the depths of infinite space. Is there any power adequate to recall this star from the voyage to infinity? We know of none, unless it be the attraction of the stars or other bodies of our sidereal system. It therefore becomes a matter of calculation to determine whether the attraction of all the material bodies of our sidereal system could be adequate, even with universal gravitation, to recall a body which seems bent on leaving that system with a velocity of 200 miles per second. This interesting problem has been discussed by Professor Newcomb, whose calculations we shall here follow. In the first place, we require to make some estimate of the dimensions of the sidereal system, in order to see whether it seems likely that this star can ever be recalled. The number of stars may be taken at one hundred million, which is probably double as many as the number we can see with our best telescopes. The masses of the stars may be taken as on the average five times as great as the mass of the sun. The distribution of the stars is suggested by the constitution of the milky way. One hundred million stars are presumed to be disposed in a flat, circular layer of such dimensions that a ray of light would require thirty thousand years to traverse one diameter. Assuming the ordinary law of gravitation, it is now easy to compute the efficiency of such an arrangement in attempting to recall a moving star. The whole question turns on a certain critical velocity of twenty-five miles a second. If a star darted through the system we have just been considering with a velocity less than twenty-five miles a second, then, after that star had moved for a certain distance, the attractive power of the system would gradually bend the path of the star round, and force the star to return to the system.

If, therefore, the velocities of the stars were under no circumstances more than twenty-five miles a second, then, supposing the system to have the character we have described, that system might be always the same. The stars might be in incessant motion, but they must always remain in the vicinity of our present system, and our whole sidereal system might be an isolated object in space, just as our solar system is an isolated object in the extent of the sidereal system. We have, however, seen that for one star at all events the velocity is no less than 200 miles a second. If this star dash through the system, then the attractions of all the bodies in the system will unite in one grand effort to recall the wanderer. This attraction must, to some extent, be acknowledged; the speed of the wanderer must gradually diminish as he recedes into space; but that speed will never be lessened sufficiently to bring the star back again. As the star retreats farther and farther, the potency of the attraction will decrease; but, owing to the velocity of the star being over twenty-five miles a second, the attraction can never overcome the velocity; so that the star seems destined to escape. This calculation is of course founded on our assumption as to the total mass of the stars and other bodies which form our sidereal system. That estimate was founded on a liberal, indeed, a very liberal interpretation of the evidence which our telescopes have afforded. But it may still fall short of the truth. There may be more than a hundred million stars in our system: their average weight may be more than five times the weight of our sun. But, unless the assumption we have made is enormously short of the truth, our inference can not be challenged. If the stars are sixty-four times as numerous, or if the whole mass of the system be sixty-four times as great as we have supposed, then the critical velocity would be 200 miles a second instead of twenty-five miles a second. Our estimate of the system would therefore have to be enlarged sixty-four-fold, if the attraction of that system is to be adequate to recall 1830 Groombridge. It should also be recollected that our assumption of the velocity of the star is very moderate, so that it is not at all unlikely that a system at least one hundred times as massive as the system we have supposed would be required if this star was to be recalled. The result of this inquiry is really only to be stated as an alternative: either our sidereal system is not an entirely isolated object, or its bodies must be vastly more numerous or more massive than even our most liberal interpretation of observations would seem to warrant. It seems more reasonable to adopt the first branch of the alternative. If this be so, then we see that 1830 Groombridge, having traveled from an indefinitely great distance on one side of the heavens, is now passing through our system for the first and the only time. After leaving our system this star will retreat again into the depths of space, to a distance which, for anything we can tell, may be practically regarded as infinite. Although we have only used this one star as an illustration, yet it is not to be supposed that the peculiarities which it presents are absolutely unique. It seems more likely that there may be many other stars which are at present passing through our system. In fact, considering that most or all of the stars are actually in motion, it can be shown that, in the course of ages, the whole face of the heavens is gradually changing. We are thus led to the conclusion that our system is not an absolutely isolated group of bodies in the abyss of space, but that we are visited by other bodies coming from the remotest regions of space.—*Contemporary Review.*

ON BRAIN-WORK AND HAND-WORK.

By R. M. N.

DR. BEARD'S treatise on the "Longevity of Brain-Workers" was ably reviewed some years ago in the "Journal of Science." Still it appears to me that the last word on this topic has not yet been said. Certain points, both of distinction and of resemblance, seem to have been overlooked as well by reviewer as by author, and certain of the conclusions drawn are at least open to question.

I may perhaps be allowed to put the opening question, What is work? The common reply is, "Any pursuit by which a man earns or attempts to earn a livelihood and to accumulate wealth." This definition is the more to be regretted because it cherishes, or rather begets, the vulgar error that all persons who do not aim at the accumulation of wealth are "idlers." In point of fact such men may be doing far greater services to the world than the most diligent and successful votary of a trade or a profession. Darwin, having a competency, was therewith content. To him, and to others of kindred minds, the opportunity of devoting his whole life to the search after scientific truth was a boon immeasurably higher than any conceivable amount of wealth. Shall we call him an idler? Nor is science the only field which opens splendid prospects to men of independent means. Art, literature, philanthropy, have all their departments, unremunerative in a commercial point of view, or at least not directly remunerative, and for all these cultivators are wanted. Therefore, reversing the advice given by routine moralists, I would say to wealthy young men of ability: "Do not take up any trade, business, or profession, but do some of the world's unpaid work. Leave money-making to those who have no other option, and be searchers for truth and beauty." Every one who follows this advice will contribute something to show the world that the race for wealth is not the only pursuit worthy of a rational being. I should define work as the conscious systematic application of mind or body to any definite purpose.

I said "of mind or body." Perhaps the expression may sound old-fashioned; so, to avoid grating on the nerves of a monistic world, I will say "of brain or muscle." But can we draw a sharp, well-defined boundary-line between brain-work and muscle-work? Recent investigations into the functions of the brain show that it has the task of directing and co-ordinating muscular effort. The athlete, or say the musical performer, has not merely to strengthen his muscles and acquire flexibility of arm, hand, and finger; his exercises serve at the same time to develop and perfect those regions of the brain by which the muscles in question are actuated and co-ordinated.

Professor Du Bois-Reymond, in his admirable articles on "Exercise" ("Popular Science Monthly" for July and August, 1882), contends that "bodily exercises are not merely muscle-gymnastics, but also nerve-gymnastics," and that practice in the movements of the limbs is "essentially exercise of the central nerve-system." Hence muscle-work which is not at the same time brain-work is a chimera, which has no existence. But it will now be asked, Is there any brain-work without muscle-work? Undoubtedly; we may see phenomena, we may reason upon them, and come to a conclusion concerning their nature without any muscular action at all. But if we even wish to write down our results, or to tell them to a friend, some muscular action, small though it be, is needed. Or we wish to go further: not content with merely observing the phenomena which chance brings before our eyes, we go forth in search of facts. Here muscular-work is blended with brain-work. A step further: We wish to put definite questions to Nature, to perform physical, chemical, or physiological experiments. In all these cases the hand has to be the inseparable companion of the brain. The efficiency of the one will not compensate for inefficiency in the other. Now, the work of the experimentalist rarely requires great strength, but it invariably stands in need of delicacy, nicety of touch and movement, bodily or, if you will, muscular, attributes to be reached only by training.

It is the same in the fine arts. The painter needs not merely an exquisite perception of form and color, an instinctive—as it appears to outsiders—appreciation of their relations and harmonies; unless he possesses in addition to all this the requisite nicety of touch, he must fail to embody in visible form the conceptions present in his brain. Precisely the same is it with the musician. The orator and the actor must also, in addition to their mere mental gifts, have vocal organs thoroughly developed and disciplined. Thus we see that in the highest walks of science and art, brain-work and muscle-work exist, I might say, in a state of interpenetration.

Again, at a work-table in Y—— Street sits a microscopist, carefully studying the peculiarities of a newly detected microbion, or dissecting the larva of the Phylloxera. What is he? Brain-worker, or muscle-worker? You pronounce him a brain-worker; his brain, in your opinion, doing the larger—the essential—part of his task. So be it. I convey you to X—— Street, where at another work-table sits a microscope-maker. He is accurately adjusting an objective of high power. What is he? Like the user of the microscope just mentioned, he requires the utmost delicacy of touch, the highest manipulative skill. Like the microscopist, also, his brain performs the essential part of the task. But you will probably call him a hand-worker or muscle-worker, because he is a mechanic!

Surely, then, we must admit that there is no hard and fast boundary between the brain-worker and the muscle-worker. There is no muscle-work without brain-work; there is little brain-work of a high order without muscle-work.

There are, however, gradations. There are kinds of muscle-work, so simple, so monotonous or uniform in their character, that they are, with very little practice, performed automatically, with no conscious effort of the brain. Such, for instance, is the work of the agricultural laborer in digging, mowing, thrashing, etc., or of the hodman carrying bricks and mortar up a ladder. All such work, it is generally found, can be performed by means of machinery. Perhaps this may enable us to find a definition, or rather a limit, for muscle-work.

I must now ask what classes of society can rank as brain-workers. Dr. Beard seems to include here, clergymen, lawyers, physicians, merchants, scientists, and men of letters. He does not make any mention of artists, teachers of different branches of knowledge, manufacturers, etc. Now, if the merchant, the man who distributes, fetches, and carries, is to rank as a brain-worker, surely must the producer, who much more frequently originates out of his own mind something new to the world. We may also ask, Does the term merchant include the retail dealer, the clerk, and the commercial assistant? If so, we find the brain-working class re-enforced by a number of persons who certainly have little need for muscular exertion, but little also for brain-work, and many of whose tasks and duties might be performed by machinery. Again, where are we to place the speculator, the gambler, and the forger? Muscle-workers they are only to a very small extent, though the forger requires a wonderful amount of manipulative skill. He must, however, be regarded as a doomed species, since the Nesbit patent safety-check carries in it the germs of his destruction.

It becomes very difficult to say with accuracy who are to be classed as brain-workers and who as muscle-workers, and, still more, who are to be referred to Dr. Beard's third class, "those who follow occupations that call both muscle and brain into exercise." This class, as I have endeavored to show, includes almost every one who works at all. Until we are able to furnish a correct classification of mankind as brain-workers and muscle-workers, it will be very difficult to enunciate any true and valuable proposition concerning either group.

Twenty years ago, Dr. Beard laid down among others the following set of propositions: That the brain-working classes—clergymen, lawyers, physicians, merchants, scientists, and men of letters—live very much longer than the muscle-working classes; that the greatest and hardest brain-workers of history have lived longer on the average than brain-workers of ordinary ability and industry; that clergymen are longer-lived than any other great class of brain-workers.

The first of these propositions admits of statistical proof or disproof. The life-lengths of the classes of men above mentioned can be ascertained, and their average duration compared with the mean length of life prevalent in their times and countries. But is the superior longevity of these classes due to the fact that they are brain-workers, or must it not be traced to a complication of causes? If brain-work is *per se* salutary and conducive to long life—which I do not deny—and if, as we may gather from Dr. Beard's second proposition here given, its beneficial influence is proportionate to its intensity, we should find the men whose brain-work is devoted to origination stand highest in the list. As such I should undoubtedly rank discoverers in science, inventors in the industrial arts, poets, musical composers, and painters (not of portraits). But the third proposition entirely clashes with this conclusion. Dr. Beard tells us that, of all brain-workers, clergymen are the most long-lived. Yet they can scarcely be called the hardest brain-workers, since what is demanded from them is not origination, creation, but expression. If a clergyman initiates new doctrines he is in danger of becoming a heretic. He is expressly forbidden to do what is expressly demanded from the man of science or the author. Indeed, till a comparatively recent date, the life of an English country clergyman has always been considered as one of the easiest of all careers, making no heavy demands either upon brain or muscle.

Indeed, Dr. Beard, when he undertakes a formal explanation of the great longevity of the clergy, makes some very important concessions. He remarks that "their calling admits of a wide variety of toil"—"In their manifold duties their whole nature is exercised"—"Public speaking, when not carried to the extreme of exhaustion, is the best form of gymnastics that is known." Dr. Beard here admits, what I also maintain, that the most healthful work is that which duly and harmoniously calls into play all the various faculties of a man. Brain-work is in itself good and wholesome—undoubtedly better than pursuits which exercise the muscles alone, leaving certain regions of the nervous centers inactive. But it is still inferior to work which exercises the entire system. Whatever calling effects this most thoroughly and equally will be the ideal vocation. But it may be said that the duties of the physician call a wide circle of powers into play. Why, then, is he less long-lived than the clergyman? In his case there is wanting any physical exercise which may take the place of public speaking, and he is more exposed to death from contact with malignant disease.

As an instance of the especial benefit to be derived from an exercise of the whole system, I may glance at the lessons to be gathered from the experience of exploring expeditions in unhealthy countries. The first to succumb are porters, guides, muleteers, private soldiers and sailors, etc. Next come military and naval officers, while the doctor, the botanist, the geologist, etc., hold out to the last, their sole advantage being a more thorough exercise of the whole system, muscle and brain alike.

Dr. Beard gives another reason for the longevity of the clergy—their comparative freedom from anxiety. This is the critical point to decide whether brain-work shall be healthful or harmful. Let a man work knowing that his livelihood is secure—that it is indifferent whether he completes any given task this month or this time six months—and no amount of study will harm him. But tell him that he must complete some task by a given date under penalty of dismissal, or that his prospects in life depend on his passing an examination better than a score of competitors, and the probability is that his studies will bring on softening of the brain, heart-diseases, or perhaps Bright's disease.

Dr. Beard formally admits that "worry is the one great shortener of life under civilization, and, of all forms of worry, financial is the most frequent and the most distressing." Hence the differences between his views and mine are very much smoothed over, and we must take in a "Pickwickian sense" his declaration elsewhere that "brain-work is the highest of all antidotes to worry."

He brings forward yet another reason for the longevity of clergymen—"their superior temperance and morality." That such superiority, if it exists, will have an influence in favor of health and long life, I readily admit. But it is very doubtful whether they are in this respect superior to other brain-workers. In the career of the scientist mutinous passions are simply crowded out. For him the struggles with temptation, of which the ethicists tell us, have simply no existence. How it may be among those brain-workers who move in a more emotional sphere, I can not presume to say.

Dr. Beard's contention that the brain-worker is, as a class, happier than the muscle-worker, is very questionable. He asks: "Where is the hod-carrier that finds joy in going up and down a ladder; and, from the foundation of the world until now, how many have been known to persevere in ditch-digging or sewer-laying, or in any mechanical or manual calling whatsoever, after the attainment of independence?" Such persons, I think, might be found. Many of these manual occupations would, as far as I can judge, seem happier than a life spent at the merchant's desk or at the exchange. If the man of business "continues to work in his special calling long after the necessity has ceased," it is because he has been trained to believe that accumulation of wealth is the whole duty of man. "Nearly all the money of the world," says Dr. Beard, "is in the hands of brain-workers." This may be true; yet, at the same time, many of the hardest and most capable brain-workers rank among the very poorest. Young men are now warned by their friends to avoid the highest class of brain-work, and even to shun the learned professions, "because they do not pay." I meet with books containing the records of original research, yet for which the author has received less than the wages of a stone-breaker for the time employed. I meet with inventions which ruin the inventor and enrich his followers. Verily the manual laborer has scant cause to envy the brain-worker.—*Journal of Science.*

SKETCH OF PROFESSOR RICHARD OWEN, F. R. S.

PROFESSOR OWEN'S especial field of labor, that of comparative anatomy, covers every portion of the realm of zoölogy; and in that field, as one of his biographers well observes, he has published original papers on every branch of the animal kingdom, living and fossil. Another writer, reviewing his work, has said felicitously and justly that, "from the sponge to man, he has thrown light on every subject he has touched."

RICHARD OWEN was born in Lancaster, England, July 20, 1804. He received an elementary education at the grammar-school of his native town, and was for some time a pupil of a surgeon in that place. He became a student of the University of Edinburgh in 1824, and there enjoyed the guidance of the third Monro, Alison, Jameson, and Hope, in the university, and of Barclay in the out-door school. He was one of the founders of the Hunterian Society, and was chosen president of it in 1825. He visited Paris in the same year, and made the acquaintance of Baron Cuvier. Having spent about a year in the study of medicine at Edinburgh, he went to London, and became a student in the medical school of St. Bartholomew's Hospital, where he received the diploma of the Royal College of Surgeons in 1826. He had intended to enter the navy, but had settled down to practice in London, when Dr. Abernethy, with whom he had been associated for a little time at St. Bartholomew's as one of the dissectors, procured for him a position as assistant to Dr. Clift, Curator of the Museum of the Royal College of Surgeons. In this position it was his duty to make the catalogue of the Hunterian collection; and he prepared catalogues of the "Pathological Specimens," "Monsters and Malformations," and, chiefly, of the "Specimens of Natural History in Spirits," in 1830 and 1831. He continued the study of these collections through many years, succeeding Clift as curator of the museum on his death, and was gradually led by them to the extensive field of research with which his name is connected. In order to identify the specimens, it was necessary to make new dissections; and these were constantly opening new paths of inquiry and leading to new discoveries. He issued a "Descriptive and Illustrated Catalogue of the Physiological Series of Comparative Anatomy," in sections, from 1833 to 1840; the "Paleontological Catalogue," in 1845 and 1854; and the "Catalogue of Recent Osteology," in which he described 5,906 specimens, in 1854. The work of cataloguing and examining for the catalogues was accompanied with constant additions to the specimens and consequent growth of the collection till, in 1856, when Owen's connection with the work ceased, they filled ten times the space that had been sufficient for them in 1828.

An important corollary to these labors was the editorial work he performed upon the writings of Hunter, the illustrious founder of the collection. In 1837 he published a new edition of Hunter's "Animal Economy," to which he added all the known published papers of the author; and he gave, in the preface, the first descriptive narrative of Hunter's real discoveries. He afterward published two volumes of Hunter's "Essays and Observations on Natural History, Anatomy, etc.," which had been transcribed by Clift before Home destroyed the originals, and had been deposited by him, with an autographic authentication, in Owen's hands. The preface to this work embodied a showing of the advanced views which Hunter entertained in geology and paleontology.

In 1834 Dr. Owen was appointed to the newly-founded chair of Comparative Anatomy in St. Bartholomew's Hospital, and two years afterward was made the first Hunterian Professor in the Royal College of Surgeons. He filled this position for twenty years, after which, in 1856, he was appointed Superintendent of the Natural History Department of the British Museum.

The history of the whole of the earlier thirty years of Professor Owen's active life is illustrated by the records of his anatomical and zoölogical investigations. His earliest published paper was a demonstration of the manner in which an aneurism had been obliterated by Dr. Stevens, of Santa Cruz, by means of a ligature of the internal iliac artery, which was communicated to the Medical Society of St. Bartholomew's Hospital in 1830. Soon after becoming connected with the Hunterian Museum, he obtained a specimen of the *Nautilus pompilius*, or pearly nautilus, an animal then almost unknown, on which he published a memoir, with drawings by himself, foreshadowing the advanced views on structure and affinities which characterize his scientific system. In 1835 he published the first account of the *Trichina spiralis*, that remarkable nematoid worm of swine and men which has since become famous as a cause of disease.

Professor Owen's earliest communications to the Royal Society were papers on the generation of the ornithorhyncus and the kangaroo. In numerous later memoirs he discussed the structure and affinities of the higher quadrumana, and proposed the use of the brain-structure as an important element of classification. Between 1840 and

1845 appeared his "Odontography," a very important work, founded on microscopic examinations, containing descriptions and drawings of the structure of the teeth of every class of animals. His "Lectures on Comparative Anatomy and Physiology" were published between 1843 and 1846. His great work on the "Archetype and Homologies of the Vertebrate Skeleton" was the fruit of twenty-one years of study of the subject, and presented a revision of Cuvier's conclusions in the direction of recognizing a greater conformity to type than his illustrious predecessor had been willing to admit. In forwarding a copy of this work to Professor Silliman, of Yale College, Professor Owen wrote, in 1846: "You may remember the condition in which this philosophical department of anatomy was left by the great Cuvier and Geoffroy, and the discussions which unhappily tended to sever those estimable men in the latter period of their lives. The result was the formation of two schools, or parties, in the French world of anatomy, and subsequently the facts and arguments bearing upon these transcendental questions have been viewed in Paris through the prism of such party feeling. The chief and most cherished labor and reflections of many past years have been devoted by me to the acquisition of such truth as might lie at the bottom of the well into which this philosophy of anatomy seemed to have sunk after the departure of the great luminaries of the Jardin des Plantes."

In this work, and one on "The Nature of Limbs," that appeared after it, Professor Owen developed the idea of Oken, that the typical form of development in the higher mammals is the vertebra. In another work, "On Parthenogenesis," he introduced a term, which has since come into general use, to describe a most curious and interesting phenomenon in reproduction.

A very important division of Professor Owen's investigations is his work relating to the apteryx, and other fossil gigantic birds of New Zealand, concerning which he presented numerous carefully elaborated papers to the Royal and Zoölogical Societies. The successful restoration of one of these birds, from the few parts first found, was regarded by him as affording a vindication of Cuvier's principle, that the entire animal may be reconstructed from a single bone, or articular facet of a bone. By other applications of this principle to more or less complete fossil remains he was able to restore many remarkable forms of extinct animals from the fossil fragments brought home by Darwin from South America. He carried on valuable studies on the sloths from the same region, among which was the mylodon, and described the gigantic extinct marsupials of Australia. Turning his attention to the fossil beds at home, he published memoirs on the chelonia of the Purbeck limestones and Wealden clays, and the reptiles of the London clay and the cretaceous formations, and a monograph of the British fossil mammalia. Among his later studies in the field of fossil anatomy is his reconstruction of the curious long-tailed bird from Solenhofen, the *Archeopteryx*.

In one of his communications to the Royal Society (April, 1872), on the fossil mammals of Australia, he remarked, touching upon some generalizations suggested by the then present stage of discovery, that "the disappearance of the larger species was explicable on the principle of the 'contest of existence,' as applied by him to the problem of the extinction of the fossil birds of New Zealand ('Transactions of the Zoölogical Society,' vol. iv, 1850), and subsequently by Darwin to the incoming of new species, as 'the battle of life.'" In concluding this paper he remarked that "it is neither creditable nor excusable that so great a divergence should still be maintained, chiefly through theological teaching, in the ideas of the majority of men 'of ordinary culture' as to the cause and conditions of the distribution of living species over the globe from those suggested by the clear and multiplied demonstrations of science." One of his studies in the London clay, in 1873, brought to light the *Odontopteryx*, a fossil bird, having the peculiarity not found in any existing bird, and one previously unknown in birds, of jaws provided with long, conical, bony processes, like the serrations in a coarse saw.

When he assumed the position to which he was called at the British Museum, Professor Owen's attention was at once directed to the insufficiency of the space the museum afforded for the accommodation of the natural history collections. Repeated representations had already been made on this subject in vain. The Government would not enlarge the provisions at the museum, and finally intimated that it would prefer the alternative of having the collections removed. Professor Owen determined to accept this alternative, and had plans prepared for a large new museum at South Kensington, which would afford a superficial space of five acres to well-arranged collections. The plan was approved by the Government, but did not receive the favor of the House of Commons. Professor Owen then published a pamphlet "On the Extent and Aims of a National Museum of Natural History" (1862). After ten years more of agitation, a parliamentary appropriation was obtained, in 1872, with which the present magnificent range of buildings, now rapidly filling with the nation's treasures of natural history, were erected. "In the obtaining of this splendid casket in which to display Nature's gems," says "Nature," "Professor Owen has seen accomplished one great object of his life." "Nearly a quarter of a century," said the same journal in 1880, "has elapsed since he entered on his duty at the British Museum, and the record of his contributions to science during this period equals, if it does not surpass, that of the previous thirty years' period. Among the more important of these we must notice: 'Memoir on the British Fossil Reptiles of the Mesozoic Formations—Pterodactyles,' 1873–1877; 'On the British Fossil Reptiles of the Liassic Formations—Ichthyosaurs and Plesiosaurs,' 1865–1870; 'On the British Fossil Cetacea of the Red Crag,' 1870; 'On the Fossil Reptiles of South Africa,' 1876; 'On the Classification and

Geographical Distribution of Mammals,' 1859; a 'Manual of Paleontology.' The long list of papers published in the 'proceedings' of learned societies, to be found in the Royal Society's invaluable catalogue (numbering over three hundred and sixty), includes many the scientific value of most of which would have given an abiding fame to their author."

Professor Owen was a member of the commission to inquire into the health of towns, in 1843 and 1846; was one of the commissioners on the health of the metropolis, in 1846 and 1848; and was a member of the commission on the meat-supply in 1849. In 1848 he published a special report on the sanitary condition of his native town of Lancaster, which was followed by the introduction of an improved sewerage and a new water-supply. He was one of the commissioners for the Great Exhibition of 1851, and was chairman of two of the juries in the Great Exhibition of Paris in 1855.

In the way of honors, Professor Owen received the Royal Medal from the Royal Society in 1842, and the Copley Medal in 1846; the "Ordre pour le Mérite," from the King of Portugal, in 1851, and the Cross of the Legion of Honor from Napoleon III in 1855; degrees from the Universities of Oxford, Cambridge, and Dublin; and an honorary Fellowship in the Royal College of Surgeons of Ireland. In 1858 he was elected one of the eight foreign associates of the Institute of France, in place of the botanist, Robert Brown. Prussia gave him its order of merit, and Italy its order of St. Maurice and St. Lazare; the Emperor of Brazil, the Imperial Order of the Rose; the Queen of England, the order of the Bath. He was President of the British Association in 1857, and his name is on the lists of honorary or corresponding members of most of the learned societies of Europe and America. In 1874 he gave new evidence of the extent and comprehensiveness of his researches by presenting to the Anthropological Institute an interesting paper on the races of ancient Egypt, as depicted in the sculptures. Continuing his studies in this direction, as well as in the whole field of anthropology, he made before the International Congress of Orientalists in the same year, as president of its ethnological section, the most remarkable address of the meeting, in which he recommended adherence to the scientific method in the study of ethnology, and particularly of ancient Egyptian and Oriental history.

In 1880 "Nature" reported Professor Owen as still active in labor at an age when most men have to cease from their work; and added that no better proof could be given of a spirit still young, than to witness the energy with which he had entered upon the occupation of the new home for natural history at South Kensington. Still, in the present year, by the latest accounts received from him, though he is seventy-nine years old, he was in good health, and publishing important papers.

CORRESPONDENCE.

FLORIDA AS A HEALTH RESORT FOR CONSUMPTIVES.

Messrs. Editors.

IN "The Popular Science Monthly" for March, Dr. George E. Walton, of Cincinnati, has an article on "The Remedial Value of the Climate of Florida," some of the statements in which, for the sake of accuracy, it seems desirable to correct.

What Dr. Walton says of the humidity is true. It can not be compared with Minnesota (that is, the northern part of Minnesota) for dryness; but it will compare favorably with other *southern* localities in Europe and America; for instance, we see by Dr. Walton's table, page 644, that the humidity of San Antonio and Florida is about the same; and just here let me say that writers on Florida climate are apt to take Jacksonville as a *representative* locality, because the available statistics usually come from there. The Signal-Office is there. But it is by no means the best locality for invalids. It has the advantages and the disadvantages of a city, though a small one. It is much damper than other points in East Florida frequented by invalids; fogs are more prevalent, and last longer. It is not so safe to be out after sundown. As we go up the river the dampness lessens for a hundred miles. During the months of February, March, and April, 1878, using a Mason's psychrometer (wet and dry bulb), and comparing my observations with those of the Signal-Office at Jacksonville, the relative humidity for three months, in 1878, is for that city 66·2, according to Dr. Baldwin's observations for several years 62·6, *while for Palatka it is* 61·3.

The summer dampness is just what Dr. Walton says of it, three fourths of all the rain-fall of the year occurring during that season. But, further on, Dr. Walton says, "The prime need of a consumptive is that he shall be a great deal out-of-doors, that he shall breathe pure air," etc. "Is the climate of Florida fitted to do this? . . . I answer no!" On the contrary, I answer emphatically yes! Here is just the advantage of Florida over the cold and cool resorts. Here, one is constantly incited by the sunshine and the delightful climate to be all the time out-of-doors. As regards physical exercise, during most of the time one is not incited to *it*. But there are *cool changes* during the winter and spring months (which are peculiar to this climate, distinguishing it from a purely tropical), during which one may exercise on horseback, on foot, or by rowing. That people here are indisposed to exercise is true; but it is not always, by any means, because of the temperature, but of constitutional indolence Those who take an interest in their surroundings, or who are fond of fishing and hunting, may be seen at all times, in warm and cold weather, putting forth all requisite energy. Persons must *seek occupation* and *amusements* in order to get the benefit of climate. What Dr. Walton says about *tubercular* consumption, especially the latter stage, is true, and it is true of cool and cold climates also, but not to the same extent, perhaps, as of warm and moist. That is, the universal admission of all honest writers on climates and health resorts is, that such cases die wherever they go. They are necessarily incurable, with very few exceptions, and notable exceptions occur here as elsewhere. And here let me explain why so many more consumptive cases die in Florida than in other resorts. When they get reduced almost to death's door by softening of deposits, fever, diarrhœa, etc., they are too ill to go to Europe, and also unable to bear any change, except to a *warm* climate; consequently, the mass of them come to Florida, often with a knowledge on the part of the physician and friends that they are certain to die, but clinging to the last straw themselves.

Dr. Walton says. "During the last six months of 1881 there were thirteen deaths in Jacksonville (population, 8,000) from consumption, these deaths being of residents only, and excluding all non-residents or visiting invalids. This is a mortality of 1·62 per 1,000, being a greater mortality than occurred in Cincinnati during the same time, which was 424 in a population of 280,000, or 1·51 per 1,000. . . . It may be stated in this connection that natives of Florida taken with consumption frequently seek other places and climates as a means of cure."

I am certain that Dr. Walton has fallen into an error in his statement with reference to the deaths from phthisis among *residents*, if he means natives or even persons who have lived many years in Florida. The population of the State is made up very largely of Northerners who have lived here one, two, five, ten years. No doubt many of the deaths referred to by him occurred among this class, probably all of them; for consumption is rare among natives, although they live in every way, for the most part, in opposition to the rules of health—poor food, poor water, poor habitations, insufficient clothes in cold weather—that is, the middle and lower classes do—all tending to the development of tubercular disease, and which would inevitably produce it in a less favorable climate.

Dr. Walton also refers to the want of statistics from here with regard to the results of the treatment in individual cases. The habit, almost universal, of cases of phthisis moving from place to place in Florida, after a few days' or a week or two's residence, renders the collection of such statistics impossible. And this is one of the reasons why the cases do not get the full benefit of this admirable climate. Even when they are improving rapidly in one location, they get tired and start off to some other, or because some one member of the party fancies a change, or because they have a friend or pleasant acquaintance somewhere else, although a physician may assure them that the change will be for the worse. Even patients who are referred to me by prominent physicians, and told to get my advice as to treatment and locality, go off to some entirely unsuitable place, contrary to my advice, and on that of some casual acquaintance. So much has this come to be the rule, that I now cease to waste my breath in trying to talk them out of their notions. Respectfully, yours,

Frederick D. Lente, M. D.

Palatka, Florida, *March* 10, 1883.

AN INTERCEPTED LETTER.

To the Editors of the Popular Science Monthly:

The subjoined letter accidentally fell into my hands, and, as it bears upon a certain much-discussed topic, I venture to send it to you for publication. O. B. B.

New York, *April* 1, 1883.

Dear Ma: When Suse and me got to the city we found Cousin Ralph at the depot to meet us, and we went right home with him. We had a real nice supper, and as nobody was by but Cousin Lucy, I just told Cousin Ralph plain that Suse and me had come to New York to get what some folks call a higher education. Cousin Ralph, who is real pert, said that some folks he knew, would like to *hire* an education, but I told him that if we could hire an education all right, but we wanted a first class education anyhow, right off, and that Pa was already to pay for it. I said that we had gone through our semnary at home and learned all that old Mrs. Bookup could teach us, and that was why we come to York. Well, Cousin Ralph laughed a little, and then he looked serious, and told us things that made our hair stand on end. Why it taint no use trying to get a first class education here in York because the mean nasty men folk wont let us women get it. What do you think-Cousin Ralph says that they have six police. man before the big liberay they call the Astur liberay to keep women from getting at the books there. He says the street is just full of women a wanting to get into that liberay, but these police officers with their clubs wont let em. There are lots and lots of books in that liberay, Cousin Ralph says, big histories, and big ologies, and big dictionaries, and big books upon ever so many things, and women might get ever so much education by just sitting down and studying them books, but the men are afraid of educated women, so they just put policemen there to drive off everybody that is a female. I declare its a burning shame. Why, Ma, Suse and me might learn all about Bible times, and about astronomy, and geology, and geography, and about Julius Cesar, and Cristôfer Columbus, and I don't know what else, and get a higher education all by ourselves if it werent that the men wont let us. I know it will make you real mad when you read this, just as it does Suse and me.

But that isnt all Ma. Would you believe that they won't let women buy books at the bookstores, because if they did they might get a higher education unbeknown. Cousin Ralph says that women cant get nothing but novels to read. The bookstores are just full of books that teach everything you can think of, and yet even when women have got the money to buy them the men wont let them do so. Cousin Ralph says there are books full of learning by somebody called Spensur, and some one called Hucklee, and another man called Tindell, but that it is as much as a woman's life is worth to go in and buy one. Cousin Ralph thinks she couldnt get out alive, at least he says he never saw a live woman come out of a book store with one of them books. All women would have to do to get a real first class education would be to go and get books out of the book stores, but the mean jealous men say they shant do it, and so keep them just as ignorant as they can be. And then Cousin Ralph says they wont let women go to lectures on history, and the siences as folks say. There are lectures given free at what I think Cousin Ralph called the Hooper Union, but he says if women went there to get lectures free, theyd be just driven off by policemen. Lots of things might be learned by going to lectures, but the poor women arent allowed to. Its real dreadful what a time we women have in trying to get learning.

And then Cousin Ralph says that the publishers wont publish books anymore with learning in them. Why they just print lots and lots of trashy novels which women have got to buy because they wont print nothing else. There's what is called the Franklin square liberay and the Sea side liberay, that keep on printing good for nothing novels, and women who want cheap books have to read them, because the men who print books dont want women to get a higher education, they really dont, and so they just flood the country with books that women have to read, because they cant get into the public liberaries, and aint allowed to buy books by Spensur and other learned people. Its just a conspiracy, Cousin Ralph says, to keep women down. I think its a great shame, dont you, Ma. But Suse and me mean to see if we cant get a first class education somehow. More next time, from

Your affectionate daghter,

Molly.

EDITOR'S TABLE.

GREEK AND LATIN AGAINST NATURE AND SCIENCE.

NOTWITHSTANDING all the efforts to reconcile and bring into harmony these great elements of education, it must be admitted that the antagonism stands out to-day more decisive than ever before. All the tendencies concur to sharpen and intensify it. In the light of the Baconian conception that "man is the interpreter of Nature, and Science its right interpretation," natural knowledge is rapidly extending and vindicating its increasing claims upon the mental cultivation of the age. But the capacities of acquisition on the part of youth remain limited; life is short, the period of study shorter, and the competition of subjects has forced more urgently than ever the necessity of choosing what shall be adopted as means of education and what passed by. Meantime the traditional culture fights every inch of the ground, will concede nothing, and redoubles its efforts for extension at every opportunity. The colleges raise their standards of the amount of Latin and Greek required for admission, and thus react upon the preparatory schools to stimulate classical studies and give them a higher place in popular consideration. There is, besides, a vigorous and wide-spread movement in behalf of what is called the "higher education of woman," which simply means the traditional ideal of culture. The female colleges are proud to duplicate the curriculums of the old classical establishments, and boast that they do not lower the standard of Latin and Greek. The boys have had a Latin school in Boston for two hundred and fifty years, to prepare for college; and the girls of that city, after failing to get into the old one, have established another within the past five years, which is said to be most flourishing and successful: rivalry and conflict are therefore inevitable, and our age has before it the broad issue between Latin and Greek on the one hand, and Nature and Science on the other hand, as means of cultivating the youthful mind.

The classical education is old, established, and invested with historic dignity, and as a consequence it is imperious and arrogant. That it has gone on for many centuries, is offered as its best reason why it should always go on. That there has been a progress in knowledge and in the human mind which has brought about a new order of things is ignored by it as of no significance. Nature and Science are regarded by it as mere upstarts of yesterday, full of vain pretension, and deserving only to be snubbed and thrust contemptuously aside. The last expression which we have seen of studied disparagement of Nature and Science in connection with education is an article by Mr. E. R. Sill, that appeared in the "Atlantic Monthly" for February, on "Herbert Spencer's Theory of Education." Mr. Spencer's little book upon that subject, as is well known, is a plea for more of nature and of science in our methods of mental cultivation, and Mr. Sill's article is a protest against this whole doctrine. He comes forward as a partisan of the old classical education, as opposed to the modern study of nature by the method of science. Exactly what he means by "Nature" does not so plainly appear, but by his instincts as a classicist, alive to the present emergencies, he is "down upon it" whatever it be—witness the following passage:

> For what is this "Nature" (with a capital N) which figures so largely as a final arbiter in the enthusiastic eulogies of Science (with a capital S)? Does this Nature include man and his operations, or does it not? If it does, then these very interferences are also a part of Nature. And certainly the human part of Nature has as good a claim to be the arbiter as any other part. But if it does not include man, and is merely a name for the forces and processes of the world outside of the human world, then we may safely assert our right to come down upon this Nature, and mold and control it according to our needs. Or if, to take a third supposition, this capital-lettered Nature is meant to include man only in his "natural" condition—the wild man so called, the savage, the animal—then surely the very effort of all civilization, and of education as its chief instrument, is to oppose, and whip in, and convert, and take command of these untamed forces of Nature, that we may develop the savage into the higher human being.

Now, the nature about which Mr. Sill is here so dubious, and of which he seems to be so jealous, is by no means a difficult thing to define and understand. For the purpose here in view it is the order of things in which man is placed, of which he is a part, and of which it is his highest intellectual prerogative to be the interpreter. And it is to be remembered that "this Nature" is something which had no existence in that golden age of classical antiquity which gave origin to those literatures still claimed to be best for the cultivation of the human mind.

It is sufficiently obvious that relatively to man what nature is depends upon what *he* is. To him who is ignorant of it, nature is one thing; to him who understands it, nature is another and a very different thing. How the savage regards the world, we need not here inquire, but it is desirable to know how it was possible to regard it after human culture had become greatly advanced.

Man did not begin his mental career by the study of nature. The earlier forms of mental cultivation were literary. The Greeks and Romans developed poets, dramatists, orators, historians, critics, and artists of fine accomplishments while yet nothing was known of nature. The external aspects of things were described with great fidelity, but the view was sentimental, poetic, and superficial. Into the secrets of nature at that time men could not penetrate, its course they could not explain, its order they could not conceive. They had no clew to the interpretation of even its simplest phenomena. They could look, but they could not observe; they could construct, but they could not experiment; they could guess, but they could not verify; they could speculate, but they could not create positive knowledge. There is much of interest, art, and beauty in the literatures of Greece and Rome that has been a source of pleasure to all succeeding times; but these proficiencies brought no capacity to explore and understand the surrounding world. In all the thinking, therefore, of the classical ages, nature was simply left out.

But this was not always to continue. The earlier and lower forms of mental effort gave a preparation for profounder work. Yet it was only in modern times that men began to learn how properly to inquire, and to prize the truth that results from inquiry. After much vagrant exertion, and a long and painful apprenticeship in the processes of investigation, science began to take definite form as a higher manifestation of intellectual power. Humanity had grown to a new function. The art of questioning Nature through observation and experiment was slowly perfected; the facts arrived at were classified and inductive truths established, and there grew up a new order of knowledge, which, at the same time that it gave insight into the constitution of natural things, conferred also vast power for the purposes of human improvement. We are justified in saying that in a high sense a new universe was thus created for the human mind. Through scientific knowledge man entered upon a higher intellectual career and first gained a real conception of his own possibilities and true position in the world. A new civilization followed, which is signalized in a thousand ways; and the answer to Mr. Sill's question, "What is this Nature (which figures so largely as a final arbiter in the enthusiastic eulogies of Science)?" is given in the powerful mental movements of all enlightened nations for the cultivation and extension of that natural knowledge which has become the controlling agency in the improvement of human society.

And is it to be supposed that this new power in the intellectual world is to remain impotent in the domain of modern education? Can the great revolution of ideas in regard to nature fail to bring about a corresponding revolution in the mental cultivation of mankind? The simple question is, whether the minds of our youths are to be developed in future by means of the lower or by means of the highest and most perfect forms of knowledge. Those who offer the classics as an all-sufficient means of culture discredit the achievements of modern thought, and have no more use for the knowledge of nature than had the ancient classical authors before such knowledge existed.

Mr. Sill puts his educational theory in the following nutshell, which, as will be seen, finds no room for nature. He says: "The truth is, there is a permanent aspiration in man for spiritual enlargement, for higher and richer planes of intellectual being. This aspiration has in every age reached out, no doubt more or less blindly, after whatever was greatest and best in preceding human attainment. Latin and Greek have been studied, not alone, as our author almost seems to suppose, as words and for words' sake, but for the vital contact they give with the living men who thought in Latin and Greek."

Now, granting this permanent hunger for spiritual enlargement, the question still remains how that hunger is to best appeased. Mr. Sill says by "the accumulation of man's thought and feeling concerning human life and affairs." But *what* "accumulation"? Why, the literary treasures of Greek and Latin, of course. The yearnings of human nature after intellectual illumination are to be met, not from the magnificent treasures of truth which are now the grandest possession of humanity, but by the undeveloped thought of two thousand years ago, and by bringing the minds of our youth "into vital contact with the living men who thought in Latin and Greek." The absurdity is self-evident. Men's aspirations are not to be thus satisfied. The thought concerning human life and affairs which we require for mental cultivation is modern thought—the knowledge which bears upon the emergencies to be encountered. Only by the light of the most advanced science can affairs in these times be intelligently dealt with. Our age is full of living questions which can only be resolved by modern methods. To go back thousands of years after the intellectual help we need is simply to shirk the responsibilities of the present age.

Knowledge of nature for guidance in life is the great requirement. But Mr. Sill does not seem to recognize that knowledge has any function of guidance. There is disparagement throughout his paper of the importance of knowledge for any use that can be made of it in the conduct of life. Mr. Spencer had classified the knowledges in his little book as they bear upon the activities of life, and had ranked first "those activities which directly minister to self-preservation"; and, next, "those activities which secure the necessaries of life, and so indirectly minister to self-preservation"; and then "those which have for their end the rearing and discipline of offspring." The social and political relations come next in importance; and, finally, those matters of literature and art which belong to the leisure part of life. Mr. Sill says that this scheme is fundamentally erroneous, and, in fact, "the exact reverse of the truth." Bodily and material interests are studiously belittled. Mr. Sill says: "The ordinary man, unenlightened by education, manages pretty well this matter of getting a living for his body; which is, no doubt, a necessary condition to any intellectual life, but is intrinsically of considerably less importance than that higher end, which alone, indeed, gives it any value whatever." Again, "As to the body, and as to the getting a living for it, and even as to the care of offspring, something may be left to nature and to natural instinct"; and yet again, when a youth has first become "an intelligent man," according to the traditional ideal, "he will be able to get his handy information for himself afterward, as happens to be most useful to him."

This undisguised contempt of a knowledge of the human constitution and the conditions of its welfare is more than classical. The ancients were ignorant of these things, and therefore indifferent to them; it is only in the degraded scholastic ages that we find the body and bodily interests systematically undervalued and despised. But better reasons could be given in those days for hating and crucifying the corporeal nature than can now be given for neglecting to study and understand it. Mr. Sill reasons that it is only the "higher end" which it subserves which gives man's bodily organism any value whatever; and this higher end is "spiritual enlargement," and, as spiritual enlargement is to come by vital contact "with the living men who thought in Latin and Greek," we arrive at the luminous conclusion that the final purpose of the human constitution is to acquire a knowledge of the dead languages. If this is the upshot of our existence, Mallock's question, "Is life worth living?" is not, after all, so futile. But, if we grant that it is worth living, that knowledge is of first importance which qualifies us to preserve it. To disparage this knowledge, to discourage it, or to crowd it out by any other knowledge whatever, on any pretext, is nothing less than a crime. That life is imperiled on all sides, by agencies working so variously and so fatally, and to the ignorant so mysteriously, that Divine Providence is constantly accused of arbitrary interference to destroy it, is undeniable. Science alone has furnished that knowledge of the human organism and of surrounding nature that confers the power of warding off the causes of death, and thus leads to a more reverent view of the government of the world. Right and left, and every day, and all around us, men, women, and children are struck down and sent to unripe graves for lack of the knowledge which science has given of the avoidable causes of death. And the same thing may be said of a great number of the diseases by which, if life is not ended, it is turned into a calamity and a curse. Again, science informs us concerning the operation of those numerous causes by which vitality is depressed, the bodily and mental constitution enfeebled and undermined, and existence made worthless for all its better purposes. And, yet again, we owe to science the knowledge of those laws and conditions of the human organism by which it may be improved, increased in its capacities of enjoyment, and augmented in its powers of effective action.

Classical education is worthless for all these objects. It leaves its victims in a state of ignorance as baleful as that of the helpless illiterates who have never crossed the threshold of a school-house. We pick up an admirable pamphlet by an experienced teacher of this city, Mr. John McMullen, on "The Education of the Rich." Now, the education of the rich is generally fashionable, traditional, and classical, but for the vital purposes of well-being it gives them but little advantage over the wholly untaught. Mr. McMullen pleads that the rich need to study vulgar and common things as well as the industrial classes. His words are well calculated to enforce the view taken in this article. He says:

"Is it not time that some humane person should make a movement in favor of the industrial education of the rich? Since they must live in houses, why should they not be taught something about them? Defective masonry means cracked walls and obstructed doors; defective carpentry means general discomfort and an occasional crash; defective flues mean midnight fires; while defective plumbing and ventilation mean diphtheria and death.

"Let us at least teach them enough to prevent them from being poisoned by the plumber, dying 'as the fool dieth,' like rats in a corner, in the luxurious homes which they themselves, perhaps, have reared. Thus we have read recently in the papers, of one man who built an expensive and luxurious house, and lost four children in one month from diphtheria. Some three years ago, I had in my school two bright boys, the sons of intelligent and educated parents. A little brother at home sickened and died; then a little sister; and then one of my scholars became sick. A thorough examination of the house was made, and a faint, musty smell was traced to the bath-room. The mother found, to her horror, that these deaths were due to defective plumbing, and that they might have been prevented. She fled in terror from the city, and has never since returned."

DR. DIX ON THE WOMAN QUESTION.

From the amount of screaming and denunciation in the newspapers, both by editors and by correspondents, regarding Dr. Dix's lectures on woman, we infer that somebody has been badly hit, and that the doctor is to be paid off in abuse. A lady, for example, writes to the "World": "I have observed that Dr. Dix has made haste to publish his Lenten lectures without waiting for the close of Lent. This alertness is creditable to the practical and mercantile instincts of Dr. Dix. His lectures will sell now if they are ever to sell." Probably in anticipation of such insinuations, the author has prefixed a note to his volume from which we quote a few words: "I ask the reader of the following lectures to bear in mind—1. That they were written for my own people, and in the line of my usual pastoral work. 2. That they were not intended for publication. 3. That I now give them to the public in my own defense, because of the misrepresentation of my views by critics who had not the means of knowing exactly what I said, or all that I said. They are printed just as they were delivered, with scarcely the change of a word; and, in order to comply with the request of the publishers that they should appear at the earliest possible day, I am obliged to omit adding a large number of notes and quotations by which, if more time were allowed me, I should have endeavored to fortify by strong authorities the position which I have taken." Whether it was wise in Dr. Dix to yield to the hurry of his publishers, and send out his volume unfortified by the evidence at his command, may be a question; but that it was done in compliance with their wishes shows that his own preference was otherwise, and sufficiently relieves him from the mercenary imputation of the "World's" correspondent.

Dr. Dix is entitled to have his readers remember that the lectures were prepared exclusively for pastoral use, and not intended for publication, and that they have had to be printed in self-defense against misrepresentation; and this consideration should be borne in mind in their public criticism. It by no means follows that he keeps a private set of opinions for special pastoral application, and for which he is unwilling to be held publicly responsible. He was addressing a class of Christian believers who profess allegiance to Christian doctrine, as expounded by his Church; and he very naturally gave prominence to considerations which would have but comparatively little force with outside multitudes who are not in sympathy with his ecclesiastical views. As to the theological arguments which Dr. Dix brings to bear upon the woman question, we have no interest in them except so far as they strike downward and find their basis in the truth of nature. But with the main fundamental doctrines he lays down as of all-determining influence, we are in cordial agreement.

The last phase of attack upon him is an accusation that his views are not new. The "Pall Mall Gazette" declares that many of the faults of women which he notices are not American but universal, and have been recognized and satirized in all ages; and an American commentator observes that "his views of the character and duties of woman do not differ greatly from those set out in the laws of Manu, which, according to the Hindoo theologians, were drafted thirty millions of years ago."

But when the New York "Evening Post" proceeds to affirm of the cardinal doctrines of Dr. Dix that "they are in fact the views by which every step in the elevation of woman, from the beast of burden of the savage to the mistress of the modern drawing-room, has been contested by conservative or timid males, lay and clerical," it becomes worth while to revert to the author's own statement of them. The following passages from the first Lenten lecture may be fairly taken as the key to the whole exposition:

The place and work of woman in this world are, then, a place and a work in social life. And her place and work are not those of the man. His work lies outside, hers within. Without her, society could not have existed; without her, it can not last. The fact that in forming society man and woman have distinct parts implies this, that in maintaining and developing their work they shall continue to act in distinct relations to it. Something there shall be which man only can do; something which woman only can do. If she leave her own work and try to take up his, her work will remain undone; for man is not fool enough to try to do hers. And her work is inner rather than outer; it runs in the line of ordering, comforting, and beautifying. Her place is in the home first, and then in general society; and these depend on her for a grace, a help, a harmony, a good ordering, which no one else can give.

These considerations give the turn to every thought of ours about woman's work. It is impossible for me to think of it at all, without first thinking of her place in the home. That is her normal, primal seat; thence are derived all true conceptions of her rights, duty, and mission. I know the objections which will arise in your minds: that there are many women without homes or the means to make them; and, again, that, as if by a bitter sarcasm of fate, the world of to-day is so changed that it often seems as if woman must work the harder of the two in order to support the shiftless man. There are answers to these and similar objections: I shall try to give them by-and-by. But for the present I must leave the subject at this point, adding but one suggestion. I do this earnestly, seriously, and as one would speak of a matter of life or death. Let me then say that, whatever it be in thought, deed, or will that works among us now to break up the home, to make the home-idea mean and contemptible in the eyes of woman, or to unfit her for domestic duties and disgust her with her proper work, whatever now acts on her high-wrought nature, her ambition, her self-love, to turn her steps away from the home-life, and inflate her with visions of a career in the public places outside—this, whatever it be, is working against the best interests, the hope, the happiness of the human race.

If, through ease, self-indulgence, and luxury, through curiosity of learning, through self-esteem and ambitious rivalry of man, a woman becomes disloyal to the home-idea, and despises it in her heart, she is, though perhaps unaware of the fact, helping others to upset the social order.

These weighty words express the central, illuminating, and all-controlling conception of the Lenten lectures. It may be that Dr. Dix could not get a patent on these ideas for their novelty, but are they the views which, as the "Post" alleges, have been employed to resist the elevation of woman in all times? And what is there in them, expressed or implied, that can be construed as unfavorable to female elevation? Dr. Dix is no opponent of the improvement of woman by education; he only lays down the conditions on which all education which can really elevate her must depend. His views may not be new, but they have an urgent application to the tendencies of the present time. The prime postulates of all his reasoning are that woman is a different being from man, and has a different sphere from man, and, if she is to be educated in accordance with the requirements of her nature and position, she must have a different culture from that of man. His telling strictures are accordingly leveled against the wide-spread demand of the present time, that woman shall gain access to the men's colleges that they may obtain the "higher education" of men, and thus adapt themselves to the sphere and pursuits of men. Dr. Dix maintains that this would inevitably be subversive of the home-feeling; and he charges that the aspirants for wider careers have become restive under the restraints and obligations of their sex, and are cherishing ambitions which lead to a general neglect of home-life, and that will only confirm and strengthen the sentiment of disloyalty to the home. The "Evening Post" characterizes these views as a "bold defiance of the soundest, most enlightened, most religious, most conscientious judgment of the day in all lands,on the condition and needs of female education."

But is Dr. Dix really so far wrong as this extravagant language implies? We have not so read the signs of the times. If there is one thing that pervades and characterizes what is called the "woman's movement," it is the spirit of revolt against the home, and the determination to escape from it into the outer spheres of activity that will bring her into direct and open competition with men. In all the talk about female "higher education," and in all the new plans for its extension, it is notorious that distinctive home interests find no place. The literature of the woman's movement is saturated with denunciations of the vulgarity, drudgery, and slavery of life in the domestic sphere; and the "higher education" proposed is not an attempt to ameliorate, redeem, and exalt it, but a rebellion against it. The education that prepares for the home, that would awaken interest in it, give dignity to it, and transform it, is simply scouted. That the feminine nature is different from the masculine nature—different throughout, physically, intellectually, emotionally; that woman's claims, her duties, and her destiny, are profoundly different from those of men, and that her culture should have relation to the requirements of her nature—is derided by all the leaders of the present crusade to get women into the men's colleges.

The fundamental law of educational progress is differentiation of the mental activities, division of labor. In accordance with this law, we have classical colleges, medical colleges, law colleges, engineering colleges, agricultural colleges, dental colleges, and veterinary colleges, all different in the knowledge they impart and the preparation they give for the work of active life. And we have also female colleges—

Vassar, Cornell, Smith, Wellesley—all distinguished by a violation of this fundamental law of progressive education. They are all imitations of the old classical establishments, and their pride is in the perfection of the imitation. It is their boast, if not, indeed, the first condition of their endowment, that the feminine nature has no recognition either in their objects or grades of study.

If there is one female college in the land which is devoted to the cultivation of woman as an intelligent being for the discharge of her responsibilities in domestic life—which qualifies her for it, as the medical college qualifies the physician for his practice—we have not heard of its existence. It is a consequence of the rapid diffusion of education that the traditional methods of instruction are enormously extended, while existing institutions and current educational literature combine to give omnipresent influence and irresistible strength to distinctively masculine thought—that is, thought mainly pertaining to masculine spheres of action. The whole force of these ideas is brought to bear to kindle in woman ambitions of study in all these directions. Thus influenced, she wants to go into politics, law, medicine, art, literature, philanthropy, religion; and, thus influenced, she is drawn away from the home sphere, despises it for its vulgarity, and hates it as a clog and drag upon all her noblest aspirations.

Let it be emphasized, then, that those who oppose the entrance of women into the colleges that have grown up to meet the distinctive requirements of men are not, therefore, opposed to the better or higher education of woman. But that only is "higher education" for woman which perfects her nature, capacities, and requirements. Dr. Dix's view of the import of the home in civilization, its vital and ruling place in the social order, we believe to be profoundly true, and that it must be taken as the starting-point of all substantial improvement and higher cultivation of the female sex. Let women have their own colleges, that shall be neither copies nor appendages of men's colleges, and that shall confer a culture comprehensive, refined, and practical, but with supreme reference to a higher preparation for administering home affairs intelligently, and thus in the most efficient way elevating the standard of social life. When they ask for this education, there will be no opposition, and there will be plenty of means to secure it.

It was inadvertently stated, in noticing "The Gospel of the Stars" last month, that its author, Rev. Joseph A. Seiss, was a clergyman of the Episcopal Church. This turns out to be a mistake, and is resented as an imputation upon that highly respectable body, if we may judge by the number of letters we have received, denying the statement, with varying comments, and declaring that Dr. Seiss belongs to the Lutheran communion, which must be held responsible for him.

In the article "Speculations on the Nature of Matter" ("Popular Science Monthly" for April), the following corrections should be made: On page 798, eighth line from the top, it should read, "namely, the inverse squares of the distance *without* the sphere, and directly as the distance *within* it." And, on line 27th of the same page, it should read "directly as the distance."

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES. No. XLIV.

Animal Intelligence. By George J. Romanes, LL. D., F. R. S. New York: D. Appleton & Co. Pp. 520. Price, $1.75.

The author of this work has come prominently forward within the last few years as an able cultivator of the science of comparative psychology, and the treatise he has now given to the world is probably the most trustworthy and instructive that has yet been contributed to that science. There has been a copious literature of anecdote designed to illustrate the mental capacities of the most intelligent members of the animal series—as the dog, the elephant, the monkey, and the ant; but while, on the one hand, the statements have often been so extravagant as to awaken incredulity, on the other there has been but little exposition of principles which would enable the reader to judge of the truth or error of current representations. The interest in the subject has always been great, and, with the prevailing lax habits of criticising evidence, many stories have passed into circulation, and been accepted, which would hardly bear examination. It was eminently desirable, therefore, and for scientific purposes imperative, that the popular statements should be rigorously sifted, in order that we may find out what may be relied upon as true. It is obvious that only the thoroughly prepared psychologist is competent for such work, and many years of study in this field have well qualified Mr. Romanes to undertake it.

The present volume is in a certain sense complete in itself; and from another point of view it is but a foundation, which is yet to have its superstructure. It has long been the author's intention to write a treatise upon comparative psychology, in the light of the doctrine of evolution, and his intention was to treat the whole subject in a single work. His preliminary inquiry was, of course, into the facts upon which such a view must rest, but he found his materials so extensive, and in themselves so important, that he was compelled to arrange for two separate books; the first to be made up of the observed facts, carefully collated and classified, so as to give the grades of intelligence actually reached in the various groups of the animal kingdom, and to leave for a second volume the problem of psychical development to be derived from these data. The present book on "Animal Intelligence" is the first, and is mainly descriptive, while the second, to be built upon it, will be more analytic and philosophic.

Undoubtedly the present volume will have the highest interest for general readers, as it involves no speculation or abstruse reasoning, and aims only at descriptions and discriminating estimates of the degree of intelligence manifested in the different groups of animate creatures.

But while Mr. Romanes has closely sifted his materials, so as to furnish only authenticated facts, it would be a great mistake to suppose that his pages are less entertaining than the loose compilations with which we have been familiar upon this subject. The phenomena are equally surprising and wonderful, but with the further advantage that we have a fair confidence in their reality. The intelligence displayed by the inferior animals is often well calculated to awaken astonishment, and we are free to confess that some of Mr. Romanes's stories would excite incredulity if we had not a pretty strong confidence in his caution, and if the special manifestations alleged were not confirmed by other and similar observations. To the general reader, the book will prove a fund of interest on one of the most fascinating of subjects, and to the student of natural history it will have a scientific value as affording a sound basis for the formation of conclusions respecting the psychical capacities of animals.

In regard to the vexed question of mind and instinct in the lower animals, of which so much has been written, the author lays down at the outset the principle that he will follow in determining mental gradation, and this may be gathered from the following remarks in his introduction:

"The criterion of mind, therefore, which I propose, and to which I shall adhere throughout the present volume, is as follows: Does the organism learn to make new adjustments, or to modify old ones, in accordance with the results of its own individual experience? . . . I may, however, here explain that in my use of this criterion I shall always regard it as fixing only the upper limit of non-mental action; I shall never regard it as fixing the lower limit of mental action. . . . In other words, because a lowly-organized animal does *not* learn by its own individual experience, we may not therefore conclude that, in performing its natural or ancestral adaptations to appropriate stimuli, consciousness, or the mind-element, is wholly absent; we can only say that this element, if present, reveals no evidence of the fact. But, on the other hand, if a lowly-organized animal *does* learn by its own individual experience, we are in possession of the best available evidence of conscious memory leading to intentional adaptation."

Essays in Jurisprudence and Ethics. By Frederic Pollock, M. A., LL. D. Macmillan & Co. Pp. 377. Price, $3.

Although but little oneness of form will be expected in a work like this, composed of occasional pieces which have appeared in divers journals and reviews, yet so much unity of purpose and thought are to be found in it as to give a considerable measure of coherence. The essays fall into two divisions, in the first of which legal topics predominate, in the second ethical. In the first, it has been the author's aim to consider legal ideas and institutions as affected by or as affecting the wider interests of history, politics, and practical legislation. In the second division he has endeavored to bring to a better-defined issue certain points of ethical discussion, by the help of distinctions founded on familiar legal conceptions, and by specifically applying those conceptions and distinctions to admitted facts. In both subjects he has preferred to use the historical method—taking the term in a pretty wide sense. Yet, in respect to the method followed, whether critical or analytical, the author takes no narrow view, and it will help to the understanding of the character of his book if we quote his prefatory remarks upon this subject:

There may be an apparent inconsistency in the points of view taken in some of the legal essays. I have started sometimes from the pure analysis of the modern English school of jurisprudence, sometimes from history, sometimes from practical expediency. My own opinion is that all these methods are legitimate, and that, if their results fail to agree, it is the fault, not of the instrument, but of the worker; No doubt there exists a tendency to conflict between the historical and the analytical manner of considering legal phenomena. The historical student is tempted to regard analytical jurisprudence as shallow sciolism, while the analytical jurist is apt to charge the historical and comparative method with laxity of thought and antiquarian pedantry. Both methods are, in truth, useful and necessary, and either of them alone is imperfect; the modern developments of legal theory have shown them in their power and in their shortcomings.

The history of law was by no means neglected before the rise of modern critical jurisprudence; but its results were of little value so long as they could not be read in the light of general ideas and principles. Blackstone gives the history of English law from the thirteenth century onward, with sufficient fullness for all ordinary purposes, and, as a rule, with great accuracy; the historical merit of his "Commentaries" has been too much overlooked in the discussion of his faulty arrangement and inadequate theories. Montesquieu not only collects a great quantity of materials for legal history, but has a notion of historical method and comparative research far in advance of other writers of his time. Yet all this work remained unfruitful for the best part of a century. It had to be fertilized by the ideas of the analytical school. Bentham, on the other hand, had no room in his mind for history. He would have liked to make a clean sweep of all the laws and customs of Europe. and start afresh with a code warranted to secure the greatest happiness. Even language had for him no continuity to be respected. He seriously drafted specimens of legislation in a style invented by himself as the most appropriate for the purpose, and defying all the usages of common syntax. A system proceeding from this habit of mind could not easily adapt itself to the facts of different ages and societies. Its general propositions were, in truth, like those of political economy, drawn from the conditions of a particular society at a particular time, or, rather, those conditions as they would be in the absence of disturbing elements. These conditions have still their peculiar value for scientific jurisprudence, insomuch as they are those which more and more tend to be realized in the progress of modern civilized communities. But this value can not be rightly perceived, and set on its true footing, until the extreme claims of abstract analysis have broken down in the presence of unforeseen and refractory elements of fact.

Among the papers in this interesting volume we have been most impressed with those on the "Laws of Nature and Laws of Man," "The Theory of Persecution," "The Casuistry of Common Sense," and a "Review of Spencer's 'Data of Ethics.'"

A History of the People of the United States, from the Revolution to the Civil War. By John Bach McMaster. In five volumes. Vol. I. New York: D. Appleton & Co. Pp. 622. Price, $2.50.

In two provinces of thought, not formerly regarded as scientific, a powerful influence has, nevertheless, been exerted by the physical science of the present century—we refer to philology and to history. It is not the students of these subjects that have initiated the changes they have respectively undergone: the influence exerted has been indirect, and the result of the habits of thought engendered strictly within the physical sphere. Yet so considerable has been the impression made upon these subjects in this direction, that it is much more common now than it formerly was to speak of the science of philology and the science of history.

In the case of history, other influences, no doubt, have come into play to modify it, yet the reaction of the scientific method is seen in the more rigorous scrutiny of historic evidence, in the clearer conception of a natural order in human society, and in the greater importance assigned to the environing conditions of nature. But besides this it has been the effect of science to compel a closer attention to and a higher estimate of elements formerly neglected or overlooked. Science has thus concurred with the general advance of democratic ideas in giving greater consideration to the character and interests of the common people. Macaulay was no scientist, but he was a man of sufficient breadth and sagacity to discern the unmistakable tendencies of modern thought to obliterate the old factitious distinctions between the dignified and the vulgar in historic exposition. Down to the time of this writer, history remained very much what it had always been, a chronicle of the doings of kings, commanders, diplomatists, and the ruling classes of society. He made an epoch in historic literature by first systematically taking the people into account in his delineation of the progress of historical events. His example has been inevitably followed by other authors, so that a new quality, so to speak, has been given to recent historic works. Mr. McMaster's book has been written from a thorough appreciation of the later point of view. It is a history, and the first yet attempted, of the *people* of the United States. It is said it is an imitation of Macaulay; but it is high praise to recognize it as a successful imitation of his method in a new field.

It is not, however, to be supposed that Mr. McMaster has ignored the political aspect of the history of the country, or neglected the eminent political characters that have figured in American affairs. No account of the American people would be at all sufficient that did not give prominence to their relations to government. The citizens of the United States have always been participants in the political activity of the country; more so, indeed, than has been the case in any other nation. The work before us is, therefore, necessarily to a large extent a political history, and in the first volume, now issued, we have an interesting survey of the movements of the various communities which were at length fused into a national unity by the adoption of the Constitution of the United States.

Yet that which distinguishes the work is the detailed delineation of those various social conditions, characteristics, and habits of the common people, which are both of intrinsic importance in themselves and indispensable to the understanding of the course of political action. The pictures of the social life of the people at the close of the Revolution, in the various modifications it manifested in different localities, are most instructive. The accounts of the morals and manners, education and religion, professions and industries, the diet and dress of the people, their ideas and prejudices, the conflicts of sects and parties, the condition of cities, and the particulars of country life, in short, all the circumstances by which the complexion of society was affected, are described with a freshness of illustration which shows the most indefatigable and extended research into all available sources of information upon the subject.

This characteristic alone would give a fascinating interest to Mr. McMaster's volume, but that interest is greatly enhanced by the clearness, directness, simple earnestness, and often the eloquence of his style. This history is emphatically a book for the people, not only in the import and adaptation of its subject-matter, but in its thoroughly popular literary form. It is a book to please everybody. History here descends from its rhetorical stilts, and uses the plain vernacular of common sense, without abating a jot of its attractiveness. There is no fine writing, no straining after effect, because the interest of the topics is abundantly sufficient to maintain the reader's attention. We congratulate the author on the success of his undertaking, and all his readers on the pleasure they will have in perusing his book.

Pharmaceutische Rundschau. (Pharmaceutical Review.) Published by Dr. Fr. Hoffmann, 64 Ann Street, New York. Monthly. Pp. 24. $2 a year.

This new publication, conducted by a gentleman of the best standing in his profession, starts out with the promise of being a journal of a high order and a valuable addition to the literature of scientific specialties. It is devoted to the scientific and professional interests of pharmacy and kindred branches in the United States, and labors with well-directed vigor in every department for the maintenance and elevation of the standard of scientific attainment in its profession. The February number contains editorial articles on "Pharmacy and Public Sanitary Conditions," and "Pharmacy and Homœopathy." In the March number the editor, under the heading "Kurpfuscherei?"—which we might translate "Cure-bungling"—presents a well-considered and well-tempered discussion of the propriety of allowing apothecaries to dispense medicines, and of requiring them to qualify themselves to do so with discretion. The two numbers contain original contributions on the testing of liquorice-juice and of quinine-pills, sorghum-sugar, mass-analysis, the "Pharmacopœia of the United States," and the preparation of medicinal doses by compression. A considerable part of each number is occupied with the systematic presentation in a compressed form of notable facts in the progress of the science as currently recorded in the various journals of this and other countries, and to the proceedings of pharmaceutical societies and associations.

Whence, What, Where? A View of the Origin, Nature, and Destiny of Man. By James R. Nichols, M. D., A. M., Editor of "The Boston Journal of Chemistry." Third edition, revised. Boston: A. Williams & Co. Pp. 198. Price, $1.

This thoughtful volume consists of inculcations, reflections, and speculations touching those questions of the origin, nature, and destiny of man that have ever been regarded as of transcendent interest. How man has originated, what is the true constitution of his being, and how he stands related to the great indefinite future, are inquiries that, on the one hand, find simple answers in the beliefs of uninstructed people, and which, on the other hand, have tasked the highest philosophy of all ages, with no final agreement. But, although there remains, perhaps, as much conflict as ever over these problems, it would be wrong to say that the outcome of inquiry in all these directions has been futile. Certainly, as regards the whence and the what of humanity, a great deal is now known of which men in earlier times were profoundly ignorant. Man's nature—that is, the laws of his constitution—has been studied with fruitful results, and the laws and the knowledge thus obtained have thrown a not entirely uncertain light upon the question of his origin. Of one thing we have positive assurance: the order of phenomenal nature, of which man is a part, is no inscrutable secret; it is open to the research of reason, and it is capable of being understood as far as the nature of human intelligence will permit. The field is, therefore, open in which we may verify and extend the inquiries already begun in regard to what man essentially is and whence he has originated—the field of orderly, phenomenal, explorable nature.

But there are those—and they are possibly more numerous in these days than ever before—who maintain that man is shut into the present sphere by inexorable limits, and that, while he remains the being he is, he can never know that which is beyond the cosmical sphere of his observation and experience. They hold that this human intelligence is finite, and therefore by its quality is restricted to finite things, and can never grasp what is beyond the finite. They claim that, in its very essence, knowing is but a recognition of finite relations; that mind itself has been evolved and constituted by intercourse with nature, and is without capacities to deal with any other sphere of being. They insist that, as the human mind is finite and limited, it must stop somewhere by virtue of inherent incapacity, and that this boundary is the phenomenal sphere of being. That there may be other orders of being, and other universes beyond, they do not deny; but they say that our relations to them can never include a knowledge of them in the sense in which the term knowledge is applied to the surrounding order of things.

But the protest against this circumscription of the human mind is ancient, universal, and very deep in human nature. It is held that man has as much right to be measured by his aspirations as by any other of his psychical traits, and that he has reaches of intuition and inspirations of insight that will not be hemmed in by his transient experiences of time and space. They say he has a bodily organism by which he is confined to a very narrow area upon the little planet which he inhabits, but that, nevertheless, in virtue of his higher capacities, he makes himself at home in a universe of which he can nowhere find the limit, and they hold that this fact gives high assurance that there may be still vaster possibilities and extensions in the ever-unfolding future.

The author of the little book before us belongs to this class which refuse to be shut in by the material limitations of the surrounding world. While admitting that science is phenomenally circumscribed, they hold that the unknown may not be exhausted by its methods. The book is a quiet but earnest presentation of the considerations which, in the mind of the writer, are sufficient to justify a steadfast faith in man's immortal future. It is impossible here to give any synopsis of the course of Dr. Nichols's reasoning; but those who are interested in its line of thought will find that its arguments are ingenious and instructive, and by many they will undoubtedly be regarded as cogent and valid. But they are not put forward in any dogmatic spirit. They aim simply to be suggestive and helpful, and from this point of view there are multitudes who will find them satisfactory.

Bulletin of the Archæological Institute of America. I. January, 1883. E. H. Greenleaf, Secretary. Boston: A. Williams & Co. Pp. 40.

The work of the Institute was carried on at the ancient Greek city of Assos, in Asia Minor, during the spring, summer, and autumn of 1882, with fruitful and interesting results. The explorations, not yet completed, will be continued during the present year, till the expiration of the permission which has been accorded by the Turkish Government. It is probable, the report states, that, when all is done, "the remains at Assos will not only present the most perfect idea of a Greek city that is anywhere to be obtained, but will afford a better insight into the life of an antique city than is to be gained even from the streets and houses of Pompeii." Mr. Ad. F. Bandelier presents an interesting summary of his work in New Mexico, chiefly among the ruined pueblos, and outlines the plan of a journey of archæological exploration which he is now making through the comparatively unexplored regions of the Mexican border.

On the Loess and Associated Deposits of Des Moines. By W. J. McGee, of Farley, Iowa, and R. Ellsworth Call, of Des Moines, Iowa. New Haven, Connecticut: Tuttle, Morehouse & Taylor, Printers. Pp. 24.

We have here a careful study in local geology and physical geography, from which interesting conclusions are drawn respecting the contour of the glacial terminal moraine and the conditions under which the drift-deposits were accumulated in the region of Des Moines. The peculiar fact is brought out that the rivers in this region have avoided low-lying plains and sought elevated plateaus and ridges of both sedimentary rocks and quaternary deposits, and that their general course is at right angles to the mean slope of the surface which they drain.

"Papilio." A Monthly Journal, devoted solely to Lepidoptera. Henry Edwards, Editor, 185 East 116th Street, New York. Price, $2 a year.

The publication of this journal has now been continued for over two years, the first number having appeared in January, 1881. During this time it has contained articles upon the insects within its scope, by the most distinguished entomologists in Europe and the United States. The two volumes that have been completed contain, together, about 430 pages of matter and six colored lithographs, besides several woodcuts of interest. As occurs in the early career of most natural history publications, this magazine has entailed upon its projectors a heavy loss. But they are still full of hope, and urgently ask of all who recognize the importance of such a publication, that such help as can be afforded may be freely given, in order that so excellent a labor may not be allowed to languish for the want of a little support at a critical period.

Admirable papers on subjects connected with Lepidoptera are either in hand or promised by their authors for the present volume. Each monthly part contains from eighteen to twenty-five pages, and at least four colored plates will be given during the year. For its aims, value of its articles, and general appearance, "Papilio" is one of the cheapest scientific publications in the world, and its directors promise that nothing shall hereafter be wanting on their part to maintain it in the high position to which it aspires.

A Practical Treatise on Diseases of the Skin. By Louis A. Duhring, M. D., Professor in the Hospital of the University of Pennsylvania. Third edition, revised and enlarged. Philadelphia: J. B. Lippincott & Co. Pp. 685. Price, $6.

This is a competent and comprehensive work that admirably fulfills the aim with which the author says he set out, "to write a concise and practical treatise, one which, while making no pretensions to being exhaustive, should comprise sufficient to afford a clear insight into the elements of dermatology, and a knowledge of the important facts in connection with each disease treated of." Simplicity and intelligibility have been primarily sought, and therefore questions of theory, discussions of unsettled points, and obsolete terms have been avoided. The classification of Hebra has been adopted, with some changes and modifications. The definitions of the diseases have been made from the clinical stand-point, with a view to giving them practical value, and to having them embody succinct descriptions of characteristic symptoms. In the matter of treatment, the methods favorably regarded by dermatologists at large have been mentioned, and the author has furthermore taken the pains to describe the remedies and mode of treatment which have proved of the greatest benefit in his own experience. The work was considerably enlarged in the second edition, with many additions and new chapters, and was entirely rewritten to meet the remarkable progress which had been made in the science of dermatology during the five years since the first edition was published, in 1876. Then, in a little more than another year, a critical revision was called for, with a rewriting and elaboration of the chapter on the anatomy and physiology of the skin, for the sake of incorporating the later results of the studies in microscopic anatomy. Advantage was taken of the revision to introduce additional cases illustrating rare forms of disease, and new and important observations and personal experiences. The method and arrangement of the treatise deserve commendation. The general considerations of the subject are given in the first part under the headings "Anatomy and Physiology," "Symptomatology," "Etiology," "Pathology," "Diagnosis," "Treatment," "Prognosis," and "Classification." The second part is devoted to the account of special diseases, which are classified as "Disorders of Secretion," "Hyperæmias," "Inflammations," "Hæmorrhages," "Hypertrophies," "Atrophies," "New Growths," "Neuroses," and "Parasites." In connection with each disease are given its synonyms, a general description in a sentence, its symptoms, diagnosis, etiology, pathology, prognosis, treatment, and, when proper, illustrations. The curious facts are brought out by the author that skin-diseases manifest variations of type in different parts of the world; that the differences are quite material between the United States and Europe; and that the diseases met with here resemble more closely those of Great Britain than those of either France or Germany. These facts give the work the more value as an American treatise describing American types of disease.

A Dictionary of Electricity; or, The Electrician's Hand-Book. By Henry Greer. 1883. Pp. 192. Price, $2. To be obtained of the author, College of Electrical Engineering, 122 East Twenty-sixth Street.

The Storage of Electricity. By the same. 1883. Price, $1.

Mr. Greer hopes, in the preface to his dictionary, that "the explanations may meet the wants of students and others engaged in these professions" (electrical and telegraph engineering), and it may be presumed that such was his object in preparing it; but had he been attempting instead to crowd the greatest amount of rubbish possible into the least space, he would have had no occasion to depart widely from his present performance. One example—his description of the Edison steam-dynamo—will suffice to show the accuracy and lucidity of the definitions of this remarkable dictionary:

Dynamo-Machine, Edison's Large.—This is a machine directly in the piston of an engine, and is composed of four electro-magnets, the poles, and with pipes for the circulation of air. The machine and Porter & Allen's engines are all built on a cast-iron base, the whole weighing about twenty-two tons. The field-magnets are of cast-iron, and the resistance varies between one and two ohms. The magnets are wound with No. 10 wire, Brown and Sharp gauge. The enormous pole-pieces are of cast-iron, and Edison maintains the necessity for using such pole-pieces. The armature consists of a steel shaft six inches in diameter. Mr. Edison and many other electricians claim that a low-resistance machine is the best form. Edison's latest dynamo-machine has a resistance of one two-thousandth of an ohm. Ninety-seven per cent of the electricity out of the machine is available.

The pamphlet on the storage of electricity has the advantage of the dictionary in that Mr. Greer's work consists in little more than editorial revision. The pamphlet contains a good part of Professor Sylvanus Thompson's excellent lecture before the Society of Arts on the storage of electricity, the advantage of the storage-battery as set forth in the circular of the Brush-Swan Company, and the statement of the value of the Faure battery given in the circular issued by the American company controlling this apparatus, together with descriptions of various other storage-batteries, some taken from different technical journals, and some written by Mr. Greer.

On Prehistoric Trephining and Cranial Amulets. By Robert Fletcher, Acting Assistant-Surgeon, United States Army. Washington: Government Printing-Office. Pp. 32, with Nine Plates.

Though published as one of the documents of the Powell Geographical and Geological Survey, the matter of this monograph is more European than American, but is susceptible of an American application. The author has aimed, starting from Broca's summary of the subject in 1877, to collect the accounts of discoveries of examples of trephining and cranial amulets scattered through the journals of anthropology, not only on account of their interest in themselves, but also for the sake of the illustration and guidance they may afford in American research. Numerous curious instances of the practice of trephining and the fabrication of amulets are brought to light, and the conclusions are adduced that the large number of perforated crania, exhibiting cicatrized edges, establishes the existence of a custom of trephining; that the operation was performed on both sexes, and generally at an early age; that it seems (from analogy) to have been for the relief of disease of brain, injury of skull, epilepsy, or convulsions; that it was probably performed by scraping, possibly by a series of punctures; that posthumous trephining consisted in removing fragments of the skull of a person who had undergone surgical trephining, in which each fragment was probably to form an amulet to protect from the same disease or injury for relief of which the operation had been performed; and that the evidence so far confines the custom to neolithic man on the Continent of Europe.

The Naval Use of the Dynamo-Machine and Electric Light. By Lieutenant J. B. Murdock, U. S. Navy, U. S. Naval Institute, Annapolis, Md. Pp. 44.

In this paper, Lieutenant Murdock has collected and compiled from the current scientific literature of the day such information bearing on the subject as will enable one to reach a more exact comprehension of the field open for the electric light in modern naval warfare. The applicability of the various machines and apparatuses that have been introduced is discussed, and the modifications are considered that may be necessary to adapt them to use on shipboard.

"The Sociologist." A Monthly Journal devoted to the Increase of Knowledge of the Natural Laws that control Human Happiness. Adair Creek, Knox County, East Tennessee: A. Chavannes & Co. Pp. 16. Fifty cents a year.

The publication of this journal has been undertaken for the love of the cause. The editor has sought for a paper especially devoted to the study of sociology, and, not finding it, has decided to furnish one. Profit is not the especial object of the publishers, but to create a means of communication and a means of exchange of thoughts and opinions.

"Journal of Social Science," containing the Transactions of the American Association, December, 1882. Saratoga Papers of 1882. Boston: A. Williams & Co. New York: G. P. Putnam's Sons. Pp. 164. $1.

The present number of the "Journal" contains, besides the opening address of the President of the Association, Professor Francis Wayland, and the report of the General Secretary, the papers read at the meeting in the Health and the Social Economy Departments. Among the papers in the former department we notice especially those of Dr. Ezra M. Hunt, on "The Health Care of Households, with Especial Reference to House Drainage"; of Dr. D. F. Lincoln, on "The Health of Boys' Boarding-Schools"; of Dr. E. M. Mosher, on "The Health of Criminal Women"; and of Dr. A. N. Blodgett, on "The Management of Chronic Inebriates and Insane Drunkards." Two papers in the Social Economy Department, those of Mrs. Robinson on "Early Factory Life in New England" and Lucy Larcom on "American Factory Life," depict a condition of life and, intelligence among factory-operatives, and relations between employers and employed, which Americans were once proud of, and foreigners admired, but which have now—thanks largely to the protective policy—become things of the past, and which we can hardly hope to enjoy again.

On the Value of the "Nearctic," as one of the Primary Zoölogical Regions. By Professor Angelo Heilprin. Philadelphia. Pp. 20.

The "Nearctic," in Messrs. Sclater and Wallace's classification, corresponds with the North American zoölogical region, as distinguished from the Palæarctic or Eur-Asian, and the Neotropical, or South American, regions. The question under discussion is "whether the Nearctic region should be kept separate, or whether it should form part of the Palæarctic or of the Neotropical regions." Eminent authorities differ on the subject. Professor Heilprin makes an examination, by families, genera, and species, of the mammalia, birds, reptiles, and partially the butterflies and mollusca of the three regions, inquiring how many of each are common to the Nearctic and one of the two others, and to which of the two; and concludes "that, by the community of its mammalian, batrachian, and reptilian characters, the Nearctic fauna . . . is shown to be of a distinctively Old World type, and to be indissolubly linked to the Palæarctic (of which it forms only a lateral extension)." The conclusion is further illustrated by the mollusca and the butterflies.

Department of Agriculture: Report of the Entomologist for the Year ending June 30, 1882. By Charles V. Riley, M. A., Ph. D. Washington: Government Printing-Office. Pp. 168, with Twenty Plates.

The present report, which necessarily covers only a small part of the work actually done in the entomologist's office, is devoted to some of the more important observations and experiments of a practical nature on such subjects as the cultivation of pyrethrum and its use as an insecticide, silk-culture, the cotton-worm, the chinch-bug, the army-worm, the insects affecting the orange and those affecting rice, some new depredators on corn, and various miscellaneous insects that attracted more than usual attention during the year. The large number of letters, asking for information, received at the office, has led to the preparation of bulletins on special subjects to be sent out. Such bulletins are ready on the Northern army-worm, the boll- or corn-worm, and canker-worms, and others are in preparation on cabbage-insects and the chinch-bug. Three special reports, which will be more bulky, are in preparation—a bibliography of economic entomology, and reports on the insects affecting the orange-tree, and forest-tree insects.

Bulletin of the Buffalo Naturalists' Field Club. Vol. I. Nos. 1 and 2. Charles Linden, President; George S. Wardwell, Corresponding Secretary. Buffalo, N. Y.: W. W. Hicks, Printer. Bimonthly. Pp. 48. Price, $1 a year.

The club was organized in 1880, and has shown great vitality and enlisted much interest. Being in a condition to establish a periodical of its own, and that seeming desirable, it has originated the "Bulletin," the plan of which is to publish brief summaries of general papers read at the winter meetings of the club, short original papers, or memoirs on all branches of natural science, and notes on the occurrence and habits of local plants and animals. While practical work and research are especially cultivated and encouraged, the æsthetic is not disdained, and we find the "Bulletin" as bright on that side as it is instructive on the other. Among the papers which may be mentioned as of general interest are Mr. Cowell's study of the "Adventives"—plants that have been brought, by the railroads and other means, from distant points—that have made their appearance in the stock-yards at East Buffalo, and Professor Linden's account of prominent objects of scientific interest within convenient access of the city and its neighborhood.

Report of an Exploration of Parts of Wyoming, Idaho and Montana, in August and September, 1882, made by Lieutenant-General P. H. Sheridan. Washington: Government Printing-Office. Pp. 69.

The report is accompanied by the itinerary of Colonel James F. Gregory, and a geological and botanical report by Surgeon W. H. Forwood. The expeditions centred around the Yellowstone National Park. General Sheridan recommends an enlargement of the park by extending it about forty miles east and ten miles south, and making it a national game reservation, within which the killing of game shall be prohibited. Colonel Gregory's journey resulted in a demonstration of the practicability of the route into the park from the forks of Wind River, by way of Lincoln Pass, the valleys of the Gros Ventre and Snake Rivers and Lewis's or Lake Fork of the Snake River. Surgeon Forwood's report illustrates the general features, natural history, and resources of the regions explored.

The Place of Original Research in College Education. By John Henry Wright, Associate Professor of Greek in Dartmouth College. Boston: Alfred Mudge & Son, Printers. Pp. 29.

"Original research," as used by the author in connection with a college education, means chiefly work pursued in subjects embraced in college instruction; and, inasmuch as the major part of the college course is made up of linguistic, literary, historical, and philosophical studies, the topics of inquiry are ordinarily drawn from those fields, as well as from physical science, in connection with which the term is more commonly used. The essential character of the work is that it consists in and is based upon direct personal observation and actual examination, together with inductions suggested by the facts investigated and discovered, made independently by the inquirer and without outside help. In the recorded results of the studies, the matter of chief consequence will be the earnest, independent work, the exact observation, and the hard thinking that they represent. The manner in which research of this kind is furthered and encouraged at the German universities and seminaries is described; the question whether similar methods can be applied at American institutions is answered in the affirmative; and observations and suggestions are added as to the manner in which the applications may be made.

A Study of the Manuscript Troano. By Cyrus Thomas, Ph. D. With an Introduction by D. G. Brinton, M. D. With Nine Plates. Washington: Government Printing-Office. Pp. 236.

This is an attempt to give intelligibility to one of those mysterious documents which have been left to us from the former masters of Central America; from the people who probably built some of the cities the ruins of which are numerous in that region, and were the authors of the inscriptions of Palenque. The manuscript, or Codex Troano, was so called by the Abbé Brasseur de Bourbourg, after the gentleman, Don Juan de Tro y Ortolano, of Madrid, a descendant of Hernando Cortez, in whose possession he found it. It is written, like the two other Maya codexes which have been chromo-lithographed and published, on paper manufactured from the leaves of the maguey plant. In form, it was folded into thirty-five folds, like the panoramic books of illustrations or "souvenirs," which are sold at the watering-places, and was written on both sides of the folds, giving seventy pages. The inscriptions consist of lines and columns of characters and numerals occupying the top and left side of the page, and inframing, in the rest of the space, symbolical or descriptive figures. Dr. Thomas, who acknowledges that his investigation is not as complete as he would desire, but deems it best to give the results tentatively, concludes that the work was intended chiefly as a ritual or religious calendar, to guide the priests in the observance of religious festivals, in their ceremonies, and in other duties; that the figures in the spaces are symbolical or pictographs, and refer to religious ceremonies or to the habits, customs, and occupations of the people; that the work appertained to an inland, peaceable, and sedentary people; and that the original of it was written in about the middle or latter half of the fourteenth century. Dr. Brinton gives, in his introduction, a summary of what is known respecting the Maya language and writings, which, it must be borne in mind, are quite distinct from those of the Aztecs. Two other Maya manuscripts have been published in chromo-lithography, but no attempt appears to have been made to decipher them, and several are believed to exist in private hands. In addition to the manuscripts, we have the mural paintings and inscriptions of Palenque, Copan, Chichen Itza, and other ruined cities, of the same general character. The use of the Maya mode of writing ceased after the Spanish conquest, on account of the intolerance of the priests, but many books were written by natives in their own language with the Spanish alphabet, a number of which still exist.

The Elements of Forestry. By Franklin B. Hough, Ph. D., Chief of Forestry Division, United States Department of Agriculture. Cincinnati: Robert Clarke & Co. Pp. 381. With numerous Illustrations. Price, $2.

This work is designed to afford information concerning the planting and care of forest-trees for ornament or profit, and to give suggestions upon the creation and care of woodlands, with the view of securing the greatest benefit for the longest time; and is particularly adapted to the wants and conditions of the United States. The author believes it to be the first attempt to present, in our language, and in one volume, the subject of forestry in the comprehensive sense in which he has defined it. He has endeavored to adapt the work to the wants of students of the subject, whether they be in the class-rooms of an institution, or engaged in practical labors, and to present information applicable to our own country, and to those regions where tree-planting is most needed, and often most difficult. The matter of the treatise has been admirably condensed, so that the volume is made to contain an amount of information, all of practical bearing and well expressed, that might have been made to fill two or three times the space without appearing "padded." Besides reviewing the general principles of forest botany, forestry, and the growth of trees in their various aspects, it includes chapters on the reproduction of trees from seed, and by other methods; the best manner and systems of planting; special suggestions on ornamental planting, and planting for hedges, screens, and shelter-belts; forest-fires, and protection from them, and from other sources of injury; the ravages of insects; the profit of forest cultivation; the acts of Congress in reference to timber-rights; European plans of forest management; the cutting and seasoning of wood, defects in timber and processes for increasing the durability of timber and improving its quality; the various products obtained from wood and trees; descriptions of particular species of trees, their uses and adaptations; with a special chapter on the conifers; and tree-planting in Kansas and Nebraska — the whole constituting a treatise at once scientific and practical.

The American Journal of Forestry. Vol. I. Nos. 1, 2, and 3, October, November, and December, 1882. Edited by Franklin B. Hough, Ph. D. Cincinnati: Robert Clarke & Co. Pp. 48 each. Price, $2 a year.

This new publication is devoted to the interests of forest-tree planting, the formation and care of woodlands and ornamental plantations generally, and to the various economies therein concerned, and comes very appropriately when public attention is called to the subject by a dozen different influences and agencies. The present numbers are occupied to a considerable extent with the proceedings of the American Forestry Congress, at its Cincinnati and Montreal meetings, and publish some of the valuable papers that were read there. One of the most noticeable papers is that of Mr. Charles Mohr, of Mobile, Alabama, on the

"Distribution of the more Important Forest-Trees in the Gulf Region." The editor contributes observations in forestry matters made by him during a recent journey in Europe; Professor Spalding, of Ann Arbor, a paper on "Forestry in Michigan"; and Dr. Warder, of Ohio, accounts of experimental forest plantations in Iowa and near Waukegan, Illinois.

The Scientific and Technical Reader. London, Edinburgh, and New York: T. Nelson & Sons. Pp. 400. Price, 2*s.* 6*d.*

The "Reader" is a compendium of brief selections in different departments of science, usually from standard authors, arranged so as to present a general order of collection, and designed to instruct the reader on the subjects discussed in an agreeable manner. The selections are classified and arranged under the heads "Geographical," "Geological," "Botanical," "Zoölogical," "Physiological," "Physical," and "Technical."

Tables for the Use of Students and Beginners in Vegetable Histology. By D. P. Penhallow, B. S. Boston: S. E. Cassino. Pp. 41. (With blank pages for notes.)

This work was first conceived as an aid to the author's own students in vegetable histology. It has been prepared with the aim to bring together the most prominent facts and reactions of an elementary course of histology in such a manner that the student may have them on his work-table ready for immediate and constant reference, and may use them as a general guide. The work being tentative, it has been deemed desirable not to make it too extended till the plan has been approved by qualified judges.

Transactions of the Linnæan Society of New York. Vol. I. New York: Published by the Society. H. B. Bailey, Corresponding Secretary. Pp. 168. Price, paper, $2; cloth, $3.

The Linnæan Society of New York was formed in 1878, with eleven members, and was organized with Clinton Hart Merriam as president; Harold Herrick as vice-president; and Ernest Ingersoll as secretary. Abstracts of its proceedings and various papers read before it have appeared in different scientific serials, but it has felt the need of a direct medium of publication. The outgrowth of that need is the present volume, executed in the highest style of the printer's art, with thick paper and wide margins—a volume worthy of the objects of the society, and of the valuable and interesting papers which it contains. The papers are: "The Vertebrates of the Adirondack Region, Northeastern New York (General Introduction—Mammalia; Carnivora), by Clinton Hart Merriam, M. D.; "Is not the Fish-Crow (*Corvus ossifragus*, Wilson) a Winter as well as a Summer Resident at the Northern Limit of its Range?" by William Dutcher; and "A Review of the Summer Birds of a Part of the Catskill Mountains, with Prefatory Remarks on the Faunal and Floral Features of the Region," by Eugene P. Bicknell. The volume is adorned with a steel-plate portrait of Linnæus, from an old engraving in the possession of Mr. L. S. Foster, as a frontispiece.

Ansichten über die Ursachen der Vulcane (Opinions on the Causes of Volcanoes). Pp. 6. Neptunisch oder Plutonisch? (Neptunian or Plutonian?) Pp. 14. Both by Ed. Reyer, Vienna.

The first of these papers is a review of the three theories—those of interior heat, chemical action, and mechanical action—of the origin of volcanoes, with a discussion of the causes of eruptive phenomena and outbreaks. The second essay considers the relations of granite, porphyry, and lava, and the origin of granite.

The Foundation Principle of Education by the State. By Samuel Barnett. Boston: New England Publishing Company. Pp. 11.

This pamphlet includes the substance of an address delivered before the joint session of the National Teachers' Association and the National Institute of Instruction at Saratoga, in July last. The purpose of the address is to show the close connection between the educational development of citizens and the welfare of the State, and the interest the State has in seeing that educational facilities are provided and improved.

Forest Protection, and the Tariff on Lumber. New York: Spirit of the Press. Pp. 35.

The whole country is suffering to an increasing extent every year from the disastrous effects of the removal of the forests; and the best economical thought of the nation is busy with the problem of preventing further destruction, and repairing the damage that has already been done. Yet the Government, in imposing a tariff on foreign lumber, is offering a premium for further destruction and a direct encouragement to a continued course of ruin. Vigorous expressions of public opinion against this senseless policy have been made through various journals. The most important of the protests are collected in this pamphlet in aid of a fuller discussion and better understanding of the subject, and for the furtherance of measures for forest conservation.

Annual Report of the Connecticut Agricultural Experiment Station for 1882. Address, New Haven, Conn. Pp. 114.

The station was removed on the 1st of September last, from the rooms of the Sheffield Scientific School to the property of five acres, which had been bought for it on Suburban Street, nearly a mile and five eighths from the City Hall of New Haven. The analyses were interrupted at that time, yet nearly the usual number of fertilizer analyses were made during the year, and of these a large proportion were on samples of complex composition. In connection with analyses of salt and saltpeter at the request of the Wilton Farmers' Club, the use of those substances as antiseptic or preservative material is discussed. The testing of milk has assumed much prominence; and in connection with it considerable information of value is furnished respecting the qualities of the specimens examined. In connection with the reports of the analyses of fertilizers, a review of the fertilizer market is given, with notices of the prices of its principal staples; and an interesting observation is reported of the value of marine mud as a fertilizer. The reports on the analyses of ensilage go to confirm, generally, the representations previously made of the value of that preparation. Interesting information and suggestions are given in connection with the seed-tests, of which twenty-four were made, mostly on sweet-corn and onion-seed.

Seed-Breeding. By E. Lewis Sturtevant, M. D., South Framingham, Mass.

The art of breeding seeds consists in producing and selecting such variations as may be found desirable, and then of establishing them so that they shall be transmissible either in their present or in an improved condition, by seed. Beeding may be carried on through the act of selection for several generations under well-considered conditions of environment, by which the heredity of the seed in the desired direction shall be strengthened. Particular attention is given in this pamphlet to the means by which the best selections of seed-corn may be developed, and established in character.

Report on the Development of the Mineral, Metallurgical, Agricultural, Pastoral, and other Resources of Colorado for 1881 and 1882. By J. Alden Smith, State Geologist. Denver, Col.: Chain & Hardy. Pp. 159.

The report claims that, by virtue of the largest returns, Colorado is the head of the mining states of the world as a producer of the precious metals. Its mines have also, for the past two years, furnished more than half the total lead product of the United States. The mining field is very large, embracing nearly all the mountain-ranges, and is extremely inviting to all persons interested in that pursuit. The report is well arranged, and gives in succession a history and description of the railroads of the State, accounts of the resources of the several counties, more general notices of certain mineral and agricultural staples and industries, and a systematic descriptive catalogue of the principal minerals in Colorado.

The Manual Training-School of Washington University, St. Louis, 1882–'83. C. M. Woodward, Secretary. Pp. 45.

The managers of this school do not assume that in other schools there is too much intellectual and moral training, but that there is too little manual training for ordinary American boys. They exact close and thoughtful study with books, as well as with tools; but by abridging a little the number of daily recitations and adding an hour to the usual school-day, they find time for drawing and tool-work. Besides the usual literary training, the students are given a course of tool-instruction, including carpentry, wood-turning, forging, soldering, and bench and machine work in iron, for which shops are conveniently fitted up, and free-hand and mechanical drawing. Each pupil before receiving a diploma must execute a project—the actual construction of a machine, with a full set of working drawings—satisfactory to the faculty. By the peculiar course pursued, the zeal and enthusiasm of the students, in all the departments of the work, have been developed to a most gratifying extent.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Astronomical Photography, pp. 2; Circulars relative to the Collection and Distribution of Astronomical Intelligence, pp. 7; Observations of the Transit of Venus at Harvard College Observatory, pp. 28; Thirty-seventh Annual Report of the Director of the Astronomical Observatory of Harvard College, pp. 15. All by Edward C. Pickering. Cambridge, Massachusetts: University Press.

The Soul and the Body. A Sermon to Medical Students. By the Rev. L. P. Mercer. Chicago: Gross & Delbridge. Pp. 31.

Perpetual Calendar. By President F. A. P. Barnard, Columbia College, New York.

The Garden of Eden (Victoria Woodhull's lecture). Reviewed by Charles Stuart Welles. London. Pp. 30.

"The Freethinkers' Magazine, and Freethought Directory, for the United States and Canada." H. L. Green, Editor and Publisher. Salamanca, New York. Bimonthly. Pp. 44.

The Charge of "Exclusivism" as applied to Homœopathists. By F. H. Orme, M. D. New York. Pp. 8.

Natural Law, or the Science of Justice, pp. 21; A Letter to Thomas F. Bayard, pp. 11. Both by Lysander Spooner. Boston, Massachusetts.

Annual Report of the State Geologist of New Jersey for 1882. By George H. Cook. New Brunswick. Pp. 191, with Plates.

Lectures delivered to the Employés of the Baltimore and Ohio Railroad Company. By Professor H. N. Martin, and Drs. H. Sewall, W. T. Sedgwick, and W. H. Brooks, of Johns Hopkins University. Baltimore: B. & O. R. R. Co. Pp. 98.

Establishment of Secondary Meridians in the East Indies, China, and Japan. Washington: U. S. Hydrographic Office. Pp. 4.

The Pine Moth of Nantucket. By Samuel H. Scudder. Boston: A. Williams & Co. Pp. 22, with a Plate.

"Transactions of the New York Academy of Sciences." Monthly. Pp. 24 $5 per annum.

Annual Address before the American Academy of Medicine, Philadelphia, October, 1882. By Traill Green, M. D., President. Philadelphia. Pp. 16.

The Percentage of College-bred Men in the Medical Profession. By Charles McIntire, Jr., M. D., of Easton, Pennsylvania. Pp. 13.

Iowa Weather-Service Annual. Illustrated. 1883. By Gustavus Hinrichs. Iowa City, Iowa.

Shade-Trees, Indigenous Shrubs, and Vines. By J. T. Stewart, M. D. Peoria, Illinois. Pp. 37.

Dime Question Books. Algebra. By Albert P. Southwick. Syracuse, New York: C. W. Bardeen. Pp. 41. 10 cents.

Illustrations of the Durham System of House-Drainage. New York: Durham House-Drainage Company. Pp. 24.

Houghton Farm Experiment Department. Meteorology and Soil Temperatures. By D. P. Penhallow, B. A. Newburg, New York: Ritchie & Hull. Pp. 57, with Plates.

Maternal Schools in France, pp. 14; Technical Instruction in France, pp. 63. (Circulars of Information of the Bureau of Education.) Washington: Government Printing-Office.

The Selective Absorption of Solar Energy. By S. P. Langley, Allegheny College. Pp. 28, with Plates.

Safety on Land and Sea. By Dr. W. F. Thoms. New York: Published by the Author, 92 Madison Street. Pp. 29.

On some Inclosures in Muscovite. By H. Carvill Lewis, of Philadelphia. Pp. 6, with One Plate.

Surgical Diseases of Women. By Romaine J. Curtiss, M. D., of Joliet, Illinois. Pp. 7.

College of Physicians and Surgeons of Chicago. Announcement. 1883. Pp. 8.

The Early American Chroniclers. By Hubert Howe Bancroft. San Francisco: A. L. Bancroft & Co. Pp. 45.

How can we escape Insanity? By Charles W. Page, M. D., of Hartford, Connecticut. Pp. 22.

The Order of Mental Disorder. By Orpheus Evarts, M. D. College Hill, Ohio. Pp. 8.

Monthly Weather Review (U. S. Weather Service). Washington: Office of the Chief Signal Officer. Pp. 23, with Four Plates.

Consultation Chart of the Eye Symptoms and Eye Complications of General Diseases. By H. G. Cornwell, M. D. Columbus, Ohio: H. C. McClelland & Co. P. 1.

"The Jeweler's Circular and Horological Review." D. H. Hopkinson, Editor and Proprietor, 42 Nassau Street, New York. Monthly. Pp. 88. $2 a year.

Pocket Logarithms to Four Places of Decimals, etc. New York: D. Van Nostrand. 1883. Pp. 139. 50 cents.

American Humorists. By Rev. H. R. Haweis, M. A. New York: Funk & Wagnalls. 1882. Pp. 1805. 75 cents.

Studies in Logic. By Members of the Johns Hopkins University. Boston: Little, Brown & Co. 1883. Pp. 203. $2.

The Alternative: A Study in Psychology. London: Macmillan & Co. 1882. Pp. 387. $2.75.

The Diadem of School Songs. By W. M. Tillinghast. Syracuse, New York: C. W. Bardeen. Pp. 160. 50 cents.

Wealth Creation. By Augustus Mongredien, with Introduction by Simon Sterne. New York, London, and Paris: Cassell, Petter, Galpin & Co. 1883. Pp. 308. $1.25.

Science in Short Chapters. By W. Mattieu Williams. New York: Funk & Wagnalls. 1883. Pp. 308. $1.

Our Choir. By C. G. Bush. New York: G. P. Putnam's Sons. 1883. Pp. 20. Illustrated.

Leading Men of Japan. By Charles Lanman. Boston: D. Lothrop & Co. 1883. Pp. 421. $2.

Bulletin of the United States Fish Commission, vol. i, for 1881. Washington: Government Printing-Office. Pp. 465.

A Manual of Chemical Analysis. Third edition, revised and enlarged. By Frederick Hoffmann, A. M., Ph. D., and Frederick B. Power, Ph. D. Philadelphia: Henry C. Lea's Son & Co. 1883. Pp. 624.

Compendium of the Tenth Census. Part I, pp. 923; Part II, pp. 847. Washington: Government Printing-Office. 1883.

Annual Report of the Chief Signal-Officer for the Year 1880. Washington: Government Printing-Office. 1881. Pp. 1,120, with 119 Maps and Charts.

The New Cyclopædia of Family Medicine: Our Home Physician. By George M. Beard, A. M., M. D. New York: E. B. Treat. 1881. Pp. 1,506. Illustrated. $7.50.

First Annual Report of the Bureau of Ethnology. 1879-'80. By J. W. Powell, Director. Washington: Government Printing-Office. 1881. Pp. 603. Illustrated.

POPULAR MISCELLANY.

Fossil Man in America.—The question of the contemporaneity of man with the horse and other pliocene mammals was recently brought up, in the Academy of Natural Sciences of Philadelphia, in the presentation of some fossil remains of horses by Professor Leidy. Professor Cope said that he believed that the contemporaneity would soon be satisfactorily established, and brought forward the Calaveras skull, which was said to have been taken from the gold-bearing gravel of California, and two observations of his own, made in 1879 in Oregon and California, as further confirmatory of the point. The "Carson foot-prints" of Nevada could also be placed in evidence, for they probably belonged to an ancestor of existing man. Professor H. Carvill Lewis insisted that caution should be exercised in accepting as evidence of pliocene man any facts as yet not verified by scientific observers. While the facts proving a post-glacial man were indisputable, the existence of pre-glacial man, either in our own country or in Europe, was not attested by any scientific evidence. The discoveries in California, made for the most part by miners in search of gold, carried with them several serious objections to the theory of great antiquity. The implements were identical in character with those of modern workmanship, and the Calaveras skull closely resembled that of a modern Indian. The fact is not generally mentioned that implements in all respects similar to those of the auriferous gravel occur upon the surface of the ground, and are believed to be the work of well-known tribes. Neither the Calaveras skull nor the implements have suffered the amount of corrosion or weathering that a great antiquity should have given them. The adherence of compact gravel to the Calaveras skull, which is regarded as a sign of great antiquity, is no evidence at all of it, for the same is seen in the case of modern coins and other objects of known date. The very fact that the relics under consideration all occur in a gold-bearing gravel may indicate the method by which many of them were buried. Gold-mining was carried on, on quite an extensive scale, by the aborigines in these same gravels. Schoolcraft describes an ancient shaft in Table Mountain two hundred and ten feet deep, at the bottom of which human bones and implements were found. The argument from analogy is so strong against the great antiquity of the California relics, that evidence of the most satisfactory kind must be required to support such a conclusion.

Dr. George M. Beard.—The late Dr. George M. Beard, whose articles in the Monthly will be remembered by many of our readers, was a graduate of Yale College, began his medical studies in the same institution, and, after an experience of eighteen months as acting assistant surgeon in the United States Navy, received the degree of M. D. at the expiration of a two years' course in the College of Physicians and Surgeons of this city. Beginning practice in New York, he early turned his attention to the study of nervous diseases, and almost immediately began to write and publish on medical subjects. Among his earlier works "Our Home Physician," 1869, "Eating and Drinking," and "Stimulants and Narcotics," 1871, were designed for popular use, and have, we understand, had a wide circulation. In conjunction with Dr. A. D. Rockwell he published, in 1875, "Medical and Surgical Electricity." "Hay-Fever, or Summer Catarrh" appeared in 1876; "The Scientific Bases of Delusions," 1877; "Nervous Exhaustion," 1880; "American Nervousness, with its Causes and Consequences," 1881.

These are among his more important contributions to medical science, and, with a large number of pamphlets and magazine articles on allied subjects, make up a volume of literary work it is rarely accorded to one man to accomplish. And when we reflect that behind much of it there lies a large amount of observation and experiment on which many of his views are founded, it becomes apparent that Dr. Beard's was an exceptionally busy as well as useful life. Yet, enthusiastic and indefatigable as he was in his chosen field, it must be confessed that the quantity of his work was too often at the expense of the quality. His conclusions were not always as thoroughly matured and as accurately verified as the interests of science demand; or, as a personal friend has said of him, while he had wonderful insight as an investigator, "his defects were too rapid generalization and too positive and comprehensive assertion of results. . . . His fame would be more enduring if he had written five books instead of fifty." Although his work is liable to these criticisms, he undoubtedly did a valuable service in calling attention to and throwing light upon a class of nervo-mental affections which, though very common and the cause of much suffering, are not yet well understood. In their further study the future investigator will find much to aid him in the writings of Dr. Beard, and, as the difficulties of the subject are more clearly realized, the work that he has done will be better appreciated.

Treatment of Stammering.—Mr. J. E. Suitterlin has for eight years conducted an institute in this city for the cure of stuttering and stammering, with most satisfactory success. His system is philosophical and simple, and is based on the plainest common-sense principles. Excluding reliance on medical aids, it comprises chiefly careful drill of the vocal organs, and such mental discipline as will contribute to the object. In the first stage of treatment, the subject is not permitted to talk, except to practice his exercises, and to make such movements in speech as can be guided and observed by the teacher. During this time he is taught to consider himself, not a patient, but a student of speech. In the second stage, which is begun when enough has been done in the first, the pupil is encouraged to talk, for practice, at every opportunity, with a "legato" movement (as in music) and a strong accent. In the third stage he is allowed to talk more naturally, but in a studied manner; and in the fourth stage he is permitted to employ his normal way of speaking, but is by this time relieved from the impediment under which he formerly suffered. The psychic part of the treatment, which aims to divert the pupil's mind from himself and his troubles, is the most difficult and, at the same time, the most essential part. The time required for success depends very largely and, in fact, chiefly on the mental constitution of the subject.

From this brief description of an effective method of treatment, the parent may gather the useful hint that, to remedy any incipient tendency in his child to stammer, he should exercise a mild and kind but firm ruling, suppress all irritability of temper, observe for the child all the laws of health, and be careful as to his own manner of talking and the patterns he may set for the child. By attention to such matters, even the most unskilled may correct the evil before the child begins to be conscious that he is a stammerer; and, by a general regard to such principles as are here laid down, the affliction might be wholly removed or its frequency greatly reduced in the course of a generation or two. The statistics collected and preserved by Mr. Suitterlin show that the stammering habit is contracted, with only very rare exceptions, between infancy and ten years of age.

The First Daguerrean Portrait.—Professor Charles E. West, who was a personal witness of the event, has contributed to the "New York Times" an interesting account of the introduction of the daguerreotype process into the United States, and of the taking of the first portrait by Professor John W. Draper, and not by Mr. A. S. Wolcott, for whom the honor has been claimed. The secret of the process having been bought and published by the French Government, a pamphlet describing it was brought to New York by a Mr. Seger. Professor Morse, to whom the pamphlet was given, employed Mr. George W. Prosch to make an instrument after the description in it. The first picture taken with this instrument—the first daguerreotype of still-life taken in this country—was a view of the old Brick Church and the City Hall in New York, and was a great curiosity. Daguerre's process required an exposure of twenty minutes, and he said that living objects could not be taken by it, on account of the difficulty of their keeping still so long. Professor Draper succeeded in shortening the exposure by substituting bromide of iodine for the iodine used by Daguerre, and with the aid of this compound took the first portrait of the human face. This was in 1839, and the success of the experiment was announced in a note dated March 31, 1840, in the London "Philosophical Magazine" for June, 1840. Professor Morse afterward tried the process, and took a portrait of his daughter. Mr. Prosch opened a daguerrean gallery at the corner of Broadway and Liberty Street, where Professor West was the first to sit for his portrait. The light of the sun was thrown directly upon his face by reflection from a mirror; consequently, he had to shut his eyes, and they were represented closed. Mr. Wolcott was not ready to begin his work till the spring of 1840; but he was successful in taking the best portraits in the city. The question of priority was not raised till 1860, when it was considered by a committee of the American Institute, to whom Professor Draper submitted a written statement, while the friends of Wolcott failed to do so. Draper is also credited in the "Edinburgh Review" for January, 1843, with having been the first person who took portraits by the daguerreotype process.

The Prevention of Insanity.—Dr. Nathan Allen, of Lowell, Massachusetts, in a pamphlet on that subject, calls attention to the prevention of insanity as a question which, although much neglected, is at least quite as important as that of the cure of insanity. The disease is very largely dependent on physical and sanitary conditions, and these should be studied out and brought within such regulation as will prevent its development. Since, according to the late Sir James Coxe, insanity originates in some form of disease or in a deterioration of the body rather than in an exclusive affection of the nervous system, its growth should be checked by a general diffusion of the knowledge of the laws of the human organism and the use of all means necessary for the preservation of good health. So far as insanity is hereditary, its transmission should be prevented by avoiding marriage with persons predisposed to it. It should be the aim of the medical profession to become so well acquainted with the diseases of the nervous system and the brain that they could detect the first symptoms of disturbed or deranged states of mind, so as to be able to treat them understandingly, and, in all probability, in many cases successfully.

The New York State Museum of Natural History.—The Trustees of the New York State Museum of Natural History, having about eight thousand square feet of space available for the exhibition of specimens requiring twenty-one thousand square feet for their proper display, complain that the present museum-building has become entirely inadequate for its intended purpose. Relief is anticipated, however, from the gradual occupation of the State Hall, a fire-proof building, which is authorized as fast as its rooms may become vacant by the removal of State offices to the new Capitol. A consolidation of the scientific work done under the patronage of the State, which is now scattered under several distinct heads, is recommended by the trustees, so as to make it all a part of the museum. The reports of the museum, and the scientific work generally, now lagging far behind, under the operation of the political patronage and plunder system of printing, are impatiently waited for by the scientific world, and the trustees suggest that the demand could be more speedily and fully satisfied if the printing of them were intrusted directly to the institution. Four volumes of valuable museum reports are still unprinted, though long due. Of the Geological Survey's work on Paleontology, five parts have been published in seven bound volumes. Five bound volumes are required to complete the work, for which a considerable proportion of the plates and manuscript are prepared. Seventeen letters and declarations, from as many eminent scientific men and societies, are published, in connection with the statement of the trustees of the museum, attesting the anxiety with which they are looking for the completion of this, one of the most important and meritorious works of the kind ever attempted.

The Solar Eclipse of May, 1883.—M. Janssen announced in the French Academy of Sciences, on the 26th of February, that the French Scientific Expedition to observe the total eclipse of the sun in May would start on the 6th of March, to meet at Panama a French naval vessel which would take it to Caroline Island, a hundred leagues north of Tahiti. After the observation is completed, the expedition will proceed to Tahiti and San Francisco, whence M. Janssen proposes to visit the observatories and scientific establishments of the United States. Search for intra-Mercurial planets will be made for the first time by the aid of photography. A grand photographic apparatus has been prepared to take in the whole field surrounding the sun for about thirty degrees, which will furnish images, if the sky is clear, of all the stars to the eighth magnitude. Gelatine plates of extreme sensibility will be employed. Other instruments are provided for photographing the corona and its spectrum, for examining the spectrum of the corona, and for the exploration of the solar regions. Several foreign astronomers will be attached to the expedition at their own request, and the American and English expeditions will co-operate with it at the same place; so that the ordinarily uninhabited Island of Caroline will become, for the hour, the scientific center of the world. It will enjoy this distinction chiefly because it and Flint Island, not very far off, are the spots most favorable for the observation of the eclipse. This eclipse is expected to offer unusual facilities for observation, on account of the long duration of totality ($5^{m.}\ 33^{s.}$ at Flint Island, $5^{m.}\ 13^{s.}$ at Caroline Island).

What shall we do with our Drunkards?—Dr. Orpheus Everts, Superintendent of the Cincinnati Sanitarium, in an inquiry on "What shall we do with the drunkard?" regards drunkenness as a disease. The only ways of dealing with it effectually are by prohibition of the sale of intoxicating liquors and inhibition or restriction of the drunkard. The former measure he dismisses as essentially impracticable, on account of the antagonism it must always excite; and he is left only the latter one, which he would have surrounded with the sanctions of the law. He proposes a scheme of a law for the establishment of Public Hospitals for the Cure of Drunkenness and Conservatories for the Protection of the Infirm, to which persons defined by it as coming under its import may be formally and legally committed for cure or care. When thus committed, they should be allowed every liberty or natural right which can be conserved without lessening the efficiency of the law, and should be protected, under the sanction of stringent penalties, against assaults upon their weakness, or temptations from any source.

Niagara Falls as a State Park.—The movement for the rescue and preservation of Niagara Falls is gathering strength, and is now seeking legislative action, authorizing the appointment of a commission to examine the question and estimate the cost of carrying out the project as an enterprise of the State of New York. It is a real disgrace to our people that this, the most wonderful object of the kind on the earth, the first feature of our natural scenery which strangers from all climes hasten to see, and which ought of right to belong to mankind, should have been left in the hands of speculators till it has been shorn of many of its natural beauties, and it can not be seen at all from our territory except on the payment of a showman's fee. By reason of these facts, and the endless extortions characteristic of the place, what used to be one of the favorite pleasure-grounds of the continent is now visited for a few hours only, as a kind of side-show, and that largely by excursions in the lump. The plan for the State's acquisition of the territory, as approved by the State Survey, contemplates the purchase of really only a small area, generally of about a hundred feet in width, extending from the head of the rapids to the upper suspension-bridge, and of the islands. Then by suitable plantations and the provision of water-breaks the ground is to be restored as nearly as possible to its natural condition and kept so. With these improvements, and the relief from extortion that will accompany State ownership, visitors will be attracted in greater numbers than ever before, as the facilities of access are improved, and what now offends their eyes is removed. The present condition of the falls and the character of their visitors, the imminent danger they are in of being robbed of all that makes them attractive, and the facts that make the question of their immediate rescue a pressing one, are forcibly presented by Mr. J. B. Harrison, Corresponding Secretary of the Niagara Falls Association, Franklin Falls, New Hampshire, in a pamphlet "On the Condition of Niagara Falls and the Means needed to preserve them." California has reserved the Yosemite Valley and the Big-Tree Grounds, and the United States the Yellowstone Lake and Geysers, as public parks. It should be the duty of the State of New York to add to the list its stupendous cataract.

Dyspepsia.—The late Dr. Leared, in his recently published essay on "The Causes and Treatment of Indigestion," lays down as a fundamental principle that the amount of food which each man is capable of digesting with ease always has a limit which bears relation to his age, constitution, health, and habits, and that indigestion is a consequence of exceeding this limit. Different kinds of food are also differently adapted to different constitutions. Dyspepsia may be brought on by eating irregularly, by allowing too long an interval between meals, and by eating too often. Frequently the meals are not gauged as to their relative amount, or distributed with a due regard to health. Thus, when we go out after taking a light breakfast and keep at our work, with a still lighter lunch only during the interval, till evening, we are apt, with the solid meal which tempts us to indulgence, to put the stomach to a harder test than it can bear. "When a light breakfast is eaten, a solid meal is requisite in the middle of the day. When the organs are left too long unemployed they secrete an excess of mucus which greatly interferes with digestion. One meal has a direct influence on the next; and a poor breakfast leaves the stomach over-active for dinner. . . . The point to bear in mind is, that not to eat a sufficiency at one meal makes you too hungry for the next; and that, when you are too hungry, you are apt to overload the stomach, and give the gastric juices more to do than they have the power to perform." Persons who eat one meal too quickly on another must likewise expect the stomach finally to give notice that it is imposed upon. Other provocatives of dyspepsia are imperfect mastication, smoking, and snuff-taking, which occasion a waste of saliva—although some people find that smoking assists digestion, if done in moderation—sitting in positions that cramp the stomach, and the pressure that is inflicted on the stomach by the tools of some trades, as of curriers, shoe-makers, and weavers. The general symptoms of dyspepsia are well known. Some that deserve special remark are fancies that the limbs or the hands are distorted, mental depression, extreme nervousness, hypochondria, and other affections of the mind. The cure is to be sought in avoiding the food and habits by which dyspepsia is promoted, and using and practicing those which are found to agree best with the system of the subject. Regularity in the hours of meals can not be too strongly insisted on. "The stomach should not be disappointed when it expects to be replenished. If disappointed, even a diminished amount of food will be taken without appetite, which causes the secretions to injure the stomach, or else impairs its muscular action."

Scotch Funerals in the Olden Time.—Mr. William McQueen, in "Macmillan's Magazine," gives a somewhat amusing description of the Scotch funeral customs of the olden time. The usages varied in details in different parts of the country, but were marked as a whole by a general similarity. In some places every man who heard of a death made it a point to attend the funeral; if a Sunday intervened, the time of the funeral was intimated in the church-yard between the services. In other places messengers were sent around to give information of the death—not to invite friends to attend, for that was regarded as a matter of course; but in Glen Urquhart the next-door neighbor of the deceased would not go to a funeral without receiving a direct invitation. The custom of supplying drink at the funeral was once universal, but it was found expedient in some places to postpone the treat till the corpse had been safely taken care of. At Bridgton, a glass of wine was given to each mourner, and a biscuit, on the top of which was placed a piece of dark-colored orange-peel. It is just possible that the presence of this ornament "was the perpetuation of a symbol used at old heathen rites. Quite within living memory it was also customary to put a black mark on some of the oat-cakes served along with whisky in public-houses in Rutherglen, near Glasgow. Few, if any, of those who observed this custom in baking the cakes latterly could have the least notion of what their action implied; but its origin may be traced to the old heathen practice at the feasts of Baal, of giving bread with a black mark upon it to those unhappy persons who were selected as victims to be sacrificed." No religious service was held at the grave; only the hats of the attendants were taken off sometimes for a moment when the coffin was lowered. The omission "had its origin, no doubt, in the Scotch horror of doing anything that might give a color to the charge of following the Roman Catholic fashion of praying for the dead." Sometimes a chapter in the Bible was read and a short prayer pronounced in the house before the procession set out for the churchyard; but care was generally taken in these preliminaries to disconnect them from the peculiar circumstances of the occasion. Thus, at one funeral, refreshments were served, and the offering of the prayers was so arranged as to give them the appearance of being a grace before and a grace after meat. The starting of the funeral procession was colloquially called "lifting," in allusion to the "lifting" of the coffin or the taking of it up to carry it from the trestles on which it rested, with "spokes" or bearing-poles. Efforts to do away with funeral treats, which were justly prompted by the scandals to which the drinking gave rise, were strongly and bitterly opposed. One man, who had become an abstainer, gave great offense by providing milk instead of liquor. His neighbors ascribed his conduct to meanness, and had nothing but scorn for his plea of principle. "Principle had nothing, and could have nothing, to do with it," they asserted. "The minister had no scruple in taking off his dram, and was he going to set himself up as better than the minister?"

Burmese Animal Life.—The "British Burmah Gazetteer" gives some notes of rare interest on the zoölogy of the country to which it relates. The mammalia include the Malasian tapir, four species of rhinoceros, a fresh-water dolphin, and bats. Most of the bats hibernate, as their congeners do in Europe, and one is remarked for the reservoir of fat which it accumulates in its tail, to serve it in winter. The list of birds runs up to seven hundred and seventy-three species, or a hundred more than there are in all Europe. A curious fact is that several species are found in the Island of Java, eight hundred miles south, while they are wholly wanting in the neighboring peninsula of Malacca. Species that are found in India only at the foot of the Himalayas, at a considerable elevation, occur here at the level of the sea. Species of birds identical with those of Europe, or similar to them, are not rare. The variety of the fauna is explained by the physical configuration of the region, where a walk of a few hours will carry one from the green sod of meadows intersected by rice-fields to the inaccessible precipices of the granitic mountains, from the sea-shore jungles of bamboo and the rich, tropical vegetation of the coasts to immense virgin forests and the stiff and dark pines of the mountain-sides. The list of reptiles is discouraging to the settler, for it furnishes four crocodiles and seventy serpents, one of which is a python thirty feet long, and the bite of fifteen is poisonous. The list of fishes is the most interesting of all. It includes the *Anabas scandens*, which they say comes out of the water and goes up into the trees for insects; species that have a reservoir of air above the gills, and will die of asphyxia if they are kept under water and prevented from drawing air directly from the atmosphere; a siluroid that has an accessory respiratory apparatus attached to the branchiæ; and the fish-scorpion, which has a long air-vessel passing across the muscles of the back, and communicating interiorly with the gills: this explains how these fish can live in mud. These respiratory organs seem closely adapted to the estivation which is the forced consequence of the pluvial *régime* of the country. After a heavy shower numerous fish will make their appearance in places that were absolutely dry a few hours before. Living fishes of certain species may be found buried two feet below the dry surface of the soil. The *Ophiocephalidæ*, like our eels, pass from one pond to another by gliding through the moist grass, and the *Amphipnous cuchia* loves to rest on the ground hidden in high grass; and one may see it leap into the water when he approaches it. The *Ophiocephalus striatus* builds a nest with its tail among the aquatic plants on the banks of the rivers, and finishes it off with blades of grass, which it cuts with its mouth. The eggs are laid in the nest, and the male takes care of them, or, if he dies or is captured, the female takes his place. Both watch the fry with as much care as a hen takes of her chickens, but will drive them away when they have become large enough, and will eat them up if they do not go. The male of the *Arius burmanicus* hatches out its little ones in its mouth; fifteen or twenty eggs in different stages of development, ana even recently hatched young ones, may be found in the buccal cavity and on the branchiæ; and, during the whole period of this incubation, the fish takes no food. The varieties of the fauna of this country support the hypothesis that it was primitively an archipelago, separated by arms of the sea. The forms are often totally different on mountains, having precisely the same geological formation, only fifteen or twenty miles apart.

A Premature Burial.—M. G. Eric Mackay presented, in "The Popular Science Monthly" for January, 1880, a number of apparently authentic instances of cases in which premature burial had occurred. In a subsequent number of the "Monthly" (August, 1880), Dr. William Lee depreciated the danger, and undertook to show that premature burials were extremely rare. An instance very similar to some of those recorded by Mr. Mackay, and showing that the danger is an actual one, is related in the "Viedomosti" of Samara, Russia. A clerk while drunk was seized with an epileptic fit, and apparently died. As the next two days would be holidays, when burials would not be permitted, it was decided to lay him in the ground that very night. Drops of sweat were seen on his face during the funeral services, but no attention was paid to the matter because it was thought the drops might have come from snow that fell on his face on the way to the church. But little earth was thrown on the coffin, on account of the lateness of the hour. When the grave-digger went the next morning to fill up the grave, he heard a noise, as of groaning and struggling in it. Instead of releasing the man, the sexton went to the priest to ask permission to do so. The priest sent him to the police; the police sent him and the man's wife, who had joined him, to the chief; the chief sent them to the archimandrite, and he to the procurator. At last a permit was obtained, after five hours, but then the man was dead, having left in the coffin evidences of a hard struggle. He had turned around, bitten his fingers, torn his flesh, and rent his clothing. It is hard, in reading this story, to decide whether most to admire the stupidity of the grave-digger and the victim's wife, or the elaborate complication of Russian red-tape.

Improvements in Insurance Management.—The "Pall Mall Gazette" notices signs of improvement and invigoration in the management of the English life-assurance companies during the past year, particularly in the matters of the settlement of claims immediately after death, liberal extensions of the limits of residence, facilities for the renewal of lapsed policies, the introduction of the paid-up policy system, and the simplification of the initiatory stages in paid-up policies. Tendencies are observed, too, toward the reduction of rates to a simple living basis, and the gradual working out of the "bonus" system. The companies are still, however, obliged to meet the sharp competition of American enterprises, which are able to offer inducements enhanced by the higher interest on their investments; but they ought to be able to neutralize these advantages, it is suggested, by those which they enjoy from the prestige of their long career and honorable position, and from the less cost at which their business is conducted.

NOTES.

The first attempt to manufacture incandescent electric lamps *in vacuo* has been ascribed to M. de Chagny, whose effort was made about twenty years ago. Mr. W. Mattieu Williams claims the credit of the invention and its successful practical application for a young American, Mr. Starr, whose patent was taken out in 1845. Mr. Williams had a share in the venture, assisted in making the apparatus and some of the experiments, came into possession of the invention by assignment on the death of Mr. Starr, and exhibited the light in the original lamp, at Birmingham, several times, more than twenty years ago. An account of the lamp is given in the "Journal of Science" of November 5, 1879, and is reprinted in Mr. Williams's "Science in Short Chapters."

The Smithsonian Institution has received from Dr. Stejneger, from Behring Island, eleven fairly perfect crania of the extinct *Rhytina Stelleri*, a mammal allied to the dugong and manatee, with sets of nearly all the other bones of the skeleton.

The additions to the herbarium of the Academy of Natural Sciences, of Philadelphia, during the past year, exceed those of any year since the organization of the Botanical Section. They are estimated at 3,346 species, of which more than one third were new to the collection, and include more than one hundred genera not before represented in it.

The composition of elephant's milk, according to the analysis of Dr. Quesneville, in the "Moniteur Scientifique," is similar to that of cream, but its consistency is different. Its odor and taste are very agreeable, and the taste is superior to that of most other kinds of milk. It is about equal to cow's milk in quality. In view of these facts, "La Nature," of Paris, does not despair of seeing the day when an adventurous speculator shall bring a troop of elephants to be driven through the streets of the city as goats are now driven, to furnish each customer with his cup of milk direct from the teat.

M. de Merejkowski has been investigating the color-sense of the crustacea, taking for his experiments the larvæ of cirripeds and a cepepod. In the dark these animals scatter everywhere in the vessel containing them; if a ray of light is admitted, they collect around it, whatever its color; if two rays, one white and the other colored, are let in, the majority congregate around the white ray, but a few go to a colored one; if two colored rays are admitted, the majority seek the brightest, but, if both rays are of equal intensity, no difference in choice is perceived.

An International Electric Exhibition will be held at Vienna, in the Rotunda and buildings of the Universal Exhibition of 1873, from the 1st of August to the 31st of October next. Goods will be received from the 1st of June, and all exhibits must be unpacked and set up by the 15th of July. The Society of Telegraph Engineers and Electricians, which numbers Sir William Thomson, and Messrs. Siemens, Preece, and other distinguished experts among its members, will manage the English departments of the exhibition. The proceeds of the enterprise are to be devoted either to such scientific institutions as may further carry out its aims, or to the pursuit of important inventions in the field of electrical science.

The French *Société d'Encouragement* has conferred the grand medal of the Economic Arts on M. Gaston Plante, for his experiments and discoveries with storage-batteries.

The Royal Swedish Geographical Society has decided to appoint a committee, consisting of Professors Nordenskjöld and Gyldén, and Consul Elfning, to consider the proposal for an international meridian and a common time.

The experiments in acclimating the tea-plant in Southern France are making encouraging progress. Grafts upon camellias have withstood temperatures below the freezing-point in the open air. A hundred and twenty trees near Messina, Sicily, planted three years ago, are vigorous and in full leaf and flower. The question now to be decided is, whether the flavor is maintained undamaged.

The Veterinary and Agricultural Society, at Chartres, France, has just published the results of a year's experiments in vaccination for anthrax according to M. Pasteur's system. The number of sheep vaccinated was 79,392, in flocks among which the total average loss per year for ten years had been 7,237, or 9·01 per cent. The deaths from anthrax after vaccination were only 518, or 0·65 per cent. The disease did not rage, however, as fatally among the unvaccinated flocks as usual, and the rate of loss among them was reduced to 3 per cent. The total loss, if there had been no vaccination, might not have been more than 2,382. Vaccination reduced this by nearly four fifths. In mixed flocks, the losses among vaccinated animals were 0·4 per cent; among unvaccinated ones, 3·9 per cent.

M. Vignier believes that animals are indebted for the powers of direction which they sometimes manifest so strikingly to the possession of a magnetic sense relating to the forces that govern both the direction and the inclination of the needle, the seat of which he locates in the semicircular canals of the internal ear.

BENJAMIN SILLIMAN, LL. D.

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MEDICAL QUACKS AND QUACKERIES.

By FRANCIS J. SHEPHERD, M. D.

JOHNSON defines a quack as "a boastful pretender to an art he does not understand," and perhaps the term is more often applied to boastful pretenders of the art of medicine than of any other.* Probably, ever since man acquired the faculty of articulate language, quacks and quackeries have flourished. In the ruder ages, man attributed all disease to the influence of evil spirits, and sought by various means to ward off or lessen their injurious and malevolent actions. Now, as an eminent physiologist has lately said, the controlling of unknown powers has always been a matter of some difficulty, and one which ordinary mortals with average ability could not successfully attempt; hence arose a class of specialists—men who, by their greater knowledge and cleverness, made others believe that they were able to cope with the unseen. These were the priests, and, without doubt, the first quacks. They supplied charms and potions, and made use of incantations, not only to cure, but to prevent disease. These services obtained for them great power and influence and increased wealth. The ancient Egyptians attributed all diseases to the anger of the gods. They worshiped Serapis as a medical divinity, and the cure of disease could only be accomplished through the intercession of this deity's priests. Thus the priests had the monopoly of medical practice, and their medical knowledge was jealously concealed from the vulgar; it was only divulged to those who with extravagant ceremonies, wonderful mummeries, and terrible vows of secrecy, were initiated into the Egyptian mysteries. It was thus that Pythagoras is supposed to have obtained the foundation of his medical knowledge and philosophy. Among the Israelites

* "'Quack' is said to be an abbreviated form of 'quacksalver,' which is derived from the Dutch *Kwabzalver*—from *Kwab*, a *wen*, and *Zalver*, an *ointment*."—*Notes and Queries.*

the priests had charge of the health of the people, and in time of plague and pestilence relied wholly on religious methods of cure. According to the accounts that have come down to us, these methods were most successful. In highly civilized Greece, priests, the direct descendants of Æsculapius, cured disease by mysterious ceremonies, music, offerings, fastings, and such like. In Rome, when a plague broke out, the priests endeavored to combat it by feasting the gods, or driving nails into the right wall of the Temple of Jupiter. The early Christian Church was strongly opposed to the progress of medicine. It believed that the power of curing disease had been transmitted from Christ and his apostles to their bishops and elders. They discarded altogether the use of medicinal agents, and healed the sick by prayer, the laying on of hands, and the anointing with oil. This form of treatment, being of the miraculous order, needed no knowledge of the nature of disease, or of the structure of the human frame. Heathen priests and physicians were regarded as sorcerers and dealers in witchcraft, and so were burned or otherwise put out of the way. For some centuries the monks monopolized all the medical practice and quackery. They made a good living, selling for large sums of money remnants of ancient martyrs, waters of holy wells, portions of the true cross, etc., as a protection against sickness, witchcraft, evil spirits, and other ills that flesh was heir to in those dark ages. They prayed to St. Anthony for inflammation, St. Valentine for epilepsy, St. Clara for sore eyes, St. Appolonia for toothache, St. Vitus for madness and poison, and so on.* It was not till after the breaking up of the powers of the priesthood by the Reformation, and the introduction of printing, that medicine began to escape from the grasp of quackery and made rapid strides toward the truth, perfecting knowledge of disease by accurate observation and the study of the human frame and its workings in health. That the emancipation of medicine from superstition did not immediately take place is evidenced by the wonderful hold the belief in the cure of scrofula by the royal touch had on the people, both medical and lay, for many years after the Reformation, nay, almost down to our own time. This most remarkable form of quackery, and one, according to

* The Medical Rose offers a peculiar and very approved remedy for epilepsy. Advising the patient to stand upright, saying the Lord's prayer with the mouth wide open to prevent the first attack, and informing us that a lunatic, an epileptic, and a demoniac were the same, he gives the following sacrophysical directions: "When the patient and his parents have fasted three days, let them conduct him to a church. If he be of a proper age and in his right senses, let him confess. Then let him hear mass on Friday, during the fast of *quatuor temporum*, and also on Saturday. On Sunday let a good and religious priest read over his head in church the gospel which is read in September in the time of vintage, after the feast of the Holy Cross. After this, let the same priest write the same gospel devoutly, and let the patient wear it about his neck, and he shall be cured. The gospel is, 'This kind goeth not out but by prayer and fasting.'"—("Rosa Anglica," p. 78, edition 1491; ib., p. 415, edition 1595—quoted in Willcock's "Laws of the Medical Profession," p. 25, edition 1830.)

some, peculiarly English in its origin, was exercised in England for nearly seven hundred years. Edward the Confessor was the first who touched for the king's-evil, and transmitted the gift to all his successors. His power was attributed not to his royalty but to his sanctity, and there "seemed little reason why his successors, who were, as a rule, no saints, should be so specially favored." The kings of France also claimed the right to dispense the gift of healing, and traced their right to Clovis. Queen Anne was the last to exercise this gift in England, and it is well known that she touched, among others, the celebrated Dr. Johnson, who was brought to the King by his mother on the recommendation of Sir John Floyer, a distinguished physician of Litchfield.* William III had too much sense to pander to the superstitious feelings of many of his subjects, and never employed the touch but once, and then he said, on laying his hands on the patient, "May God give you better health and more sense!" Queen Elizabeth was averse to the practice, but extensively performed it. Charles II excelled all his predecessors and successors in this ceremony. During his reign he touched nearly one hundred thousand persons for the evil. One year (1682) over eight thousand sufferers were subjected to his sacred touch. The patients were first examined by the King's surgeons, and, if thought to be fitting objects of relief, they were given tickets to admit them to the royal presence. When admitted, the patient knelt and was touched by the King. The clerk of the closet now handed his Majesty a gold coin, to which was attached a piece of white ribbon, and, while the King hung this round the neck of the patient, others read the prayers and ceremonies specially appointed for this purpose. We are told that the gold was a token of good-will, and not necessary to the cure, as many were healed without it, or with silver employed instead. Evidences of the efficacy of the royal touch are not wanting: Jeremy Collier says of Edward the Confessor: "That this prince cured king's-evil is beyond dispute, and, since the credit of this miracle is unquestionable, I see no reason why we should not believe the rest." John Browne, surgeon to Charles II, and a man of eminence and reputation in his profession, wrote an "Anatomick-Chirurgical Treatise on Glandules and Strumæ, together with the Royal Gift of Healing or Cure thereof by Contact or Imposition of Hands," etc. In this treatise he gives "many wonderful examples of cures by the sacred touch" of Charles II; he also relates several cases of scrofulous tumor and sore cured by being touched with handkerchiefs which had been dipped in the blood of the martyr Charles I, and asserts that the usurper Cromwell tried in vain to exercise this royal prerogative, "he having no more right to the healing power than he had to regal jurisdiction." Wiseman, in his work on surgery, which was the best book on the subject

* The gold coin presented to Dr. Johnson by the Queen is at the present time in the British Museum.

at that time, says: "I myself have been a frequent eye-witness of many hundred cures performed by his Majesty's touch alone, without any assistance of chirurgery"; still it does not appear that he sent his patients to the King, and he gives his own method of curing scrofula with great minuteness. This evidence as to the cures is apparently most complete, and is that of men skilled in the medical art who were eye-witnesses and assisted in the ceremonies. Of course now no one believes that there was virtue in the royal touch any more than that the philosopher's stone could convert baser metals into gold. If the King could cure scrofula, how is it that during Charles II's reign scrofula was more prevalent than for many years previously? No doubt it was because people neglected ordinary methods of treatment, in their desire to be cured miraculously.

The only way it is possible to explain the evidence of Browne and Wiseman is that they were ardent royalists, and held the efficacy of the royal touch to be as much a party tenet as the divine right of kings, and that by doing so they pleased the court and so advanced their own interests. Had they doubted it, they would have incurred the suspicion of being disaffected to the government.* Failures of cure were attributed, as in our own day, to want of faith, as one writer puts it, "none ever failed of receiving benefit unless their little faith and credulity starved their merits."

Curing diseases by the laying on of hands was practiced with great success by Valentine Greatraikes, an Irish gentleman of good family, who served under Cromwell both in a military and civil capacity. At the Restoration, being deprived of his offices, he undertook to cure the king's-evil by touch, or stroking, as it was called; he succeeded so well in this that he extended the field of his labors and treated epilepsy, asthma, convulsions, deafness, etc., by the same method. The latter diseases being all due to disorders of the nervous system, benefit was no doubt frequently obtained through the effect of the imagination. "Imagination," says Lord Bacon, "is next akin to a miracle-working faith." Greatraikes's fame soon spread, and he was sent for from far and near; the Earl of Orrery and Lord Conway patronized him, and he even deceived the great Robert Boyle. At length he arrived in London, where for some time he was most popular. The majority of his admirers were ladies, and on the more hysterical of the sex he performed marvelous cures. Soon, however, the tongues of slander and ridicule assailed him, and he retired to his native country and obscurity. Many others succeeded Greatraikes. John Everett, or Leverett, the seventh son of a seventh son, and a gardener, practiced

* One Thomas Rosewell was actually tried for high treason in 1684 for saying that "people made a flocking to the King, upon pretense of being healed of the king's-evil, which he could not do, but that they, being priests and prophets, could by their prayers do as much." Rosewell was tried by the celebrated Judge Jeffries and found guilty, but afterward pardoned.—(Wadd's "Mems and Maxims," p. 136.)

the "manual exercise," and declared that after touching thirty to forty a day he felt the goodness go out of him. No doubt these people practiced unconsciously what Mesmer many years after practiced by design. On the subject of Mesmerism and spiritualism I do not propose to enter. Of late years cures by the laying on of hands, assisted, however, by prayer, and the anointing with oil, have become very common, especially in the United States, the hot-bed of all sorts of quackeries. This summer there has been a "faith convention" at Old Orchard, in Maine, where many people were publicly cured by this method; all the diseases treated appeared to be, from the indefinite history of cases reported in religious newspapers, affections of the nervous system. Many hysterical cases were possibly benefited purely by the effect of the imagination : as the disases are ones of the imagination, so are the cures. We have yet to hear of a case of actual disease, such as is daily seen in our hospitals, cured by this method.

The immediate progenitor of our present race of quacks is Paracelsus, who flourished in the sixteenth century ; he generally styled himself Philippus Aureolus Theophrastus Paracelsus Bombastus von Hohenheim. His father, who was the natural son of a prince, gave him an excellent education. He studied medicine, and afterward was for some time professor at Basle, in Switzerland. Paracelsus denied the utility of knowing the cause or mode of origin of disease ; he said all he wanted to know was, how to cure it. He styled himself the monarch of physicians, and asserted that the hair on the back of his head knew more than all the writers from Galen to Avicenna, and he publicly burned their books. He invented a nostrum called "azoth," which he vaunted as the philosopher's stone, the tincture of life. He proclaimed that he had the power of making man immortal, yet he died at the age of forty-eight. Still, by the aid of opium, antimony, and mercury, he performed some wonderful cures, and to him must be awarded the credit of first drawing the attention of the profession to the value of these remedies in the treatment of diseases. He also helped medicine to advance by showing contempt for traditional methods of treatment and the humoral pathology of the ancients, which had held sway for over two thousand years.

The most remarkable example of credulity and superstition of the public is found in the history of two quackeries which flourished in the sixteenth and seventeenth centuries. I refer to the *weapon-ointment* and *sympathetic-powder* cures. The weapon-ointment was used in healing wounds ; but, instead of the ointment being applied to the wound, it was applied to the weapon which caused it. This was fortunate for the people so treated, as the applications to fresh wounds in those times were most barbarous. The ointment was prepared in various ways, and its ingredients were most diverse, consisting of human fat and blood, mummy, moss from a dead man's skull, bull's blood and fat, etc. At one time there was a schism in the weapon-salve school, and a serious and acrimonious discussion arose as to "whether it was necessary that the moss should grow absolutely on the skull of a thief who had hung on the gallows, and whether the ointment, while compounding, was to be stirred with a murderer's knife." The mode of application was this: The wound was first washed, bandaged, and ordered to be kept at rest, and then the offending weapon was anointed with the salve, carefully wrapped up, and placed in a safe position. If the weapon was left undisturbed the wound healed in a few days, but, if anything happened to the anointed weapon the wound would break out afresh. In Dryden's version of Shakespeare's "Tempest," he makes Ariel say, in reference to the wound received by Hippolito from Ferdinand:

> "He must be dressed again, as I have done it:
> Anoint the sword which pierced him with this weapon-salve;
> Wrap it close from air, till I have time to visit him again."

In Glapthorne's comedy, "The Hollander," the doctor says, "The same salve will cure at any distance, as if a person hurt should be at York, the weapon dressed at London, on which the blood is." That the belief in this salve was not universal is proved by an attack made on it by John Hales, of Eton, in a letter "to an honorable person" in 1630. He declares it is a child of but yesterday's birth, one among the pleasant fantasies of the Rosicrucians; and, as for the cures it has worked, "the effect is wrought by one thing, and another carries off the glory," etc.*

The *sympathetic powder* was much the same kind of remedy, and was introduced into England by Sir Kenelm Digby, a gentleman of the bedchamber of Charles I. It is said that a Carmelite friar, returning from the East, brought the recipe for this powder with him. Sir Kenelm did him some service, and was rewarded by obtaining the secret of the sympathetic powder. It consisted merely of blue vitriol prepared with mysterious ceremonies. Digby revealed the secret to James I, who disclosed it to Dr. Mayerne, his physician. The latter sold it to many distinguished persons, and then it soon ceased to be a secret. A solution of the powder was made, and some of the wounded man's blood-stained garments immersed in it, the wound at the same time being washed and bandaged, and strict abstinence being enjoined on the patient. As may be inferred, the sympathetic powder, like the weapon-salve, was quite as efficacious at a distance as near by. These remedies did one good: they taught people how soon wounds heal if kept clean and undisturbed, and, in fact, opened the way to our present method of treating wounds. Surgeons learned that, in their healing, Nature was a powerful factor, and must be aided, not interfered with.†

* Chambers's "Book of Days," vol. ii.

† A somewhat similar superstition exists in many parts of the country to this day. I well remember, when a child, that, having my hands full of warts, they were rubbed by my nurse with a piece of raw meat; the meat was then placed under a stone, and I was told (and this was generally believed) that as the meat decayed the warts would disap-

It would be impossible for me to describe a tenth part of the quacks who flourished in England during the eighteenth century. There was Joanna Stevens, to whom Parliament voted £5,000 in 1739, for disclosing the secret of her remedy for dissolving stone. The wonderful secret remedy consisted chiefly of powdered snail- and egg-shells, and, notwithstanding its disclosure, "there have been as many human calculi since formed by his Majesty's liege lithotomical subjects as would macadamize one side of Lincoln's Inn Fields," says Wadd. David Hartley, the philosopher, was a great supporter of Joanna Stevens, and, after eating two hundred pounds' weight of her remedy, he himself died of the stone. There was Sir William Read, originally a tailor and cobbler, and afterward a quack oculist, knighted by Queen Anne, and who not only had the care of her eyes, but also treated George I. There was the clever but vain Hill, who quacked a gout specific called "tincture of bandana," and of whom Garrick has happily said:

> "For physic and farces his equal there scarce is—
> His farce is a physic, his physic a farce is."

He commenced life as an apothecary, and ended by making a considerable figure in the fashionable world and marrying the sister of Lord Ranelagh.

Three of the most notorious quacks who imposed on the credulity of the public during the middle of the eighteenth century attained sufficient fame to be made the subject of a satirical picture by Hogarth. The picture was called "The Undertaker's Arms," with the motto "*Et plurima mortis imago*," and the most prominent figures in it were—first, Chevalier Taylor, a quack oculist of unparalleled effrontery, who wrote a most marvelous biography of himself, which at one time had a great sale; second, Joshua Ward, originally a footman, who invented a pill and drop; he was called in to see the King, who, in spite of the remedies administered, recovered—Ward for his services received a vote of thanks from the House of Commons, and got leave to drive his carriage through St. James's Park; and, third, last but not least, the celebrated Mrs. Mapp, the Amazonian bone-setter of Epsom, who surpassed all her rivals in quackery, and whose strength of arm was only equaled by her strength of language. She was the daughter of Wallis, a bone-setter, and sister of "Polly Peachem," who married the Duke of Bolton. She drove about London in a coach-and-six with outriders, and the most exalted in rank and station eagerly sought the company of this drunken female savage. She succeeded Taylor and Ward, and is sung of as follows by some Grub Street poet:

> "In physic as well as in fashion we find
> The newest has always the run with mankind;
> Forgot in the bustle 'bout Taylor and Ward,
> Now Mapp's all the cry, and her fame on record.

pear. The result of the experiment I can not remember, but I imagine the warts remained for some time after the decay of the meat.

So what signifies learning, or going to school,
When woman can do without reason or rule?"

England in the eighteenth century has been truly named the "Paradise of Quacks." Our ancestors were assuredly a nostrum-loving lot, from the King to the peasant. Truly they must have thought with the prophet, "The Lord hath created medicines out of the earth; and he that is wise will not abhor them" (Ecclesiasticus xxxviii, 4). Perhaps the most remarkable of unblushing quacks who flourished toward the end of the eighteenth century was Dr. Graham, a graduate of Edinburgh, and a fellow-student of Sir James Mackintosh. He introduced Mesmerism into England, and was nearly as successful as his master. In 1780 he went to London and occupied a magnificent mansion, which he designated the "Temple of Health and Hymen." It was gorgeously furnished, and a fortune was spent on the decorations. The spacious rooms were adorned with marble statues, stands of armor, plates of burnished steel, and superbly lighted with wax-candles; sweet strains of distant music were continually floating through the air, and delicious perfumes were always burning in swinging censers; at the door were stationed two gigantic porters, clad in showy liveries covered with gold lace. In this "Enchanting Elysian Palace" Dr. Graham delivered his lectures on health and procreation at two guineas a head, and he did not want for hearers. In his *séances* he was assisted by a beautiful woman, whom he called Vestina, the rosy goddess of health—she who afterward became Lady Hamilton, the favorite of Nelson. In the daytime he was assisted in his electrical experiments by Dr. Mitford, the father of the celebrated authoress. In this temple was a celestial bed standing on glass legs and ornamented with the richest hangings; he pretended that childless married pairs who slept in this bed would be certain to have heirs. The price was £100 a night, and many persons of high rank eagerly accepted the terms. He then advertised an elixir of life, which, it is said, he sold to more than one noble simpleton for £1,000. One mode of treatment he recommended for prolonging life was the frequent use of mud-baths. Soon, from his religious extravagances, Graham became unpopular, and, retiring from public life, he died poor in the neighborhood of Glasgow.

A species of quackery called "Perkinism," which made a stir in the world in the beginning of the present century, I must now shortly describe, for, among the delusions which have succeeded in imposing on men of education and position, it is pre-eminent. It orignated in America, and to Dr. Oliver Wendell Holmes I am indebted for most of my information on the subject. Dr. Elisha Perkins was born in Connecticut, in 1740; he practiced with success for many years, but, being inspired by the recent discoveries of Galvani, he conceived the idea that metallic substances applied in a certain manner might remove disease. In 1796 he gave to the world his metallic "Tractors." These consisted "of two pieces of metal, one iron and one brass, about three inches long, blunt at one end and pointed at the other." They (so he affirmed) "cured rheumatism, local pains, inflammation, and even tumors, by drawing them over the affected parts for a few minutes." Dr. Perkins patented his discovery, and soon found numerous adherents, many of them being men of wealth and position. His son, Benjamin Douglass Perkins, crossed the Atlantic with the tractors, and in 1798 they were employed in the Royal Hospital in Copenhagen. In London their reputation was quickly established, and they soon became the fashion. The Royal Society accepted Perkins's tractors and book, and passed a vote of thanks to him; by 1804 a "Perkinean Institution" had been founded, which published transactions and held annual dinners. Lord Rivers was the first president, Governor Franklin vice-president, and Lord Henneker, a fellow of the Royal Society, one of the members. All this time Douglass Perkins was coining money by selling tractors at five guineas each, which cost about ninepence. A hospital was built, where the only treatment was "tractoration." Persons in the highest positions willingly gave testimonials, telling of the marvelous cures wrought on themselves and their friends by these wonderful tractors. The bishops and clergymen on both sides of the Atlantic were most eager to thrust forward evidence on this medical topic; whole pages of panegyric were contributed by them. One writes, "I have used the tractors with success in several other cases in my own family, and, although like Naaman, the Syrian, I can not tell why the waters of Jordan should be better than Abana and Pharpar, rivers of Damascus, yet since experience has proved them so no reasoning can change the opinion" ("Currents and Counter-Currents," p. 85).

Many ministers of religion were furnished with tractors gratuitously, and Dr. Holmes remarks that one of the risks of infancy he had to encounter was Perkins's tractors. The medical profession was ever hostile to the new revelation, and their hostility by many was attributed to jealousy and self-interest. The Connecticut Medical Society, in 1797, expelled Dr. Perkins, for violating their regulations against nostrums and secret remedies. The bubble was burst by Dr. Haygarth, of Bath, who experimented on patients with bogus tractors made of wood: he was quite as successful with them as with the five-guinea ones! These experiments did not immediately destroy the belief of the real Perkinistic enthusiasts, because, as Froude says, "belief in the marvelous does not rise from evidence, and will not yield to it." After a time, however, Perkinism passed away so quietly that the date of its death is unrecorded. Lord Byron, in his "English Bards and Scotch Reviewers," refers to these celebrated Tractors:*

* "Thus saith the Preacher, 'Naught beneath the sun
Is new,' yet still from change to change we run;
What varied wonders tempt us as they pass!—
The cow-pox, *Tractors*, galvanism, gas,
In turns appear to make the vulgar stare,
Till the swoll'n bubble bursts—and all is air!"

Within the last few years, a form of Perkinism, or rather "metallic medicine," has appeared in Paris, clothed in the garb of science, and under the protecting influence of the great M. Charcot. Gold, silver, and other metals, in the form of coins, are applied to relieve the manifestations of the graver forms of hysteria. It has become quite the 'mode' to visit the Hôpital de la Salpêtrière, and witness the sensational cures performed publicly on the victims of hystero-epilepsy. This notoriety is both pleasing to the patients and the public. If a nervous disease is treated by unusual methods, it becomes common; hysterical subjects having always a morbid desire to make themselves remarkable, and so be the center of attraction, it pleases their vanity and self-love. The consequence of the introduction of metallo-therapy into Parisian hospitals as a mode of treatment is, that in Paris and its neighborhood an enormous number of these rarer forms of hysteria and hystero-epilepsy have been, so to speak, created, and the wards of some of the hospitals there are crowded with female patients, eager to be treated in a sensational and novel manner. They certainly derive benefit from the treatment, because, as a writer in the "Lancet" has said: "The symptoms for which metals are applied can not be ascertained without calling the patient's attention to their existence; the strange and unusual remedy of application of a string of coins can not be adopted without exciting expectation of a local result—an expectation which it has been often demonstrated is sufficient to determine the disappearance of local symptoms in this remarkable disease."

My paper would be very incomplete should I fail to mention the most successful quack this century has produced, John St. John Long. He was the son of an Irish basket-maker, and was born near Doneraile. In his boyhood he assisted his father, but, soon tiring of rush-weaving, being a clever, pushing youth, he attached himself to a Dublin portrait-painter, from whom he obtained some knowledge of painting. When next we hear of him he is starring the provinces as an historical and portrait painter, and an instructor in the art of painting in oils. It was at this time that he adopted the name St. John. With the Limerick gentry he was a great favorite, because of his entertaining manners, and his ability to ride straight across country. Becoming disgusted with provincial life, and feeling that his talents could be more profitably employed in a larger sphere, he went to London. Here, by his pleasant address and persuasive tongue, he managed to get introductions into several respectable houses, and was elected a member of the Royal Society of Literature and of the Royal Asiatic Society. But he could not live on these honors, and was glad to color anatomical drawings for the lecturers and students at the various schools of anatomy. In this way he learned something about the human frame, and before many months had passed he proclaimed to the world the discovery of a wonderful liniment, which, when applied to a healthy part, was as harmless as water, but when applied to a surface covering a diseased organ caused the morbific humor to exude. His success was immediate and great. Patients from London and all parts of the country rushed to consult the miracle-worker in his house in Harley Street. Ladies of the highest rank hastened to place themselves and their ailing daughters under his care. Long was shrewd enough not to undertake the cure of cases which were apparently hopeless. He pretended to cure consumption by the application of his liniment, and of course, as nine out of ten of his patients were women, and a large majority of these hysterical or perfectly healthy, his success was marvelous. For several years his income exceeded £13,000. He went out into fashionable society, and was a lion in the most aristocratic circles; his ready wit, fascinating manners, intellectual countenance, and handsome figure, procured him a host of admirers, among whom were Lord Ingestre, the Marquis of Sligo, Lady Harriet Kavanah, the Marchioness of Ormond, the Countess of Buckinghamshire, and many others. Long was a superb horseman, hunted regularly, and rode magnificent animals. "On one occasion, as he was cantering round the park, he saw a man strike a woman, and, without an instant's hesitation, he pulled up, leaped from his horse, seized the fellow bodily, and flung him over the park-rails." He had many offers of marriage, but declined them all. He wrote a book called "Discoveries in the Science and Art of Healing," which was well padded with letters from grateful patients, and testimonials of miraculous cures from his aristocratic friends. Soon misfortune came upon him; his liniment was applied to the back and breast of a perfectly healthy girl, inflammation set in, followed by gangrene, and in a few days his patient was no more. Long was convicted of manslaughter, and fined only £200 by a partial judge. In his trial he was supported and petted by his lady admirers, who gave evidence in his favor. One nobleman swore that Long had abstracted pure quicksilver from his head. Soon another patient fell a victim to his treatment; he was again tried for manslaughter, and again had the sympathy of his female friends, but this time he was acquitted. These trials had no effect in lessening his popularity: he went about proclaiming himself a martyr, comparing his case to that of Galileo, Harvey, and others. He died while still young, in 1834, retaining a large practice to the last. His admirers raised a magnificent monument to his memory in Kensal Green Cemetery, adorned with a long and laudatory inscription. After his death, his property became the subject of very tedious litigation. Among the claimants was a woman of humble station in life, who proved to be his wife. This explained his preference for bachelorhood. The wonderful liniment turned out to be *acetic acid*, which looks much like water. He of course substituted a bottle of water when he did not wish the "morbific humor" to come out, and so gulled his willing victims.

George Eliot, in "Middlemarch," alludes to St. John Long and his quackeries.

Homœopathy is another form of quackery to which I must shortly allude. It originated in 1796, with Hahnemann, a German physician. Hahnemann laid down, as necessary to his system, three great foundation truths:

1. *Similia similibus curantur.* This means that diseases are to be cured by the administration of substances which, in healthy individuals, produce the same symptoms or group of symptoms as the disease itself manifests. This idea was not original with Hahnemann. Hippocrates distinctly enunciates it, and since then it has been held by many physicians and others, including Paracelsus, who was the inspirer of Hahnemann.

2. That it is necessary to give remedies in infinitesimal doses. Substances which are given by the regular school in doses of four to five grains, homœopaths should give in quantities of two decillionths of a grain and less. Hahnemann says, in his "Organon": "But, if the patient is very sensitive, it will be sufficient to let him smell once of a vial containing a globule of sugar the size of a mustard-seed; after the patient has smelled it, the vial is to be recorked, and will thus serve for years without its medical virtues being perceptibly impaired." This second "great truth" was, as has been lately pointed out by Dr. Holmes, adopted from Van Helmont, a physician who flourished in the early part of the seventeenth century. He denied the existence of the four elements, and held up to ridicule the practice of letting blood for the cure of disease.

Van Helmont, in his "Ortus Medicinæ," describes a method of treatment made use of by one Butler, an Irishman, who was formerly physician to James I, and at that time was confined in prison in Belgium. According to Van Helmont, Butler performed wonderful cures with a pebble he had in his possession. He dipped this pebble quickly into a teaspoonful of olive-oil, poured this "magnetized oil" into a large vessel of oil, and directed the patient to take one drop occasionally. When one drop was put on the head of an old woman suffering from hemicrania, the pain instantly disappeared. An abbess was relieved of loss of power in her right arm by merely touching her tongue to the pebble. No doubt reading this book first suggested infinitesimal doses to Hahnemann.

Hahnemann's "third dogma or truth" was, that seven eighths of all chronic diseases are produced by psora, or itch. "This psora," says Hahnemann, "is the sole, true, and fundamental cause that produces all the other countless forms of disease, which go under the names of hysteria, hypochondriasis, debility, insanity, melancholy, idiocy, epilepsy, cancer, gout, paralysis," etc., etc. (I shall not complete the list). He tells the reader in a foot-note that it took him twelve years to trace out the source of all these diseases. This third dogma was original with Hahnemann, and no one now wishes to detract from the laurels he may have won by thus simplifying the etiology of diseases which hitherto have been so obscure in their origin.

Unfortunately for his theory, since the discovery of the *sarcoptis hominis*, or itch-insect, the dogma about the psora being such a powerful factor in the causation of disease has fallen to the ground, and homœopaths are not fond of referring to it. Like Paracelsus, Hahnemann paid no attention to the pathology * or cause of disease, but only sought for symptoms. For instance, in a case of dropsy, the cause, whether it be from the heart, the kidneys, or the liver, is not inquired into, but the symptom dropsy is treated. Dr. Black, in his "Practice of Homœopathy," tells us: "If the cause of the disease be an inflammation of the brain, a remedy has to be chosen which produces this pathological condition; and, if the exciting cause can be traced to the abuse of alcoholic liquors, a remedy should be selected which is nearest akin to alcohol in its action." This is what is called "a proving."

The dilutions are directed to be prepared by Hahnemann with as much mystery and jugglery as the "sympathetic powder." The following directions are taken from Hahnemann's "Organon": "A grain of the substance, if it is solid, and a drop, if liquid, is to be added to about a third part of 100 grains of sugar of milk in an unglazed porcelain capsule, which has had the polish removed from the lower part of its cavity by rubbing with wet sand; they are to be mingled for an instant with a bone or horn spatula, and then rubbed together for six minutes; then the mass is to be scraped together from the mortar and pestle, which is to take four minutes, then to be again rubbed for six minutes with equal force. Four minutes are then to be devoted to scraping the powder into a heap, and the second third of the 100 grains of sugar of milk to be added. Then they are to be stirred an instant and rubbed six minutes, again to be scraped together for four, and forcibly rubbed for six, once more scraped together for four minutes and rubbed down for six. Then the last third of the 100 grains of sugar of milk is to be added and mingled by stirring with a spatula. Six minutes of forcible rubbing, four of scraping together, six more of rubbing, finish the process. Now to one grain of the powder so manufactured is to be added a third part of 100 grains of sugar of milk, and the whole mixed in a mortar, and having triturated each third portion for six minutes, and scraped for four minutes, the whole powder is placed in a corked bottle and marked with its degree of attenuation, which will be the $\frac{1}{10000}$ or second dilution. The same method is observed for this powder as was detailed for the last for making any attenuation up to a decillionth and quintillionth."

* A new school, which has arisen within the last few years, also pays no attention to pathology. The members of this school do not wait for symptoms even, but endeavor to "jugulate" the disease at once. They call themselves the "Dosimetric School," because they treat disease by granules containing alkaloids and metallic salts in fixed doses.

The method for making fluid dilutions is the same, but instead of sugar of milk alcohol is used. The scrapings and triturations are exchanged for shakes of the bottle in certain directions. Toward the close of his life Hahnemann reduced the number of his shakes. He says, "A long experience and multiplied observations upon the sick lead me within the last few years to prefer giving only two shakes to medicinal liquids, whereas I formerly used to give ten."

Now to give one an idea of the potency of these drugs: to obtain a grain of the original substance in the third attenuation, one would have to swallow four hundred-weight of sugar; or, to get a drop of the original tincture, a barrel of alcohol would have to be imbibed. Now, this is only the third dilution. In the eighth dilution, to obtain a drop of the tincture the whole Atlantic Ocean full of alcohol would be necessary. Dr. Black, to whom I have referred, says he uses the first, third, sixth, ninth, up to the thirtieth dilution. Imagine the effect of one-drop doses of the thirtieth dilution! The finite mind can not comprehend the infinitesimal when thus expressed.

Homœopathy, although not yet deceased, retains hardly anything of its original character but the name. The efficacy of infinitesimal doses is doubted by the leaders of the school, and even the doctrine of *similia similibus curantur* is not now considered universal. Dr. George Wild, Vice-President of the British Homœopathic Society, in a letter to the London "Lancet," June, 1877, says that he believes "palpable doses of medicine are generally more efficacious in the treatment of disease than infinitesimal ones." Also, that "some diseases are best treated by similars and some by contraries."

The third dogma, with regard to the psora, or itch, has been, since the discovery of the itch-insect, effectually disposed of forever. As Dr. Holmes remarks, "What there is left of the three-legged stool after one of its legs is pulled out, and the other two sawed half or three quarters through, seems hardly worth sitting down on."

The name homœopathy has a charm for the public, and so is retained to juggle with. When, in 1833, the edition of the "Organon" from which I have quoted was published, the translator, in the preface, mentioned that this new system of medicine was spreading through the Continent of Europe with the rapidity of lightning. In 1880, in an address read before the Institute of Homœopathy, in Milwaukee—"How can we best advance Homœopathy?"—the author says: "It can not be denied that homœopathy has not advanced, and is not advancing, as rapidly as we once had just and reasonable grounds for expecting. In Great Britain there are but two hundred and seventy-five homœopathic physicians, and in the United States there is not one legally recognized school of homœopathy." He concludes by saying that there seems to be everywhere stagnation, if not retrogression. Dr. Smyth, in his book on "Medical Heresies," mentions that a short time since the County Hospital, Sacramento, was in charge of homœopathic physicians; quite recently they have been relieved from further attendance by the managers, because of the extravagant expenditure of money for drugs. Among the items are three pounds of salicylic acid and four thousand grains of quinine.

In Ontario, up to ten years ago, homœopaths were yearly registered by scores; since then they have to pass through the same courses and examinations as the regular students, in all but therapeutics and pharmacy. The consequence is, that in ten years there have only been two or three applications for examinations as homœopaths. Homœopathy, being a system utterly devoid of any scientific foundation, is now dying a natural death.

It is difficult to give the exact reason or reasons why quackery is so prevalent. The causes are very various and obscure. Southey says: "Man is a dupable animal; quacks in medicine, quacks in religion, and quacks in politics know this, and act upon that knowledge. There is scarcely any one who may not, like a trout, be taken by tickling." It is extraordinary what a hold the mystic and marvelous still have on many people; there seems to be in almost every one a vein of credulity and superstition against which argument is useless. The disposition to be humbugged preponderates in human nature over reason and common sense. Education, at least the education of the day, apparently has no influence in depriving people of this quality. Men of education are the very ones who have been, and are now, duped by clever quacks. A man may be an able politician, distinguished in literature, of great shrewdness in the ordinary business of life, and yet believe in spiritualism, homœopathy, Perkinism, and tar-water. When he is ill he will probably, after taking in vain the various much vaunted and advertised panaceas, call in some quack who promises a cure in a certain time and in some uncommon manner.

Bishop Berkeley is an example of a man of great attainments, whose mind was obscured by quackery. His tar-water he considered an infallible remedy for all ailments, and wrote a book describing its universal efficacy in curing disease. Dr. O. W. Holmes says: "He might have lived longer, but his fatal illness was so sudden that there was no time to stir up a quart of the panacea. He was a very illustrious man, but he held two very odd opinions, that tar-water was everything, and that the whole material universe was nothing ("Currents and Counter-Currents," p. 72). Alfred Russel Wallace,* the emi-

* Mr. Wallace, in his book on "Miracles and Modern Spiritualism," holds that the theory of a future existence as taught by spiritualists is the "only one yet given to the world that can at all commend itself to the modern philosophical mind," and in the spiritual world the law of "progression of the fittest" takes the place of the grand law of the "survival of the fittest" in the material world. He also holds that witches were what are now called "mediums." Owing to the number of witches destroyed for several centuries, the production of spiritual phenomena became impossible, which accounts for spiritualism being of comparatively recent origin.

nent naturalist and evolutionist, Mr. Crooke, the celebrated physicist, and Pasteur, the scientist, are ardent spiritualists, and believe that diseases may be cured by means of spiritualism. Disraeli was a homœopathist; Sir Robert Walpole patronized a quack medicine, said to dissolve the stone; Lord Bolingbroke died from the effects of a quack cancer-remedy; and I could enumerate many more men of equal talents who were similiarly affected with this mental obliquity.

Probably the greatest supporters of quacks and quackeries, next to the fair sex, are ministers of religion; hardly an advertisement of a quack-remedy can be read without coming across testimonials from them. They are generally the first to support any new form of charlatanism. In the country parts, especially, while administering to diseased souls they love to essay the efficacies of new cure-alls on diseased bodies. This weakness may be attributed to their well-known benevolence, and desire to do good to their fellow-men.

If anybody is bold and unblushing enough to assert that he has a remedy which cures every disease, and reiterates it often and loudly enough, he is sure to have a following of believers, among whom will be found men of ability and position. Human credulity is too strong to resist the frequent and positive assertions of the quack. Persons who are not trained in scientific methods of thought, and who know nothing about physiology, even if in the every-day affairs of life they are most clear-headed, are perfectly incompetent to form just opinions on medical matters.

The arguments in favor of the different forms of quackery are always the same. They say, "I was ill, I took a certain remedy or went through a certain form of treatment, and got well." This argument is irresistible, and "therefore quackery is immortal." Now, nine out of ten, nay, I venture to say nineteen out of twenty people, suffering from the ordinary acute diseases, if left to nature, get well. In every case of illness a quack administers remedies, and, of course, if the patient recovers, his recovery is attributed to the remedy; consequently the proportion of cures is large, and the number grows in the telling. In olden times, when diseases were treated by charms, fastings, prayers, and ceremonies, many of the physicians and priests, not understanding the power of nature, thought themselves favored with supernatural assistance. The quack of to-day, however, thoroughly understands what an able partner Dr. Nature is. If you ask a believer in some form of quackery the *modus operandi* of the drug or application, he tells you that there are many mysteries in nature which it is impossible to understand. If you attribute the effect to imagination, he answers that the remedy is quite as efficacious administered to young children and brute beasts, but, as Dr. Haygarth observes, "In these cases it is not the patient, but the observer, who is deceived by his own imagination."

Now, when any remedy has to be tested as being useful in a certain disease, we have, first, to be sure that the disease exists; secondly, that it was cured; and, thirdly, that the remedy cured the disease.

It is very common for quacks to call carbuncles cancers, ordinary sore-throats diphtheria, and so on, and so boast of their wonderful cures, when Nature alone deserves the praise. In no country in the world are quacks more abundant than in the United States. Every city teems with faith-cure men, rubbers and strokers, clairvoyants, homœopaths, eclectics, bone-setters, cancer-doctors, etc., etc. The advertising columns of the daily and weekly press, in the smaller towns especially, are principally filled with quack advertisements, some of them of the most disgusting and disgraceful nature, and these too in perfectly respectable sheets, which find their way without question into family circles. Religious newspapers are no exceptions to the rule; in them the advertisements have a religious gloss to attract the holy. Perhaps texts are quoted, or the advertiser poses as a philanthropist or clergyman, and treats the poor *gratis;* at the same time he hints that the only reason he is so generous is that he *enjoys* the luxury of doing good to suffering humanity. Quacks have many ways of advertising. One asserts, as a scientific fact, that all diseases originate in disorders of the nervous system, and urges every one, before it is too late, to come and drink of his nervine tonic. Another states that physicians now admit that all diseases are due to impure blood, and vaunts the efficacy of his magnetic blood-purifier. Then comes a vile woodcut of the inventor, with a list of the testimonials of the most laudatory character, showing how this more than human doctor had snatched the writer from the jaws of death, and perhaps something worse; or perhaps we have a "Golden Medical Discovery," and are told that the receipt for this medicine was found in the luggage of a deceased Zulu chief, or that it had been a secret of the medicine-men among the Yucatan Indians for hundreds of years, and was providentially discovered by the advertiser. To suit patients who dislike internal remedies, artful and designing quacks have furnished liver, stomach, and kidney pads, and magnetic belts, giving illustrations at the same time to show how these should be applied. I have been told by a wholesale druggist that thousands are sold by the trade, monthly, to the credulous who are continually seeking for new medical divinities. Their action is much the same as Perkins's Tractors. That these advertisers are successful in selling their wares is shown by the enormous prices they pay for advertising, and the colossal fortunes which men like Holloway, Helmbold, Ayer, and others have made. If bread-pills were to be advertised, until they came into notice, as some wonderful vegetable compound from the center of the "Dark Continent," and that they cured all diseases, they could not fail to acquire celebrity, for, of the thousands who would take them, a certain number would be sure to get well.

Another kind of quack is one who does not charge for advice, but when a patient consults him he terrifies him into believing he has some serious disease which only his medicine can cure. This is a very old form of quackery. Robert Pitt, in a book called "The Crafts and Frauds of Physic exposed," published in London in 1703, says, "A quack is a practitioner who takes no fee in specie, but makes the deluded patient pay very extravagant fees by the intolerable prices he puts on all cheap medicines, and by passing upon him very many more doses than the disease requires or the constitution can bear."

That this, the last quarter of our nineteenth century of progress and boasted enlightenment, is as rich in credulity and superstition as any of the preceding ones, is proved by the fact that thousands yearly visit shrines and sacred springs, if Catholics, and attend "faith conventions," if Protestants, to be cured of bodily ailments. Not long since one of England's proudest nobles traveled on a pilgrimage to Lourdes in the hopes that Notre Dame de Lourdes would make his only son, who is a deaf-mute, hear and speak. Every day in our own immediate neighborhood, hundreds and thousands of the maimed and the blind make pilgrimages to the sacred spring of Ste. Anne de Beaupré and are miraculously healed—have they not a mountain of crutches bearing witness to the fact? Lately in this city (Montreal), a noted female quack has made the blind to see and the lame to walk—at least I have been told so by eye-witnesses—and in consequence has attracted crowds of infatuated simpletons, who could not hand in their dollars fast enough to secure a bottle of her wonderful nostrum. The priests of a neighboring city, jealous of poaching on their own grounds, denounced her as a charlatan, and told the afflicted that, instead of being duped by this unholy woman, they should make a pilgrimage to Ste. Anne de Beaupré and be healed!

The success of this mode of treatment in hysterical cases is being recognized in France by physicians: they now, when they have an hysterical patient of a devout frame of mind, on whom they have exercised their skill in vain, as a *dernier ressort* advise that a visit should be made to the shrine of Notre Dame de Lourdes. Thus imagination often works a cure where medicine fails. These cures, as I said above, only take place when the disease is one of the imagination.

Why is quackery so much more prevalent in medicine than in any other science? Because the medical quack attributes to himself what is due to Nature. Nature can not build a railway, but she can very often cure disease. A witty Frenchman has said that medicine amuses the patient while Nature cures the disease.

Is there ever any chance of quackery becoming extinct? I fear not as long as human nature exists in its present condition. Still, no doubt, there is a probability of the number of believers in quackery being diminished by a greater diffusion of philosophical habits of thought and a more general knowledge of physiology. A writer many years ago, in one of the London medical papers, said: "The final though distant extinction of quackery is to be hoped for; it forms a fragment of that final triumph of reason and virtue which is the secret consolation of every philanthropist."

RECENT MAGNETIC STORMS AND SUN-SPOTS.

By GARRETT P. SERVISS.

NO one who beheld the great auroral displays of last year can ever forget the impression that they made. They were among the most glorious celestial spectacles that have been witnessed in our latitudes. The first one occurred on the night of Sunday, April 16th. On the afternoon of that day I was watching with a telescope two complicated sun-spots, or groups of spots, one of enormous size, which had made their appearance on the solar disk several days before. My attention had been particularly attracted to these spots, both on account of their great size and because I thought I could perceive changes going on in them under my eyes. After watching them through the afternoon I became satisfied, about an hour before sundown, that the smaller spot, which was considerably in advance of the other, and was rapidly approaching the sun's meridian, had visibly increased in size while I had been watching it, and that perceptible changes had taken place in the complicated cluster of nuclei constituting the black center of the greater spot. It was evident that a tremendous outburst of solar forces was occurring; but, although I knew of the well-established connection between such convulsions in the sun and the condition of the earth's magnetic elements, I was not prepared for the spectacle that followed.

The sun had been below the horizon only long enough for the lengthening spring twilight to fade from view, when a pale-green arch of light was seen spanning a broad arc of the northern horizon, while above it the mysterious streamers and curtains of the aurora were waving and coruscating in the sky. So quickly had the earth responded to the magnetic impulse from the storm on the sun. The popular excitement caused by this aurora was remarkable, especially among those who were not aware of the nature of the strange illumination in the sky. People gathered in knots at the street-corners, and in the little parks of the city, and gazed wonderingly at the flaming heavens. Many seemed to be seized with a mingled feeling of admiration and dread. I crossed the Fulton Ferry after midnight, when the auroral streamers were yet shooting from horizon to zenith, and Arcturus was shining brilliantly in the center of a complete crown of greenish-yellow light near the zenith. A throng gathered at the bow of the boat to watch the display, which was much more brilliant when seen from the center of the stream, away from the glare of the street-lamps. A decently-dressed and not unintelligent-looking man asked me, with a troubled look, and pointing to the heavens:

"What *is* that?"

"It's the aurora borealis," I replied.

He seemed relieved to find some one who could give it a name, and who did not appear to be alarmed.

"I thought it might be the comet the papers are talking about," he said, "and I didn't know what was going to happen."

I know that this man's vague fears were shared by others.

Everybody who had anything to do with telegraphs will remember the effects of the aurora. The wires played strange freaks. In some places they were disconnected from the batteries and worked by means of the current furnished by the magnetic storm; in other places they refused to work at all. The Atlantic cable was crippled, and at intervals, for several days thereafter, there was considerable delay of all telegraphic business. Subsequently it was learned that the auroral storm had raged, simultaneously, not only in the United States and Canada, but in Great Britain, on the Continent of Europe, and in Asia, extending clear across to the shores of China.

The next day, when I turned my telescope upon the sun, I was astonished at the changes that had taken place. The smaller spot, which I had seen increasing in magnitude on the previous day, had swollen to between five and six times its former size, so that now it was about half as large as the larger spot, and both were clearly visible to the unassisted eye, shaded with a dark glass.

I find by reference to the exact measurements of these spots, made at the Greenwich Observatory, that, whereas on the 16th the area of the smaller spot was to that of the larger about as 1 to 13·6, on the 17th the relative magnitudes were about as 1 to 2·2.

For three or four days afterward there were magnetic disturbances and occasional auroral displays at night, and during this time the activity of the solar forces continued.

On the 19th there was another magnetic storm, and coincidently with it the smaller spot suddenly increased in size again, until it was nearly as large as the other, and on the 21st it actually surpassed its neighbor in magnitude. After that both groups rapidly waned, the one which had undergone the remarkable development I have described fading much faster than the other one.

The next great display of sun-spots accompanied by auroras and magnetic disturbances—if we except one or two of minor importance and a somewhat remarkable one seen in Europe, which will be described hereafter—occurred in November last, culminating on the 17th of that month in one of the greatest magnetic storms on record, which crippled the telegraphs almost all over the civilized world. In Europe fine auroras were observed on the 12th, 13th, 14th, 15th, 16th, 17th, and 19th, accompanied by more or less magnetic disturbance. During that time a tremendous sun-spot, exceeding in size the largest of the April spots, was advancing from the edge of the disk to the center. In this country the principal auroral displays were on the nights of the 17th and 19th, and the chief force of the magnetic storm was felt on the 17th. On that day a storm of rain and snow prevailed over most of the Union, and simultaneously with this storm there raged a hurricane of magnetic forces. The effects were similar to those witnessed during the April storm, but more intense. As in April, some wires were worked without batteries, while others could not be worked at all. Cable communication was interrupted. Some startling phenomena occurred. Sparks of fire leaped from the wires and instruments. In the West, switch-boards were burned and keys melted. Operators received severe shocks. Practical telegraph men said they had never known such a powerful disturbance of the magnetic elements. In the evening, when the sky cleared at Chicago, a most magnificent sight was beheld in the heavens. The brilliancy of the aurora far exceeded that of the April display. A singular feature of this aurora, which was also noticed in Europe, was a splendid luminous arch spanning the sky from east to west and passing nearly through the zenith. Another feature that added brilliancy to the spectacle was the variety of color visible. The prevailing tints were rose-color and green, but in some places streamers and patches of violet, yellow, and orange light were seen. On the night of the 19th and morning of the 20th, the sky having cleared here, a splendid aurora was seen in New York. The magnetic disturbance also continued.

Fig. 1.

At the April meeting of the American Astronomical Society I exhibited some magic-lantern views representing the principal changes which took place in the great sun-spot during the magnetic storm of November. These views, copied from drawings of the spot made at the telescope, are reproduced in the accompanying cuts.

Fig. 1 represents the spot as it appeared on the 16th of November, the day before the culminating magnetic disturbance took place. Low magnifying powers, varying from sixty-five to a hundred and ten diameters, were used while making the drawings, as it was not desired to obtain pictures representing all the details. Consequently, only the principal features of the spot are here represented, but the reader will be able to get a better general idea of the changes that occurred from such a picture than he could from one filled with minor details. The central and lower portions of the figure are especially worthy of attention because of the indications they give of an eddying motion corresponding with what should always be seen in a sun-spot according to Faye's cyclonic theory, but which, in fact, is rarely visible. It was also in these parts of the spot that the principal changes occurred, as will be seen by reference to the figures. It is very interesting to note that in Carrington's drawings of the remarkable sun-spot which accompanied the great magnetic storm of September, 1859—a disturbance whose effects strikingly resembled those produced by the storm of last November—similar indications of a whirling motion can be detected. Another exceedingly interesting fact is that in England, on the 16th of November last, luminous points were seen rapidly crossing the great spot. This forcibly recalls the similar phenomenon of flying points of light, seen by Carrington and Hodgson, darting across the spot of 1859, and which seemed to be a signal for the outbreak of the magnetic storm that followed.

Fig. 2.

In Fig. 2, which represents the spot as it appeared on the 18th, the day after the great magnetic storm, evidences of cyclonic motion are still, perhaps, visible, though they are rather suggested by a comparison of the appearance of the spot with that shown in the previous figure than by any clear indications in the figure itself unconnected with the other one. The roundish, nuclear mass near the center suggests by its form a whirlpool-like motion, but it is difficult on that hypothesis to account for the long, straight channel connecting it with the oblong figure on the right. The peculiar crooked figure seen in the lower part of the first picture has, it will be perceived, apparently broken up into several fragments, but this by itself is not inconsistent with the theory of an eddying motion.

Fig. 3 represents the appearance of the spot on November 19th, auroras and magnetic disturbances having in the mean time continued. Still further changes, it will be seen, have taken place, and the lower portion of the spot shows a tendency to separate from the larger mass above—a phenomenon that is of not unfrequent occurrence.

I find, by reference to my note-book, that other changes were visible on the 20th, but unfortunately I was prevented from sketching them. After that, unfavorable weather, and other interruptions, prevented me from sketching the spot, but the sketches that were made cover the period during which the most remarkable changes occurred, as well as that of the greatest magnetic disturbances. In order to

FIG. 3.

obtain a clear notion of the tremendous forces involved in the changes represented in the drawings, it is necessary to consider the enormous size of the spot as measured in square miles. Counting the whole area covered by the various nuclei and the penumbral depression surrounding them, the spot was not less than 60,000 miles long and 40,000 miles wide. In other words, it covered 2,400,000,000 square miles of the solar surface. The area of the whole surface of the earth, land and sea, is less than 200,000,000 square miles, so that if the crust of the earth had been peeled off like the skin of an orange, spread out flat and plastered against the sun, it would have looked like a mere outlying patch beside the great congeries of sun-chasms constituting this gigantic spot. Masses of gaseous matter, many times greater than the earth in volume, must have been hurled and whirled about there with tremendous velocity in order to produce the changes which the telescope revealed. Milton's description of the battling elements of chaos, through which Satan fought his way, will apply, though inadequately, to the scenes of chaotic fury of which such a sun-spot is the theatre.

In Fig. 4 is represented a very remarkable spot which, because it made its appearance at about the time the great comet was in perihelion, in September last, and broke out on the portion of the solar globe which was nearest to the comet at that time, has been fancifully called the "black eye that the comet gave the sun." There were other spots visible at the same time and they also were ascribed by some to the influence of the comet. Some plausible reasons have been shown in favor of this view, and Professor Kirkwood's opinion that the great sun-spots of June, 1843, were caused by the large comet of that year has been freely quoted in support of it. Of course, the question whether this particular spot and its companions originated in some disturbance caused by the comet, whether by the fall of meteoric masses following in the comet's track or otherwise, can not be settled either way by positive evidence at present. But, while there are improbabilities in the way of the hypothesis, it may, at least, be said that, if any comet could produce a sun-spot without actually tumbling into the sun itself, the comet of last year ought to have been able to do it, for, as is known, it almost brushed the sun in its perihelion swing.

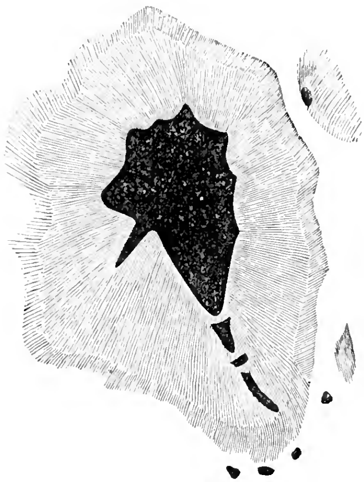

Fig. 4.

This great spot, however, is interesting on another account. The cut represents its appearance on October 1st, when it had reached about its greatest development. On October 2d there was a magnetic storm which was felt principally in Europe. The storm was very much less severe in its effects upon the telegraphs than those of April and November, but it was accompanied by the appearance throughout England, Scotland, and Western Europe of a most beautiful aurora.

In conclusion, it may be said that, while the evidence furnished by the great magnetic storms of last year was hardly needed to complete the chain of proof of the intimate connection between solar outbursts and the magnetic conditions prevailing upon our globe, yet this evidence was of such a striking character that it must rank among the most interesting of all that bears upon this question. It is, perhaps, worthy of remark that the period of sun-spot maximum through which we have just been passing has also furnished a good deal of evidence in favor of the views of those who think a connection can be traced between sun-spots and the weather. It is only necessary to point to the facts that 1881 and 1882, as well as the beginning of 1883, have been remarkable for cyclones, tornadoes, storms, and floods, and that, coincidently with these meteorological disturbances, huge spots and other evidences of commotion have appeared in the sun. Here is a splendid field for investigation.

VIVISECTION IN THE STATE OF NEW YORK.

By BURT G. WILDER, M. D.

"I know that physiology can not possibly progress except by means of experiments on living animals, and I feel the deepest conviction that he who retards the progress of physiology commits a crime against mankind."—CHARLES DARWIN.*

THE objects of this article are—1. To enlarge the slender store of published facts respecting vivisection in the United States. 2. To discuss briefly certain general aspects of the question. 3. To examine the existing and proposed laws concerning it. 4. To consider Mr. Henry Bergh's fitness to initiate such legislation. 5. To express what seems to be the sentiment of most well-informed, humane persons regarding experimentation upon animals.

I. Aside from editorial articles and resolutions of medical societies, public discussion of vivisection in this, the State in which it is already somewhat limited by law, has been nearly confined to four gentlemen besides the present writer. Mr. Bergh's single contribution will be more conveniently considered later. Professor J. C. Dalton has contented himself hitherto with the general statement † that "the exhibition of pain in an experimental laboratory is an exceptional occurrence. As a rule, all the cutting operations are performed under the influence of ether. . . . This is because the infliction of pain is generally no part of the experimenter's object, and on every account it is preferable for him to avoid it." The foregoing refers directly only to laboratory investigations, and it may undoubtedly be inferred that, among the experiments before classes in the lecture-room, the painful constitute a still smaller minority. ‡ What they have been is shown by Dr. A. J. Leffingwell # in quotations from the larger physiological treatises of Professors Dalton and Flint. Among the numerous illustrative operations mentioned as performed by these teachers in two of the largest medical schools in the coun-

* From a letter to Professor Holmgren, April, 1, 1881, published in "Nature," April 21, 1881, p. 583.

† "Experimentation upon Animals," etc., New York, 1875, p. 8.

‡ In a letter to the writer, dated January 11, 1883, Professor Austin Flint, Jr., says, "In my class demonstrations, I do not make experiments upon animals involving more pain than is caused, for example, by pithing to kill, or injecting an anæsthetic subcutaneously."

\# "Does Vivisection pay?" "Scribner's Monthly," July, 1880, pp. 391–399.

try, there appear to be seven in which anæsthetics are not always employed; in them, there is reason to believe that the pain inflicted is either brief or not very severe. There is also reason for believing that there is an annual decrease in the number of such demonstrations.

Mr. Bergh wishes to suppress vivisection by act of Legislature. Dr. Leffingwell would legally restrict painful experiments to original research under rigid surveillance. Professor Dalton seems to think no discussion of the subject is required.* Dr. L. S. Pilcher believes † it only necessary that "the public should be informed of the truth relating to vivisection in order that there should be secured to science every advantage and privilege which its advancement may need." The writer's communication ‡ of two years ago, together with opinions which will be repeated at the close of this article, stated that he had taught physiology for twelve years in a university, and for half that time in a medical school, and yet had never performed a painful vivisection.

Since Cornell University owes its existence largely to the action of the State Legislature, and is bound by its charter to "receive, without charge for tuition, one student annually from each Assembly district," there are peculiar reasons for making known the exact condition of sentiment and practice therein with regard to vivisection. Aside from practical work in the laboratory, the physiological teaching comprises two courses of lectures, special and general. In the former, those who intend to become physicians, or to teach physiology, are made familiar with the details of experimental manipulation. In the latter, the verbal instruction is illustrated by experiments differing little from what are performed in some medical schools. The following are fair selections from these experiments:

1. A frog is killed by "pithing" with a sharp knife, and the brain is destroyed with a piece of wire. The mucous membrane of the roof of the mouth is removed, and the action of the cilia shown in various ways. 2. A frog is rendered motionless by the injection of a little curare under the skin. Two of the toes are tied apart, so as to stretch the intervening "web." The circulation of the blood is then observed under a microscope. Since it is not certain that sensibility is abrogated by curare, the animal is treated just as if it were in its normal condition, to which it commonly returns after a short time. 3. A pithed frog is employed for the demonstration of nervous, muscular, and reflex actions. Although the animal is dead as a whole, the irritability of its muscles and nerves and spinal cord persists for some time after the brain is destroyed or the head cut off. 4. From an anæsthetized frog the brain proper is removed. So long as the medulla remains, the respiratory movements continue; when it

* In the letter already mentioned, Professor Flint says, "I think investigators and teachers should be the sole judges as to what is necessary in their investigations and teachings."

† "How Vivisection concerns Every Citizen," "Christian Advocate," July, 1880.

‡ "The Two Kinds of Vivisection—Sentisection and Callisection," "Medical Record," August 21, 1880.

is destroyed, they cease. 5. A cat is etherized, inhaling the anæsthetic slowly and without apparent discomfort in a glass box made for the purpose. The trachea is opened, and a glass tube inserted. This is then connected with a U-shaped tube partly filled with a colored liquid; the effect of the respiratory movements in expanding the lungs is shown by the oscillation of the liquid. 6. With an etherized cat the trachea is connected with a pair of bellows. The medulla is cut and the lungs are artificially inflated with the bellows. In this way the heart is kept beating while the entire ventral wall of the chest is removed and the heart exposed to view. If removed from the body, the heart soon ceases to beat. 7. With a cat, anæsthetized and then pithed, the respiratory muscles are stimulated directly or through their nerves. 8. From an anæsthetized frog the cerebral hemispheres are removed. After recovering from the operation, such a frog may remain for weeks in a stupid condition, neither moving nor feeding voluntarily, although it can swim, balance itself on the edge of a board, and swallow food placed in the throat. It thus approximately exemplifies the life of some idiots. 9. A cat is etherized, and part of the right hemisphere exposed. A light interrupted current of electricity is applied to certain spots, and the invariable response is by definite movements of the limbs of the opposite side. Other regions give no response at all. 10. With an etherized cat the vagus nerves are exposed in the neck. A large needle, with a head of red wax, is passed through the skin and muscles, so that its point is fixed in the heart, the pulsations of which are then indicated by the oscillations of the head. When a somewhat strong interrupted current of electricity is sent through one or both of the nerves, the heart beats more slowly, or stops altogether. The current is stopped, and the pulsations recommence. The nerves are then cut, and the heart beats more rapidly, but the respiratory movements are slowed. In this, as in all other experiments under anæsthetics, the animal is killed before revival.

The significance of these and similar experiments may be ascertained from any physiological treatise or well-educated physician. Only the first and the last can be commented on here. Cilia are minute filaments of protoplasm which, among other localities, cover the surface of the membrane which lines the air-passages. Independently of the will they keep up a rapid lashing movement, more forcible in one direction, so that the dust inhaled with the air is continually swept from the smaller tubes into the larger, and so to the larynx, whence it is voluntarily expelled. If we reflect upon the inevitable consequences of a vacation, or "strike," of these millions of irresponsible "sweeps," we shall feel it well worth while to inform ourselves as to their appearance and mode of action, even though the acquisition of this knowledge costs the lives of many frogs. The last experiment affords some clew to the nervous mechanism through which the action of the heart may be accelerated or retarded, or wholly checked on account of violent physical or mental impressions. Who that has felt his heart "flutter," or "stand still," would not, even in a slight degree, fathom the mystery which still surrounds the relations of our bodily organs to each other and to the mind?

Those who denounce all vivisection as "barbarous" are asked to note that the performance of the ten experiments above described involves only the pain of a hypodermic injection or of pithing, since, whenever the animal is alive during the operation, complete insensibility is produced by anæsthetics. Most of the experiments, however, are done upon dead animals—that is, a man treated in like manner would be legally defunct. In the ordinary sense of the word, therefore, such experiments are not vivisections at all, although they are so by virtue of the persistence of vitality in certain organs and tissues.* According to information from various sources, it is probable that the large majority of experiments in this State, whether in medical colleges or other institutions, whether for research or for teaching, are, like those described above, performed upon animals completely anæsthetized or actually dead.†

II. Many persons find it difficult to dissociate the word *vivisection* from the sufferings which were, perhaps, unavoidable before the discovery of ether and chloroform, and from those which are inflicted at the present day by careless or unfeeling experimenters. The proposed laws likewise ignore the difference between experiments in respect to pain. In England the question has been similarly befogged by the use of a single term for two different ideas. In the face of the official reports showing, according to Dr. Gerald Yeo's later estimate,‡ that only twenty-five out of one hundred experiments caused any pain at all, Frances Power Cobbe has the hardihood to say,# "We find it practically impossible to separate torturing from non-torturing vivisection." In view of all this ambiguity, whether due to ignorance or design, I have ventured to suggest ‖ that painful vivisection be known as *sentisection*, and painless vivisection as *callisection*. The desirability of some verbal distinction was presented to Mr. Bergh, both in the article referred to and in private letters, dated February, 1880, and October, 1882. His only reply is the following, dated November 3,

* It is stated that the Danish Society for the Prevention of Cruelty to Animals has offered a prize for the best essay upon the performance of physiological experiments upon recently killed animals.

† Opinions to the same effect have been expressed by well-known teachers in a sister State, and in Great Britain. In "Scribner's Monthly," September, 1880, page 766, Professor Horatio C. Wood says, "So far as concerns the medical schools of Philadelphia, vivisection without anæsthetics is not practiced to any extent, if at all, for class demonstration." In "The Popular Science Monthly," April, 1874, Professor Michael Foster says, "So far as I know, in this country at least, physiologists always use anæsthetics when they can." See also the very comprehensive and important "Facts and Considerations Relating to the Practice of Scientific Experiments on Living Animals, commonly called Vivisection," issued by the Association for the Advancement of Medicine by Research, "Nature," March 13, 1883, which appeared after this article was in type.

‡ "The Practice of Vivisection in England," "Fortnightly Review," March 1, 1882, pp. 352–368.

\# "Vivisection: Four Replies," "Fortnightly Review," January 1, 1882, pp. 88–104.

‖ In the article referred to on page 170.

1882: "Pardon me for saying that 'if the rose would smell as sweet by any other name,' surely the blood of tortured animals would also retain its repulsive odor under any other designation." Perhaps Mr. Bergh and Miss Cobbe vaguely apprehend that, should the intelligent people of their respective lands once realize that three fourths or more of what are indiscriminately stigmatized as vivisections are absolutely painless, their denunciations would have little weight, their occupations would be gone.

Specific repressive legislation is commonly directed against the ignorant or the vicious. Laws for the suppression of vivisection stand almost alone as aimed against those who are charged with the mental and physical welfare of the community, and whose official positions and social relations would enable them to further materially the general objects of the Society for the Prevention of Cruelty to Animals. I am not aware of any action upon the part of the teachers of this State respecting Mr. Bergh's efforts to deprive them of the most effective means of illustrating physiology, but the sentiment of the medical profession has been clearly expressed. As stated by Dr. Dalton,* and in the "Medical Record" for February 28, 1880, and February 10, 1883, Resolutions affirming the value of experiments upon animals, and deprecating legislative interference therewith, have been adopted by seven medical schools of the State, by the State Medical Society, and by sixteen organizations representing various localities or special branches of the science. It is hardly to be expected that many physicians † or teachers will enroll themselves under the banner of humanity to animals so long as the same staff carries the black flag of anti-vivisection, which in their eyes is inhumanity to man.

Few educated persons doubt that experimental physiology has practically contributed something to human welfare, and the probability or even possibility that knowledge so gained might save the life or the health of a single child must be felt, at least by the parents of that child, to justify the sacrifice of "a wilderness of monkeys," not to mention lower forms. Naturally, therefore, among the writers in favor of vivisection, nearly all have confined their arguments to the medical and surgical advances which have been made or aided thereby. Some (Dalton, Foster, Leffingwell, and Yeo) have implied, perhaps unintentionally, that physiology appertains only to medical science; while others (Owen, Tait, etc.),‡ defenders as well as opposers of vivisec-

* "Experimentation upon Animals," chapter iv.

† According to the Report for 1882, the American Society for the Prevention of Cruelty to Animals contains four hundred and two members or donors. *Four* of them are physicians.

‡ Richard Owen, "Experimental Physiology, its Benefits to Mankind," etc., London, 1882; Lawson Tait, "The Uselessness of Vivisection upon Animals as a Means of Scientific Research," "Transactions of the Birmingham Philosophical Society," April 20, 1882; G. F. Yeo, "Vivisection and Practical Medicine," "Popular Science Monthly," March, 1883.

tion, exclude it from the category of appliances for instruction. Yielding to none in my conviction of the indispensableness of experiments on animals to the prevention and healing of disease and injury, I believe that a higher and broader ground should be taken. "The knowledge of the human body," whether gained by dissection or by experiment, "belongs to every man, woman, and child, and has no more exclusive connection with physic than with law, engineering, or architecture." Consequently, had vivisection accomplished absolutely nothing for medicine or surgery, nevertheless experiments upon animals, necessarily painful in some cases, should be performed by competent persons for the advancement of physiological knowledge, just as experiments are done in chemical and physical research, and *experiments, commonly painless, should be constantly employed in physiological teaching, simply because the information so imparted is more interesting, more intelligible, and more lasting than what is given in any other way.** The spirit and methods of modern scientific teaching are well conveyed in the motto, "*Iter longum per præcepta, breve per exempla*," to which may be added the metric imitation of a familiar proverb, "A gramme of experiment is worth a kilogramme of talk." Logically, indeed, unless it be wrong to *kill* animals for the sake of mental acquisition, the exclusion of painless experiments from physiological teaching would be comparable with the abolition of museums, models, and *vivaria* of all kinds because most animals have been figured and described. On this point most persons will admit the force of Dr. Bartholow's query, "If animals are sacrificed for the support of men's bodies, why should they not contribute to the improvement of men's minds?" †

III. "An act for the more effectual prevention of cruelty to animals," passed April 12, 1867, embraces two sections relating to experimentation upon animals:

SECTION 1. If any person shall overdrive, overload, torture, torment, deprive of necessary sustenance, or *unnecessarily* ‡ or cruelly beat, or needlessly mutilate or *kill*, or cause or procure to be overdriven, . . . or needlessly mutilated or killed, as aforesaid, any living creature, every such offender shall, for every such offense, be guilty of a misdemeanor. . . .

SEC. 10. Nothing in this act shall be construed to prohibit or interfere with any *properly conducted* scientific experiments or investigations, which experiments shall be performed only under the authority of some regularly incorporated *medical college or university* of the State of New York.

The following is the bill for the total suppression of vivisection

* As has been pithily stated by Huxley at the close of an article "On Elementary Instruction in Physiology," "Popular Science Monthly," October, 1877.

† Lecture reported in the "Medical Record," October 11, 1879, p. 342.

‡ Certain words of this and the following extracts are italicized with reference to comments which will be made presently.

which has been introduced, at the instance of Mr. Bergh, at the last three sessions of the Legislature :

SECTION 1. Every person who shall perform, or cause to be performed, or assist in performing, in or upon any living animal, an act of vivisection, shall be guilty of a misdemeanor.

SEC. 2. The term *vivisection* used in this act shall include every investigation, experiment, or demonstration, producing, or of a nature to produce, pain or disease in any living animal, including the *cutting*, wounding, or poisoning thereof; except when the same is for the purpose of curing or alleviating some physical suffering or disease in such living animal, or in order to deprive it of life when incurable.

Whether or not this law would, or is designed to, interfere with the slaughtering of animals for food, or with the extermination of pests, or even with the drowning or suffocation of impounded dogs under the supervision of Mr. Bergh's Society, does not especially concern physiologists ; but the points indicated by the italicized words are worthy of consideration. In the law of 1867, the words *needlessly* and *properly* are used. In the absence of specification as to who shall determine what is needless or proper, would not the decision rest with the administrators and executors of the law? If so, might not the first section be so interpreted as to permit any amount of pain as "needful" for scientific purposes? Other magistrates and police, on the contrary, might deny the "propriety" of any experiment upon living creatures, and thus interdict everything of the kind under the tenth and apparently permissive section. The tenth section expressly restricts even "properly conducted experiments" to medical colleges and universities. Pending the elimination of this impediment to the advancement and diffusion of physiological knowledge by private individuals and by the teachers in the normal and other schools, it is to be hoped that the clause may be interpreted as liberally as are the Sunday laws of the "New Penal Code." The peroration of Mr. Bergh's vivisection address puts the following words into the mouth of a "victim": "If my life be necessary to you, take it." The most natural interpretation of this sentence is that, in the mind of its author, the advancement or dissemination of human knowledge is sufficient justification for putting an animal to death. But his proposed law permits no cutting, wounding, or poisoning excepting for the sake of the animal itself. What are we to understand upon this fundamental question? *

Respecting the last section of the law of 1867, Mr. Bergh says,

* On the 23d of December, 1882, I addressed Mr. Bergh a letter asking whether his bill is designed to prohibit the following operations: confining the animal with cords or bandages; subcutaneous injection of curare; killing by pithing; experimenting under anæsthetics, the subject being killed before revival; experimenting under anæsthetics, the animal being allowed to revive, and to endure the healing of clean incisions. Notwithstanding a later request for attention, no reply has been received.

"So long as this remains unrepealed, these scientific horrors, which I hold to be an insult to the Deity and to the civilization of our generation, will proceed." * Let us see what facts Mr. Bergh has to offer in support of so decided a condemnation. Of his Vivisection Address, several pages are occupied with descriptions of more or less cruel European experiments, and with lurid comments thereon ; *a single page is devoted to a single New York case.* Immediately after dwelling at some length upon the atrocities perpetrated in the veterinary school at Alfort, in France, he says : "Those of you who have been able to listen to the recitals I have just made, will, perchance, experience a glow of national pride at the thought that such devilish deeds are impossible in this happy land of yours ; but your self-gratulation is but partially true, as I have lately had occasion to verify. On the 19th of December, 1879, I dispatched an officer of the society I represent to attend an exhibition of a similar sort at one of the colleges of the city of New York. . . . A live dog was brought in, said to be under the influence of an anæsthetic." The rest of the description indicates that the experiment was the same as No. 6 of those mentioned upon page 171. So far, therefore, as depends upon the evidence furnished by Mr. Bergh, to evoke the law for the suppression of vivisection in the State of New York, because formerly anæsthetics were unknown, and because in France they are still too often unemployed, is as if an army were summoned for the extermination of the panthers in the "North Woods," upon the pleas that they were numerous and dangerous not many years ago, and that at the present time in India thousands of people are annually slain by tigers.

So far as I can ascertain, Mr. Bergh is not only the originator and instigator of the anti-vivisection legislation in this State, but almost its sole supporter. No articles by members of his society have come to my notice. According to the "Medical Record" for March 13, 1880 (page 292), in that year but a single vote was cast in the Assembly against the acceptance of the adverse report of the committee to which his bill had been referred. Its fate at the last session is thus announced in the Annual Report of his Society: "That sum of all physiological villainy, vivisection, which I again recommended to the consideration of that sapient State congress which was characterized by a portion of the press as a 'mob,' has been remorselessly, and at the bidding of a heartless and opinionated medical faculty, disrespectfully slaughtered as before."

Nevertheless, in a letter dated November 24, 1882, Mr. Bergh says, "I am not quite sure whether I shall introduce a vivisection bill at the ensuing session"; and in view of what has taken place in England, at first sight a most unlikely nursery for any movement in behalf of animals, it may be well to consider somewhat carefully his qualifications for leadership in a movement of such importance.

* Vivisection address, 1880, p. 24.

IV. The experiment above mentioned is characterized by Mr. Bergh as "the crucifixion of a sentient, unoffending being, . . . an immortal work of the Deity." The grave question of the immortality of animals need not be discussed here. The adjective *unoffending* is objectionable merely because, like so many other words used by the same writer, it tends to throw a sentimental film over the eyes of logic and severe justice through which the whole matter should be viewed, and it is altogether probable that the dog thus utilized for the exemplification of several important physiological truths was, like most vivisection "subjects," a worthless street cur whose death, in the manner described, was a relief to the community, and a positive deliverance from a worse fate through hunger or cold, or at the hands of ill-regulated boys. But, in the entire absence of evidence that the animal was conscious, the use of the words *sentient*, *crucifixion*, and *exhibition of a similar sort* constitutes an exaggeration so great and so mischievous that it can not be lightly passed. It is akin to affirmations in other parts of the address: "The effect of curare in itself is horrible beyond conception; . . . it is an error to suppose that anæsthetics subdue completely the pain of operations; . . . the hands of the preceptors in our medical colleges are daily incarnated with the warm blood of tortured animals ruthlessly slaughtered." If, with Huxley, we hold that "the assertion that outstrips evidence is not only a blunder but a crime," the offenses of Mr. Bergh are too many for enumeration here.

The "quotations" upon which Mr. Bergh bases the surprising claim * that "vivisection has been the subject of universal condemnation by the more eminent members of the medical profession in Europe," have been scrutinized by Dr. Dalton.† After showing that Professor W. B. Carpenter expressly repudiates the views attributed to him, Dr. Dalton inquires: "What shall we call this manipulation of the facts used to convey an impression at variance with the reality? If we did not know that it came from a professional philanthropist, we should be inclined to give it a very awkward name." Again: "If confinement in State-prison were the legal penalty for tampering with an author's opinions and falsifying his language, I am afraid Mr. Bergh would have been there long ago."

It can hardly be denied that, taken by themselves, some of Mr. Bergh's affirmations and accusations suggest that his hatred of vivisection is stronger than his love for courtesy and truth, and if the argument *sævus in Europa, sævus in America*, which is really all he has to offer against New York physiologists, were turned against him in the original form of *falsus in uno, falsus in omnibus*, the advocates of unlimited dog-fights and cocking-mains might well object to the recognition of such a witness against their favorite sports. But, when all

* "Memorial to the Legislature," 1880, section 5.

† "Mr. Bergh as a Commentator," "The Nation," October 16, November 6 and 20, 1879.

else is considered, the evidence proves too much. The man of pure and upright life; the heroic defender of the weak against the brutal; the tireless organizer of a society, for the main object of which he has secured legislative and legal co-operation, and the sympathy of the better part of the community, surely such a man can not be a common scold and an habitual liar.

Is there a less harsh alternative? After thoughtful consideration of nearly all Mr. Bergh's published writings, and of several courteous private letters, I conclude that, in regard to experimentation upon animals he is not morally perverse, but mentally incapacitated for accurate observation, correct quotation, logical argument, or legitimate conclusion; that, in short, so far as vivisection is concerned, he is of unsound mind.* This charitable view of his character may serve to explain passages like the following: † "As another proof of the profane extremes to which these dissectors of living animals will go, Robert McDonald, M. D., declared that he had opened the veins of a dying person, remember, and had injected the blood of an animal into them, many times, and had met with brilliant success. In other words, this potentate has discovered the means of thwarting the decrees of Providence, where a person was dying, and snatching away from its Maker a soul which he had called away from earth." ‡

In view of all these things, is Mr. Bergh's single-handed crusade against practical physiology anything more than an unintentional burlesque of reform? Is it compatible with the highest usefulness of the society which he represents or with the dignity of the Legislature of a great State that he should be permitted to repeat the fiasco? Should he persist, in open disregard of his own dictum, "Laws can not precede public opinion, but must be the outgrowth of that opinion," the interests of humanity in its widest sense would certainly be promoted in this State by the authoritative assurance that his extreme views are not shared by the American Society for the Prevention of Cruelty to Animals.

V. The concluding division of this article combines: A. A summary of the facts and views already presented; B. A brief statement of certain matters which could not be fully discussed on this occasion; C. An expression of what I believe to be the sentiment of unprejudiced, humane, well-informed persons respecting the legitimacy of experiments upon animals and the desirability of legal interference therewith.

* This idea is suggested, perhaps without design, in Dr. Dalton's characterization of Mr. Bergh's attack upon Magendie as "crazy maledictions." "Magendie as a Physiologist," "International Review," February, 1880.

† Vivisection address, p. 15.

‡ See also his letter respecting experiments upon transfusion, "New York Evening Post," Feb. 28, 1883.

1. The object of an experiment may be the advancement of knowledge by research, or its diffusion by teaching.

2. In respect to the infliction of pain and death, experiments are of four kinds: (1.) The animal has been recently killed; (2.) The animal is rendered insensible by anæsthetics and killed before revival; (3.) Anæsthetics are used during the experiment, but the animal revives and endures the healing of wounds; (4.) Without anæsthetics, the animal is subjected to cutting operations, or to the effects of poisons or of insufficient food.

3. All experiments at Cornell University belong to the first two groups. Of all the experiments performed during the past year in the State of New York, whether for research or instruction, probably less than one tenth would come under the fourth class, and not more than one tenth under the third. In view of what is learned from these experiments, the total amount of pain and death inflicted is insignificant.

4. It is desirable to make a verbal distinction between painful and painless experiments, and to adopt a single term in place of the phrase experimentation upon animals.*

5. Over and above the utilitarian argument drawn from its subserviency to medical science, physiology should be pursued and illustrated experimentally like chemistry or physics, because it is a most interesting and suggestive branch of knowledge.

6. In the State of New York are very few men whose natural and acquired powers of body and mind qualify them to determine when painful experiments are required, to perform them successfully, and to wisely interpret the results. Such men, deserving alike of the highest honor and the deepest pity, should exercise their solemn office not only unrestrained by law, but upheld by public sentiment.

7. All teachers of physiology, from primary schools to universities, should illustrate their instruction by experiments upon animals, chiefly if not wholly painless.

8. All experiments should indirectly inculcate humanity to animals. The victims should be treated with respect on account of what is learned from them, and with gentleness because "cruelty to animals is the beginning of cruelty to man." Even the administration of anæsthetics should cause the least possible discomfort.

9. The abolition of vivisection in the State of New York is demanded by a single individual, who has not as yet displayed the necessary qualifications for dealing with so large a problem. The laws proposed by him are vaguely framed, and inconsistent with his own utterances upon the subject.

10. A single physician has advocated legal restriction of painful

* Such a term is zoöpery, from the Greek ζοον, *an animal*, and πειραω, *I experiment.* By inflection we get *zoöperal, relating to experimentation on animals, and zoöperist, one who performs such experiments.* In this connection, it is to be noted that many experiments are upon dead animals, and some involve no cutting at all.

experiments. Otherwise, so far as appears from published resolutions, legislative interference is opposed by the medical profession of this State.

11. Judging from English experience, the interdiction of all vivisection would seriously impede the progress of physiology in this State.

12. While physiologists justly resent attacks grounded in ignorance and maudlin sentimentality, they should avoid and discountenance even the appearance of bravado and indifference to the suffering of animals.

13. So long as the people and the Legislature are satisfied that physiological investigators and teachers regard the infliction of pain as undesirable on every account, no legal restrictions are likely to be put upon vivisection in the State of New York.

QUARTZ: ITS VARIETIES AND FORMATION.

By Rev. J. MAGENS MELLO, F. G. S.

QUARTZ is in its many forms probably the most abundant, as well as one of the most beautiful, of all the various minerals which enter into the formation of the earth's rocky surface. To describe it and its principal varieties, and to give a short sketch of the modes of its occurrence and of its formation, will be the object of this paper. Among the elements known to chemistry is one named silicon, sometimes called silicium; the oxide of this substance, which is never found in a free state in nature, constitutes silica, the chemical name for quartz and all its varieties. Its pure crystallized form is familiar to us as the colorless and transparent rock-crystal.

As rock-crystal, the typical form of quartz, is an hexagonal prism terminated at each end by a rhombohedron, when broken it will be seen to have a conchoidal or splintery fracture. Rock-crystal is very widely distributed, being found in rocks of all ages. The most beautiful and perfect specimens are usually obtained from large cavities or geodes in the older igneous rocks, and also from veins in these and other rocks. The size and color of quartz-crystals vary greatly; some are so small as to be microscopical, while others are of very considerable bulk. In the museum of Berne may be seen specimens of both the clear rock-crystal and also of black or smoky quartz upward of a foot in length; there are also some very large ones in the British Museum. Quartz-crystals are often found presenting almost every shade of color—yellow, brown, black, red, blue, violet, and green. Various names have been given to these colored varieties. The violet, blue, and some of the yellow, and even of the white crystals, which, when fractured, are seen to have a peculiar undulated structure, which Sir D. Brewster pointed out, have been classed together as amethysts, a name often popularly restricted to the violet crystals, which owe their beautiful tint to the presence of oxide of manganese. Violet amethysts are not uncommon in the geodes occurring in volcanic rocks in many localities; but the finest are obtained from Siberia, Persia, India, and Ceylon; while Brazil yields white and yellow amethysts. The yellow and brown crystals known as cairngorms are varieties of rock-crystal or of crystallized quartz, if we restrict the term rock-crystal to the clear, colorless specimens. The darker brown and black crystals, as well as those designated as cairngorms, may be grouped under the common name of smoky quartz. The dark-green quartz is called prase, and is colored by amphibole; there is also a lighter green species known as chrysoprase, tinted, it is said, by oxide of nickel; while oxide of iron probably gives color to the numerous red varieties. The common milk-white quartz, which is the ordinary quartz of veins and of quartz-rock, will be found, on microscopical examination, to be really transparent, but so full of minute cavities as to cause it to assume its milky opacity.

Quartz-rock, or massive quartz, is often found in mountainous masses, hundreds of feet in thickness. Many of the quartz schists and micaceous schists consist chiefly of quartz irregularly split up by thin leaflets of mica. Sandstone rocks, often consisting of little besides more or less rolled grains of quartz, will have been derived from the breaking up, under various denuding agencies, of rocks in which quartz has been the prevailing mineral. Veins of quartz have already been mentioned. These are very frequent in the old slate and schist rocks, sometimes forming broad and irregular bands; at others, mere threads traversing the other materials. Such veins will often present open spaces in which the quartz will be found regularly crystallized.

Flint and chert are forms of quartz usually occurring as concretions in limestone rocks; sometimes, however, as bands of considerable thickness. The black color so common to the flints of the chalk formation and to the chert nodules and bands in the mountain limestone is due to the presence of carbon. Hornstone is merely a variety of chert.

Chalcedony has been described as a mixture of crystalline and amorphous quartz; its tendency is to assume a botryoidal or stalactitic form; and its numerous variations of color and modes of occurrence have led to the adoption of different distinguishing names. Carnelians and sardes are only color distinctions of chalcedony; and the immense family of agates, including the onyx and sardonyx, is more or less composed of chalcedony, disposed in layers, regular or irregular, and combined with other forms of quartz, such as amethyst, jasper, etc. This latter name is applied to an aluminous variety of quartz: it is opaque, and has a less crystalline appearance than ordinary quartz. It is very varied in color: some beautiful red, brown, and green-banded stones are obtained in Siberia, in Egypt, and elsewhere. Bloodstone is considered to be a mixture of chalcedony and jasper, colored by metallic oxides. One of the most beautiful forms of quartz is opal, which is nothing more than amorphous silica combined with water, which has filtered out from the rocks, usually igneous ones, and is found in cavities and fissures in those rocks. Bohemia, Hungary, Auvergne, and Queensland yield opals, some of them of great beauty and value.

Having thus briefly pointed out the principal varieties of quartz, and the modes of their occurrence, we will next turn to the history of their formation. We shall find that quartz may have been formed by more than one process in the grand laboratory of Nature. According to Cotta, there are two modifications of chemical composition in quartz, which are distinguished by their different degrees of solubility. "The one is insoluble in water and in every acid except hydrofluoric, and the other is soluble in water at high temperatures, especially in the presence of other acids and alkalies." The insoluble variety of quartz may, it is said, in process of time become "converted into the soluble by the contact-influence of infiltrated moisture." It may, however, be noted that ordinary quartz, if fused with carbonate of soda, becomes soluble in water, and from this solution gelatinous silica is precipitated by hydric chloride. Years ago it was noted that silica when combined with an alkali is soluble in water, and that thus the decomposition of feldspar might in some instances be a source of silica in solution. The residue of decomposed feldspar, when it has been examined, has been found to contain only a portion of the silica due to it, the remainder having been dissolved. In a similar manner mica is another mineral which may be a source of supply for pure silica. A fact of some importance in studying the mode of the formation of quartz is that, unlike feldspar and other minerals, which in crystallizing pass at once from the fluid to the solid state, quartz passes through an intermediate viscous or colloid condition before it assumes the crystalline form. It is, comparatively speaking, only very recently that we have had any practical acquaintance with this colloidal form of silica. The late Mr. T. Graham, by his most valuable experiments in dialysis, succeeded in obtaining pure silica dissolved in water, which rapidly assumed a gelatinous condition.

The three principal agencies that have taken part in the formation of quartz are heat, water, and organic life. When we examine, by the aid of the microscope, certain forms of quartz, such, for instance, as the crystals occurring in some of the quartz porphyries, and occasionally in the pitchstones, as well as much of the quartz of granite rocks, we find that they contain minute cavities which inclose very frequently tiny crystals of other minerals; in the quartz of granite these are very often found to be alkaline chlorides, or sometimes the cavities are filled up with glassy mineral matter—as, for instance, in the quartz of some of the Icelandic trachytes. Other cavities are found, especially in the granitic quartz, filled with gas, or sometimes with water, or liquid carbonic acid. In these latter cavities small bubbles will be found which are movable; the smaller ones, indeed, appear to be endowed with a kind of perpetual motion of their own. The quartz in these rocks must have crystallized at a very high temperature—indeed, where glass cavities occur, from a state of true igneous fusion. Mr. Sorby has shown that the solvent power of liquid water at the temperature of about 412° C. is very great: its action on glass has been such as to produce quartz-crystals from it.

There seems to be clear proof that the quartz of the granite rocks which contains partially filled fluid cavities, and cavities inclosing crystals of common salt, etc., has been formed in a partially melted mass of rock, and began to crystallize when that mass was exposed to the solvent action of liquid water, at a temperature not far below 400° C., but yet not sufficiently high to expand the water into steam. Mr. Sorby concludes that "by far the larger part of the quartz in granitic rocks was set free and crystallized through the action of liquid water, at a temperature of a dull-red heat, just visible in the dark. The exact temperature may, however, have varied considerably, since, if the pressure were not sufficiently great, the water might remain in the form of steam until the rock had cooled somewhat more." It has been noticed as somewhat remarkable that the quartz in granite should have been usually the last mineral to crystallize, although it is that one which is the most difficult to fuse, and which would therefore naturally be expected to have been solidified before the feldspar and the mica. But it has been shown that, when quartz is in combination with other mineral substances, it is often as readily fusible as they are; and thus what must be called accidental circumstances may have led, in the case of the rocks in question, to its being crystallized after the feldspar, which we so generally find to have modified the form of the quartz; this latter appearing as a glassy paste inclosing the accompanying minerals, instead of having a definite form of its own. It has also been observed that the feldspar in solidifying would liberate a sufficient quantity of heat to enable the quartz to retain its viscous state (Durocher); just as, on the other hand, in the quartz porphyries we see an instance of the analogous effect of the crystallizing quartz upon the feldspar. It is asked how the enormous masses of quartz which form some of the schistose rocks can have been produced? We must appeal to metamorphism. The contact of highly-heated eruptive matter might thus alter a quartz or sandstone into an almost pure quartz-rock. Heat and pressure combined are mighty agents, which might also effect a similar change during the course of long ages.

That water at a high temperature can hold quartz in solution is well illustrated by the deposits of silicious sinter, thrown down by thermal springs, as, for instance, the geysers of Iceland, and by others in Kamchatka and in New Zealand: this silica often incrusts mosses and other substances in the same way that we may see calc-tuff forming petrifactions in other localities. The delicate, feathery crystallizations of silicious sinter are extremely beautiful.

The quartz of veins appears generally to have been deposited from aqueous solution, and will be seen, as has been already remarked, to contain innumerable cavities inclosing water. Occasionally these watery cavities are of large size, and may be observed without any instrumental aid.

Among the most varied and beautiful forms of quartz which have had a purely aqueous origin are all the varieties of crystalline and amorphous silica, which frequently coat the interiors of geodes and other hollow spaces in the igneous rocks, and which consist chiefly of an intermingling of chalcedony and jasper, and are conveniently grouped under the general name of agates. Pure rock-crystal, amethyst, cairngorm, and other valuable crystallized forms of quartz, are often found in connection with the same rocks, or in others of a more purely metamorphic character. All these varieties of quartz are secondary formations, deposited from watery solutions. The exact mode in which agates have originated is a question full of interest, and not easy in every case to answer. A wonderful history of mineral growth is written in the folded leaves, if one may so denote the bands of a single agate. A very large number of agates consist of more or less concentric layers of chalcedony of various colors (the colors depending on the presence of metallic oxides), together with jasper, rock-crystal, amethyst, etc., in many cases.

Chalcedony is sometimes described as a reniform condition of silica, and though apparently amorphous, when it is microscopically examined, it generally, if not always, exhibits a minute and definite radiated crystalline structure. It frequently forms stalactites, and many of the most exquisite of the banded agates are sections cut from stalactitic formations. Jasper may be looked upon as chalcedony, which, as it consolidated, caught up a certain amount of alumina, or sometimes of lime or oxide of iron. Professor Ruskin, who has paid some attention to this subject, has observed that "jasper will collect itself pisolitically out of an amorphous mass into a concretion round central points, but does not actively terminate its external surface by spherical curves; while chalcedony will energetically so terminate itself externally, but will, in ordinary cases, only develop its pisolitic structure subordinately, by forming parallel bands round any rough surface it has to cover, without collecting into spheres, unless provoked to do so by the introduction of a foreign substance, or encouraged to do so by accidentally favorable conditions of repose."

According to the same observer, some agates appear to be of the nature of concretions formed from within, round a nucleus; these would consist of chalcedony or jasper in the inner portions, and have distinctly crystallized exteriors. There is another class of agates composed of external bands of chalcedony or jasper, stalactitically deposited in a cavity which may either have a hollow center, or one filled up with crystals of quartz. There appear, however, to be intermediate varieties in which concretionary or stalactitic formations have been combined with, or interrupted by, other modes of growth.

Some of the most curious and beautiful agates are those containing dendritic crystallizations; in these we see, in the more or less transparent chalcedony, which in these agates is not banded, wonderful mossy or confervoid-like growths, often very closely resembling vegetable forms. The valuable stones from Mocha contain ferruginous brown or black inclosures, while some of the dendritic agates from India are filled with a bright-green network of what appear to be filaments of confervæ. These dendritic forms in the moss-agates are mostly the oxides of iron or manganese; or in the green Indian pebbles, delessite or chlorite. The question of their origin is a difficult one. In some agates the dendrites may have resulted from a segregation of the oxides of the metals from the colloid or partially crystallized silica; in other cases they may be the effect of subsequent infiltrations; or, again, the quartz may have been consolidated around previously existing crystallizations. With regard to infiltration by these oxides, it is well known that even the most compact-looking chalcedony is permeable, as it is possible by steeping it in solutions of the aniline or other dyes to impart the most brilliant tints to agates, the dye undoubtedly gaining access to the interior of the specimen through the interspaces of its minutely crystalline structure.

In a large group of agates, of which beautiful specimens come from India, an appearance of banded formation is seen, which, upon microscopic examination, resolves itself into an infinite number of red or brown spots, regularly arranged in bands or concentric groups: these spots appear to be segregations of oxide of iron. I have not seen a specimen of this species of agate cut sufficiently thin to show whether the arrangement of these minute spots is dependent upon a banded structure in the chalcedony itself, or whether it is independent and the result of molecular force which has determined the arrangement in question. It may here be noticed that a vast number of the Indian agates come from the neighborhood of the Gulf of Cambay. Near Turkeysar there are agate conglomerates intercalated between beds of laterite which belong to the Eocene period. These conglomerates we may suppose to have been derived from the denudation of the earlier igneous rocks which abound in the same district. Uruguay, in South America, also produces a large number of remarkably fine banded agates. Sometimes well-formed quartz-crystals will be found inclosing other substances, which, in some instances, have been caught up by the crystals in the course of their formation, or have crystallized, perhaps, almost simultaneously with the quartz. In other cases the quartz is proved to have crystallized over other previously-formed crystals; thus schorl is occasionally seen partially inclosed in quartz-crystals and partially free, the ends of the crystals of schorl projecting through the quartz. Titanite, asbestus, and other minerals are not unfrequently found in minute acicular forms in quartz. The quartz in the igneous rocks may frequently be seen to inclose crystals of feldspar or titanite, or portions of the matrix which must have been previously solidified.

Opal, as has already been pointed out, is a product of aqueous origin found in the fissures and amygdaloid cavities of igneous rocks. Its wondrous play of colors has given rise to much discussion by Brewster, Des Cloiseaux, and other writers. Some have attributed it to the presence of numerous cavities of varying size, which cause a kind of iridescent refraction. Des Cloiseaux was inclined to suppose that organic matter might be inclosed in small quantities in its cavities. The most reasonable supposition, however, appears to me to be that of Reusch—that light reflected or transmitted from numberless flaws in the mineral gives rise to the phenomena in question through a process of double refraction.

We may now turn to the consideration of forms of quartz which have a more or less organic origin. At the head of these may be placed such undoubtedly organic aggregations of silica as the Tripoli and semi-opal of Bohemia, which consist almost entirely of fossil diatomaceæ. Some beds of rock also in the Island of Barbadoes are found to be composed of little else than polycystinæ and spiculæ of sponges. Much of the flint so characteristic of the chalk-rocks, as well as the chert of the greensand and of the mountain limestone, appears to have been derived from the precipitation, by organic substances, of silica held in solution by the waters of the ocean; at any rate, much of it seems to have been thus deposited; flinty nodules are often found to consist of fossilized sponges, the silicious skeletons of which may have attracted to themselves the silica dissolved in the surrounding water. Spiculæ of sponges, diatomaceæ, foraminifera, shells, corals, and other organisms are abundant in the flint, and also in much of the chert. Recent observations by MM. Guignet and Teller have shown that the water of the Bay of Rio de Janeiro contains large quantities of both silica and alumina in solution, the amount in the case of silica being as much as 9·5 grains per cubic metre.

Wood will sometimes be found to be pseudomorphosed into silica, the woody structure being replaced atom by atom, so that the minutest vessels are perfectly preserved. Various species of palm from the East Indies are frequently found fossilized in this manner, and sections of them make very beautiful objects for the microscope. Large fragments of a partially silicified wood, named *Endogenites erosa*, may often be found in the neighborhood of Hastings, derived from the wealden formation.

The curious so-called mineral beekite is really coral or shelly matter which has been replaced by silica. Researches into the behavior of the colloid form of silica, already spoken of, have shown how in many instances large deposits of silica, such as the flinty bands of the cretaceous formation, may have originated. Mr. Church's experiments, made some years since, proved that the minutest particle of carbonate of lime was sufficient to transform the pure aqueous solution of silica into the solid state in the course of a few minutes; and he was able, by the infiltration of silica in solution, to replace almost entirely the carbonate of lime in recent coral by silica, producing by this means what may be looked upon as a kind of artificial beekite. Thus in the slower, perhaps, but mighty chemistry of nature, marvelous reactions may have taken place, giving rise to some of the multitudinous forms in which silica presents itself to the mineralogical student.—*Science-Gossip.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M.D.

CONSUMPTION (*Concluded*).

THE MOUNTAIN-CURE.

CARBONIC acid, the lung-poisoning residuum of respiration and combustion, is heavier than the atmospheric air, and accumulates in low places—in wells, in cellars, in deep, narrow valleys, etc.—and often mingles with the malarious exhalations of low, swampy plains. On very high mountains, on the other hand, the air becomes too rarefied to be breathed with impunity. It accelerates the respiratory process, as the amount of air inhaled at one inspiration does not contain oxygen enough to supply the wants of the organism at the ordinary rate of breathing, and is therefore especially distressing to diseased (wasted) lungs, whose functions are already abnormally quickened, and can not be further stimulated without overstraining their mechanism.

In the temperate zone, the purest and at the same time most respirable air is found at an elevation of about four thousand feet above the level of the sea, an altitude corresponding to the midway terraces of the European Alps and the average summit-regions of our Southern Alleghanies. The broad table-lands of the Cumberland Range are several hundred feet above the dust-* and-mosquito level.

* While the treeless plateaus of the Pacific slope are in a chronic state of sand haziness. In Southern Colorado, too, every high wind shrouds the mountains in whirls of a kind of sand-dust that can be felt under the eyelids and between the teeth.

Between the thirty-fourth and thirty-sixth degrees of north latitude the elevated plateaus have the further advantage that their climate equalizes the contrasts of the season: it mitigates the summer more than it aggravates the winter. Southerly winds predominate, and melt the snow with the same breezes that cool the midsummer weeks, for in the dog days the Mexican table-lands are considerably cooler than our Northern prairie States. In the Alps of North Carolina, Tennessee, and Northern Georgia land and labor are so cheap that even people of moderate means can build a sanitarium of their own. It has been often observed that the moral effect of a residence at a place where consumptives congregate is not favorable to the cure of the disease; and, moreover, a private establishment lessens the danger of contagion. The cheapness of living may be inferred from the fact that at the Chalybeate Springs of Benton, Tennessee, where board-rates vary from fifty to seventy-five cents a day, the visitors from the surrounding country towns, nevertheless, prefer to board on the co-operative plan: the proprietor of a kitchen-garden furnishes vegetables, a stock-farmer fresh meat, the owner of a carriage free transportation, and every family has a little cottage of its own. Summer-guests who come to drink mountain air can build their cabins wherever they find a convenient plateau, and contract with the next farmer for all the comestibles they may need in addition to their canned provisions. They can cook at their own fireplace. A log-house can be made as airy as any tent, and is out and out more comfortable. A rough-hewed porch-roof, projecting like the veranda of a Swiss *chalet*, will keep the cabin both dry and airy; square holes in the center of each wall can serve as windows in fine weather, and during a storm can be shut with a sliding-board. Between May and November the winds in the Southern Alleghanies come from the south or southwest, nine days out of ten, and, in order to get the full benefit of the pure air, the house should face one of the thousand promontories of the southwestern slope that rises in terraces from the "Piedmont counties" of North Carolina and Northern Georgia, with a free horizon toward the plains of the Gulf-coast. Have the door on the south side, and keep it wide open all night, as well as the windows or louvers in the opposite wall. If the windows do not reach to the ground, spread your bedclothes upon a hurdle-bedstead rather than on the floor, in order to enjoy every afflatus of the night-breeze. Night and day one can thus breathe mountain airs that have not been tainted by the touch of earthly things since they left the pine-forests of the Mexican Sierras. Every inspiration is a draught from the fountain-head of the atmospheric stream.

There is no need of living on oiled sardines where the brooks are full of speckled trout. Those who *must* break the commandment of Brahma (and the highland air confers certain immunities), may devour their humble relatives in the form of wild-turkeys, quails, and opossums ; but the products of the vegetable kingdom are cheap, and diversified enough to make up a tolerable *menu.* Sweet-potatoes at twelve cents a peck, string-beans fifteen, green peas twenty-five ; strawberries ten cents a quart, roasting-ears a cent a piece, brown beans actually a bushel for one dollar—Dalton (Georgia) market-prices. "Semi-annual" comestibles in proportion : eggs eight cents a dozen, butter twenty cents a pound in mid-winter, and ten cents in summer. Milk is a drug in the market ; a good milch-cow can be hired for a dollar a month, a cow-boy for two dollars and his board. Whortleberries are sold at five cents a quart, but the pleasure of picking them is worth a great deal more. The lamest and weakest can join in that sport, for the shrub attains a height of three feet, and thus saves one the trouble of stooping.

About an hour after breakfast the colony (or family) should muster for out-door exercise. The choice between the various opportunities for entertaining work is the only difficulty, for Nature has provided them in embarrassing profusion. Expert bee-hunters can find four or five hive-trees in a single day. The chestnut-forests of the upper ridges are full of squirrels, and with a dog, a sack, and a good axe, it is not difficult to catch one alive, and turn it over to the quartermaster of the pet-department. Climbing trees is an exercise that brings into action nearly every muscle of the human body, and, like the *mal de monte*, the shudder that seizes the traveler at the brink of Alpine precipices, the dizziness that takes away the breath, returns it with interest and is a mechanical asthma-cure. Entomologists may combine the gratification of their mania with useful exercise by rolling logs in quest of big-horn beetles. Log-rolling and tumbling rocks from the tops of projecting cliffs is the spice of life in the engineering enterprises which a campful of male North Americans are sure to set afloat—as enlarging the entrance of a cave, constructing a graded trail to the next spring, to the next wagon-road, or to a favorite lookout point. Enterprises of that sort involve a good deal of grubbing and chopping, but also many interesting discoveries—geological specimens, an unknown chrysalis, new varieties of ferns and mosses. As the work progresses it becomes a pastime rather than a task, and novices feel inclined to agree with engineer Spangenberg, that "with a little management a first-class railroad can be built to any point of the continent earth." There is no cliff that can not be circumvented or terraced. With a slight curve in the road an apparent obstacle can be utilized as a bulwark. In fallen trees the removal of a few side-branches develops revolving faculties. A pickaxe makes a whole wilderness plastic.

The summer air of the highlands makes out-door life a luxury, but the chief advantage of the plan is this : The stimulus of a pleasant pastime enables a man to beguile himself into about ten times as much exercise as he could stand in the Turner-hall. The visitors of a hygienic gymnasium take their turn at the horizontal bar as they would swallow the drugs of a public dispensary: they know that it is a lesser evil, they know that the road to Styx is the alternative, they intend to come every day, but the intolerable tedium of the crank-work exercise soon shakes that resolution. The motive for exertion is too abstract; it lacks the charm of progressiveness and the stimulus of a proximate, tangible, and visible purpose. The sham competition of a regiment of invalids under the command of a *turn-master* does not much sweeten the bitter broth; it is still crank-work, minus the club of the jailer, and nine out of ten hygienic gymnasts will soon find or make a pretext for discontinuing their visits. How many out of a hundred pupils of a young ladies' seminary would dream of performing their "callisthenics" at home? They would as soon walk on all-fours, or ride on a dry clothes-line. But arrange a May-day picnic in the mountains, and they will beat a kid in climbing up the steepest rocks, and swing on wild grape-vines for hours together.

It is likewise certain that fatigues can be far better borne if the body is not encumbered with a surplus of calorific clothes. A pair of linen trousers, a flannel hunting-shirt, and a loose necktie, make the most hygienic summer dress. In the afternoon remove the necktie and roll up the shirt-sleeves: it can do no harm to imbibe fresh air by all available means, and let the cutaneous lungs share in the luxury. Nor is there any excuse for the wide-spread fallacy that it is dangerous, even in the most sweltering nights, to remove the bed-blankets. Kick them into the farthest corner if they become too warm, and sleep in your shirt and drawers, or under a linen bed-sheet. Half-naked lazzaroni sleep the year round on the stone terrace of the Museo Borbonico and outlive the asthmatic burghers in their sweat-box dormitories. The body effects part of its breathing through the pores. Painting a man with yellow ochre and copal-varnish would kill him as surely as hanging him by the neck. The confined air between the skin of the body and a stratum of heavy blankets gets gradually surcharged with carbonic acid—in warm weather even to the verge of the saturation-point. The perspiration is thus forced back upon the body; and the lungs—perhaps already weakened by disease—have to do double work.

Hunters may find it hard to return in time for dinner, and need a rallying-signal. One P. M. is a good time for a general shouting-match. Wake the echoes of the old mountains; the spirits of the departed Cherokees are tolerant—offer a premium for the loudest and ghastliest war-whoop, and depend upon it that no pulmonary disaster will spoil the triumph of the victor. Blood-vessels are not ruptured in that way, but by sudden movements or abrupt ejaculations, when terror or a similar emotion has driven the blood back upon the heart. But, while the mind is at ease, and the lungs not strained by a desperate exertion of the pectoral muscles, I would defy a consumptive to yell himself into a hæmorrhage. A vocal effort does not injure the respiratory organs; on the contrary, it strengthens them. Statistics show that lecturing and preaching *savants* outlive their graphic colleagues. In Carrollton, near New Orleans, I knew a hectic old Mexican banana-vender who was so short of breath that he had often to clutch the legs of his chair in his dire struggles for life-air, and who told me that every few days or so he had to hitch up his market-wagon, and bawl out his wares at the top of his voice, and for hours together—*in order to ease his lungs.* Intead of speaking in a whisper, consumptives should envy cattle-drivers, whose business gives them a plausible pretext for yelling.

The prejudice against after-dinner speeches is founded upon a more valid reason. Rest, mental and physical, is really a prime condition of a thorough digestion. Invalids, especially, need a liberal *siesta*, and a two hours' nap in the shade of a shelving rock can do no harm. Long, sultry afternoons, though, are unknown in the highlands, and before 3 P. M. the air will again be cool enough for any kind of outdoor sport. If the spring needs cleaning out, a wheelbarrow full of flat rocks from the next creek will turn it into a deep, limpid *brunnen*, where a pail can be filled at a single dip. On sunny days butterfly-hunters may bag their game on every mountain-meadow. Grasshoppers can be flushed by the dozen, and make the best bait for brook-trout. The rock-benches at the water's edge would invite to a prolonged session if other pastimes were not too tempting and numerous. There are raspberries and muscadines in the brake; farther up the woods are strewed with chestnuts, and the collector soon learns to find the little dells where they accumulate, like nuggets in the cavities of a California gold-creek.

It is astonishing how work of that sort makes the hours vanish, together with many evils which tedium is apt to aggravate: languor, spleen, and dull headache. But more wonderful yet is its effect on the disorders of the respiratory organs. Under anything like favorable circumstances the lungs are, indeed, the most *curable* part of the human body. With every inspiration the balm of pure air can be brought into contact with the thousand times thousand air-cells of the respiratory apparatus,* and, as we breathe about twenty times per minute, the panacea can be applied twenty-seven thousand times in twenty-four hours. Every day six hundred and eighty cubic feet of gaseous food circulates through the lungs of a full-grown man, carrying nourishment and restoratives to every fiber and enabling it to rid itself of its morbid excretions. The rapidity of the remedial process has more than once forced upon me the thought, "What persistent outrages against the health laws of Nature must it have required to make the lungs the seat of a chronic disease!"

* "It has been calculated by M. Rouchoux that as many as 17,790 air-cells are grouped around each terminal bronchus, and that their total number amounts to not less than 600,000,000" (Carpenter's "Physiology," p. 507).

The mountain-cure remedies assist Nature only in an indirect way, but before the end of the first week the BREATHING POWER of the asthmatic lungs will revive as seeing and hearing awaken after a trance. The respiration is still short and quick, but becomes less and less laborious; the patient need not gasp for air; his lungs have resumed business, and attend to all the details of its functions till it becomes entirely automatic.

EXPECTORATION becomes less frequent; the source of the affection seems to retreat upward, the *sputa* come from the upper air-passages, and without the preliminaries of a worrying cough. Their quantity gradually diminishes, and the relief is permanent, while cough-medicines loosen the phlegm only by increasing its quantum, and discharging it with a tide of artificial mucus.

The NIGHT-SWEATS, too, soon disappear, for they can be cured on the *similia similibus* principle of the homœopathists—by day-sweats. Put on a flannel shirt, get an old axe and try your luck with a good-sized bee-tree, or with the old log that obstructs the trail. Keep a tin cup about you, and assist Nature by frequent trips to the spring. No matter if you have to change your flannel shirts four times a day; depend upon it that you will not need them at night. The hectic fever abates; the cause has been removed. The sweats as well as the fever are induced by a pulmonary inflammation that increases the temperature of the body, but can be relieved by giving it a chance to eliminate the morbid matter. The four or five quarts of water that were excreted in the process of perspiration have circulated through every pore of the respiratory organs and depurated them more effectively in a single day than the repeated doses of a cough-exciting nostrum could do in a week. After the return from the mountains to the city (not before November, if possible) the occasional recurrence of the trouble will generally be limited to the rainy weeks of the first month, for the antipyretic influence of cold, clear weather rivals that of the perspiration-cure.

The danger of a HÆMORRHAGE is generally passed when the cessation of purulent expectorations proves that the disease has become non-progressive, and that the ulcers begin to cicatrize. *Hemoptysis*, or blood-vomiting, is the only symptom of their disease which is liable to shake the characteristic *hopefulness of consumptives*. It generally frightens them considerably; they are apt to protest against out-door proceedings, and speak with bated breath, under the (erroneous) impression that a vocal effort has somehow induced the trouble. It can do no harm to humor that disposition; but keep the patient on his legs—lying down flat on the back after a heavy hæmorrhage is almost sure to bring on a relapse before the end of twenty-four hours. For the first three or four hours walk slowly up and down, try to keep up a deep and calm respiration, and, if possible, take the first nap in a sitting posture—propped up with cushions and pillows. At the end of forty-eight hours the danger is past, and out-door exercise may be gradually resumed.

For stubborn DYSPNŒA (want of breath) there is a somewhat heroic but almost infallible palliative, though I own that the *rationale* of its efficacy is somewhat undefined—artificial insomnia. Read or write as long as that will keep you awake; after midnight walk up and down the room for fear of falling asleep in the chair, and toward morning, when drowsiness becomes irresistible, go to bed for a few hours, and that they will be passed in peaceful sleep can generally be inferred from the circumstance that by that time the dyspnœa has disappeared. After the second night's vigils the trouble is not apt to recur for a month or so. But, unless the distress is utterly unbearable, or the necessity for prompt recuperation very urgent, it is, on the whole, better to eschew palliatives and rely on the only permanent asthma-cure—the gradual but normal invigoration of the whole system.

In CHRONIC CATARRH—a frequent concomitant of a tubercular diathesis—the obstruction of the nasal ducts by accumulated mucus yields in a day or two to any exercise that brings into play the muscles of the neck, shoulders, and chest, such as shouldering a good-sized log, walking bolt-upright with two large pails full of water, or a loaded wheelbarrow. A very simple household remedy is a palliative to the same effect: hot water applied to the palms of the hands and the soles of the feet. It affords immediate though often only temporary relief; for the diathermal influence of the hot-water treatment, as it were, dries up, and thus temporarily reduces the mucous accumulations, while the preferable exercise-cure more gradually but permanently removes the cause of the trouble.

The stitch-like PAIN IN THE CHEST is apt to recur with every catarrh, and forms, indeed, only an incidental concomitant of tubercular consumption. It is a pleuritic affection, and is often entirely wanting in cases that end with death by tubercular cachexia. The Calmuck Tartars, who defile the air of their family tents with tobacco-smoke and suffer the usual consequences, cure pleuritic inflammation by a simple method of inunction: viz., by fomenting the nape and chest with hot mutton-tallow. When loss of appetite indicates a derangement of the digestive organs, ointments may be used as a temporary substitute for a demulcent diet.

Dropsical swellings, chronic diarrhœa, with frequent chills, prove that the disease has reached the colliquative or hopeless stage of its development. But, even under such circumstances, the mountain-cure, in the form of moderate exercise in the pure air of a highland sanitarium, will confer at least the negative benefit of saving the patient from the horrors preceding the last act of a hospital-tragedy—it will insure an anæsthetic conclusion of the disease; the vital strength will ebb away in a painless *deliquium*.

But while the vital forces still keep the foe at bay, i. e., before the symptoms of the decline have assumed the chronic form, before the process of digestion becomes utterly deranged, before the impoverishment of the blood results in dropsy and a livid discoloration of the lips, while the patient has intervals of sound sleep and sound appetite, and strength enough left to walk a couple of miles—there is more than an even chance that the disease can be permanently cured. One memento only of its ravages will remain—the acceleration of the breathing-process whenever the convalescent engages in active exercise. But even that inconvenience can be diminished by a system of training that will gradually inure the lungs to the strain of the ordinary movements and exertions of daily life: namely, by walking up-hill (or up-stairs) with a load of daily increasing weight. After two months or so it will take two scuttles full of coal to produce the panting and gasping which used to result from a small pailful of water, and the mere weight of the body will seem barely sufficient to indicate the difference between a rough mountain-trail and a graded pike-road.

A few years ago an emaciated Canadian miner came South for his health, and located a small placer-claim on the plateau of the "Fort Mountain," in Murray County, Georgia. The mountain is a mile high, and the up-trip with a few dozen eggs from the next valley farm obliged the miner to stop every few minutes to keep his chest from bursting, but before the end of the year he was able to make the same trip, without a stop, with a bushel-bag full of corn-meal. The waste from the corrosions of the tubercle-virus can perhaps never be repaired, but the healthy tissue of the remaining portion of the lung is susceptible both of expansion and invigoration. The lungs expand and contract with the chest. If three sisters marry on the same day—the first a ferryman, and learns to row a boat; the second a tailor, and takes to tight-lacing; the third a grocer, and tends his shop—an autopsy would show that in twenty years after their separation the ferrywoman's lungs have grown fifty per cent larger than the shopkeeper's, and fully twice as large as the dressmaker's.

But few consumptives ever outgrow the sensitiveness of their lungs, and must beware of contagion, avoid crowded meetings and lectures, and rather offend Mrs. Grundy than prolong their visits to a catarrh-infected house. Thoroughly healed though reduced lungs (reduced often to two thirds of their original size) will perform their functions in a sufficient manner for a long series of years. With the above-named precautions and a nutritive but strictly non-stimulating diet, there is no reason why a convalescent from pulmonary scrofula in its most unmistakable form should not enjoy an out-door festival in honor of his eightieth birthday. It is well known that in the *deliquium* of pulmonary consumption, in the stage of violent hæmorrhages and dropsical swellings, the confidence of the patient often gives way to gloomy forebodings—the harbingers of the long night that never fails to cast its shadows before. But this despondency is not more significant than the hopefulness that precedes it. For I believe that instinct is right in both cases, and that in the first stages of its development consumption is really the most curable of all chronic diseases. Chateaubriand, Heinrich Voss, Count Stolberg, Alfieri, Francis Deak, and Dr. Zimmermann, were descended from consumptive parents, but redeemed their constitutions by traveling and out-door exercise, and attained to a more than average longevity. Goethe, in his younger years, was subject to hectic fevers, with frequent hæmorrhages, but recovered and died as an octogenarian.

A tendency to emaciation, the most characteristic symptom of tuberculosis, generally continues to counteract the normal effects of a liberal diet, even combined with continence and a tranquil mode of life; but the limitation of that tendency is a sufficient guarantee that the disease has become non-progressive. But there is a still surer criterion: consumptives are generally remarkably fair and smooth skinned. The reason is, that the dross of the cachectic system gravitates toward the diseased lungs. An East-Indian surgeon found that small-pox can be localized by rubbing the chest with croton-oil, and thus concentrating the eruption. Pulmonary consumption is a kind of centralized scrofula. Two hundred years ago, when the cutaneous form of the disease was more frequent, surgery was often invoked to remove ulcers that threatened to disfigure the patient or destroy his eyesight. The approved method was to produce an artificial and larger sore, where it could not do so much harm, on the arm, below the chin, or on the nape of the neck. The larger sore attracted the morbific matter; and thus healed the smaller one. For cognate reasons, a scrofulous affection of the respiratory organs acts, as it were, as a *cosmetic*. Pimples disappear; boils head at once, and without suppuration; intemperance, surfeits, a congenital taint of scrofula, do not affect the color of the face; and (excepting the effect of gross dietetic abuses, which ultimately react on the lungs) the cutaneous excretion of such impurities is therefore not an unfavorable symptom. For their reappearance on the surface of the body proves that the respiratory organs have ceased to attract the cachectic humors of the system; in other words, that the tubercle-sores have cicatrized, and the lung-destroying virus has been eradicated.

A GERMAN VIEW OF THE "DATA OF ETHICS." *

By FRIEDRICH VON BAERENBACH.

PHILOSOPHICAL thought is tending more and more toward concentrating itself upon problems of physiological as distinguished from metaphysical psychology, and to the inquiry after those facts which can be ascertained. The best workers in this field are still

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troubled, nevertheless, lest they may lose the connection with the sciences, and particularly with that special research and exact calculation under the influence of which a happy reaction has made itself felt in the various departments of philosophy against the intuitive and undisciplined ways of thinking that have characterized many metaphysicians.

As in life all gives place to the question of the highest utility, so in science all gives place to pure theoretical interest in enriching our knowledge of facts. But, while this may find its justification in the history of culture, the problems of the work of culture are no more exhausted thereby than the problems of thought. Philosophy would surrender her most important function were she to shirk the solution of those problems which she alone can solve. To these problems belong, last not least, those of ethics.

The progress of scientific knowledge in all domains of inquiry is the mightiest instrument in aid of the progress of culture. Its influence reaches, directly or indirectly, to all human relations, not excepting moral development. Apparent contradictions diminish or disappear before the macroscopic glance, which, not fixed upon any isolated point, takes in the whole range of facts and causes in their mutual relations. We are at the same time convinced, even by the consideration of the educational influence which scientific efforts have acquired in all strata of modern society, that all is not done. The gap is visible and sensible in philosophy and in life.

The needs of a great community of thinking men neither seek nor find any satisfaction in the dogmas of a positive confession of faith, while, for the foundation of a system of practical regulative laws and ethical principles, the progress of inductive science does not furnish all that is needed. A bridge is wanted, which shall establish connection with active life; a well-spring of right, from which laws and principles can be drawn and distributed.

According to some philosophers, ethics stands or falls with metaphysics. That this is not the case has been proved by the isolated achievements in moral philosophy of the disciples of modern positivism, and is demonstrated afresh by Herbert Spencer in his "Data of Ethics." This author occupies so conspicuous a position among the philosophic writers of the century, that the summons to a study of his works may well find ample response.

We may gather, from the preface to his last work, how Herbert Spencer, like other founders of great philosophic systems, esteems the importance of ethics. "This last part of the task it is to which I regard all the preceding parts as subsidiary." From the beginning of his philosophical activity this was the "last goal," the object to which all efforts were preparatory—to find a scientific basis for the principles of good and bad in action.

"Now that moral injunctions are losing the authority given by their supposed sacred origin, the secularization of morals is becoming imperative. Few things can happen more disastrous than the decay and death of a regulative system no longer fit, before another and better regulative system has grown up to replace it." For this reason, Herbert Spencer has sought to fill the gap caused by the disappearance of the code of supernatural ethics, by a code of natural ethics.

The vacuum is before us, while some consider the filling of it superfluous and others impossible. Herbert Spencer believes that it can and must be filled. High above all problems of cultural and scientific endeavor he places that of the foundation of scientific ethics.

It is presumed, in the conception of ethics, that it shall establish the "ought." Unlike other moral systems, scientific ethics deals with the establishment of the practicable "ought"; not with duties *in abstracto*, but with duties which can be performed. For, "by association with rules which can not be obeyed, rules that can be obeyed lose their authority." Here the critical point of view is established whence scientific ethics must prove the conclusions of moral philosophers upon their merits.

Throughout the "Synthetic Philosophy," which will be closed by the "Principles of Ethics," of which the "Data of Ethics" forms the first part, the fundamental principles of modern evolution are enlisted for the solution of biological, sociological, and psychological questions, to such an extent that this philosophy may be described as a distinct branch of the philosophy of evolution. No system of natural philosophy has, with equal consecutiveness and completeness, adapted the achievements and the hypotheses of modern natural science to the construction of a philosophy on a scientific foundation.

Herbert Spencer's "First Principles" serve as an introduction to this philosophy, and define the stand-point from which the author surveys the whole range of philosophical inquiry. This work undertakes the experiment of a universal application of the fundamental laws and hypotheses of natural science, at the same time generalizing the principle of evolution, and making it the one great underlying principle. It takes up the work of critical philosophy, defining the limits of the knowable and the unknowable. It attempts the only possible reconciliation between religion and science, by pointing to their common, final resting-place in the absolute. The works included in the "Synthetic Philosophy" form parts of a great system held together by the principle of evolution; displaying stupendous learning, and a rare universality of scientific culture, entitling their author to a place, *mutatis mutandis*, beside Aristotle himself. These comprehensive writings afford, even to those who can not accept their underlying principles, a plenitude of instruction.

As to the statement of the problem in general form, serious difference of opinion is hardly possible. For every school and from every stand-point, ethics is a regulative discipline; not laws of the actual, but laws of the "ought"; not laws of conduct in general, but of conduct of a certain kind. As logic establishes the regulative laws and postulates of scientific knowledge, ethics establishes the regulative principles of moral life.

The stand-point assumed by the author, in dealing with evolution, serves also in ethics. It appears to him evident that, from indifferent actions to actions which are good or bad, the transition is quite gradual. In ethics, as in evolution, the higher development must be explained by the lower. The study of ethical problems presupposes the study of human action as a whole, and this again presupposes that of the actions of living beings in general. The study of the evolution of action forms the preparation for ethics.

It is shown, in the first place, that "higher organic development is accompanied by more highly developed action." The latter is "an improving adjustment of actions to ends, such as furthers the prolongation of life, such as furthers an increased amount of life." Action adapts itself more and more to self and race maintenance; and here also the general evolutionary principle is applicable. "Race-maintaining conduct, like self-maintaining conduct, arises gradually out of that which can not be called conduct; adjusted actions are preceded by unadjusted ones."

In treating of good and bad conduct, Herbert Spencer, in the first place, endeavors to establish the meaning of the terms "good" and "bad." Actions properly adapted to ends are good, and actions not so adapted are evil, both these definitions being taken in a relative sense only. Good conduct is identical with the most highly developed conduct, which "simultaneously achieves the greatest totality of life in self, in offspring, and in our fellow-men."

Pessimistic verdicts upon the value of life are combated by the author with all the might of his intellect, as standing in harsh contradiction to every paragraph of the unwritten moral code of humanity. He leans toward a limited optimism. He rightly urges that pessimists and optimists agree on one point. Both "assume it to be self-evident that life is good or bad according as it does, or does not, bring a surplus of agreeable feeling. . . . Each makes the kind of sentiency which accompanies life the test."

A general consideration of the conflicting views of life brings the author to the conclusion that the good, on the whole, is that which causes pleasure; that our ideas of good and evil arise from the certainty or probability that the same will call forth, somewhere or some time, pleasure or suffering.

Not man as an individual, independent of social relations, of family, people, state, society; not man or humanity in the abstract; but man in society, the social individual, the member of the social union, is the subject for whose moral action, for the adaptations of whose conduct to the highest aims of social life, it is the business of scientific ethics to establish normal principles. It was, therefore, necessary to loosen the bonds which had bound ethics to unscientific propositions and dogmas of traditional transcendentalism, and to establish its scientific character by a union with the foundations of our scientific knowledge. This, in brief, is the programme for the reform of ethics, or, rather, for its establishment on a new basis. The unscientific methods employed by ethical writers are sharply criticised; the logical propositions upon which the foundation of scientific ethics depends are clearly stated; and the false premises exposed which render all scientific procedure impossible.

In the exposition of the relativity of suffering and enjoyment, and in the sections on "Egoism *versus* Altruism" and "Altruism *versus* Egoism," the author grapples with the fundamental problems of anthropological ethics. The priority of egoism is convincingly set forth, the spontaneous origin of pure altruism, and the interdependence and complementary relations of both principles; while the one-sided assertions and demands of their respective champions are refuted. The final reconciliation of egoism and altruism is inferred from evolution, from which the author also reaches that conciliatory and compromising position which enables him to reconcile many seemingly contradictory phenomena.

Evolutionary morals are wholly hedonistic. The happiness-giving is the good; and it is owing to theological and political influences alone that mankind overlook this truth. The idea and the desire of happiness, of perfect well-being, necessarily mark the character of good conduct. Moral life is a series of compromises between egoism and altruism. All other moral principles derive their conditional justification from this first principle of human action, which is characterized by Kant as the negation of all morality. The idea of perfectibility is tried by the same standard, and we are reminded that capacity for the reception of happiness is the highest proof of the perfectibility of human nature. Aristotle, who recognized happiness as the highest aim of human endeavor, took a step out of his way when he "sought to define happiness by the aid of the word 'virtue,' instead of defining virtue by the aid of the word 'happiness.'" Hence it must be conceded that "the conception of virtue can not be separated from the conception of happiness-producing conduct; and that, as this holds of all the virtues, however otherwise unlike, it is from their conduciveness to happiness that they come to be classed as virtues."

The welfare of society as a whole is regarded as the first problem, but not as the final object, being preparatory to the furthering of individual life and welfare, which is to be compassed by the fostering of social interests. The subjection of personal to social welfare is regarded as a temporary consequence of the existence of antagonistic societies; and, when the social aggregate, arrived at a certain elevation of development, shall no longer be in danger, the welfare of individuals will be the object. Individual happiness has the last word.

In the "System of Synthetic Philosophy," evolution is the universal world-law, the law of laws, dispensing with all need of stern commandments of revealed religion and theological morality. The evolution of human nature and society brings with itself this, that human conduct becomes better and better adapted to individual and social aims; that good conduct (adapted to the preservation of the race) gradually overpowers bad conduct (unadapted to self and race maintenance) in that struggle for existence in which morality and virtue have on their side every advantage. As the fitter organism survives the less fit, so must moral conduct in the natural course of things gain the upper hand, and immoral conduct tend more and more toward extinction. Thus, according to immutable laws, higher forms of conduct must be evolved from the original conduct of man in his lower estate, as higher organisms are evolved from lower. Changes such as have taken place in the course of civilization will take place again. The want of faith in a further like development, whereby man's nature will be brought into harmony with his condition, is only one of the innumerable proofs of an inadequate knowledge of causality; and he who has learned to put aside primitive dogmas and primitive ways of looking at things, and who has appropriated those modes of thought which science produces, can not believe that the "wholesome working Force" which has hitherto so changed all forms of life according to the altered requirements of their being, will not continue to operate in the same direction.

Ethical evolution affords an imposing outlook for the future of mankind. Man does not waver, like Hercules, between virtue and happiness. He is spared all pain of choice. Virtue and happiness are the one inseparable goal which he approaches with steady advance. Nature herself leads him on, and he has in his own nature the assurance of victory. Ceaselessly bent upon his own advancement, restlessly at work improving the conditions of his existence, he at the same time nourishes his moral life. No moral law opposes the impulses to this advance. No antinomy between moral and natural law needs solution, no strife between moral and sensual impulses need be decided. Always and everywhere an aspiration, a goal. No subjection of the *ego* to a law which commands without regard to weal or woe, no sacrifice of individual claims, no giving up of self at the bidding of an absolute moral law. Development is never interrupted. In ceaseless progress it approaches the goal—the greatest sum of well-being. The rigoristic "Thou canst, for thou oughtst," has no place here. Guidance is enough, compulsion is not needed.

This ethics is confessedly utilitarian, before all things a higher form of utilitarianism; but no raw materialist philosophy of usefulness, addressing itself to brutal egoism, to sensual enjoyment, to the worship of material wealth, to the thirst for riches and power at the expense of others. Whatever furthers development and brings its goal nearer, is useful; and the goal of development lies in a fair and distant future, whose outline the philosopher thinks he sees. The highest aim, to which all others are subsidiary, to which the strivings of the best are directed, is a moral order of life corresponding to the noblest longings of reason, of the most highly developed man in the most highly developed society. Such a system appeals to that ennobled and enlightened utilitarianism which constitutes the longing after ideal possessions—the condition of the highest welfare of man.

The rigorism of other moral systems has no place in the ethics of evolution. Its moral law is not like that of Kant, sublimely above all connection with natural impulses and inclinations, nor does it constitute moral life a continuous battle against desires which aim at the furthering of individual happiness. "Great mischief has been done by the repellent aspect habitually given to moral rule by its expositors, and immense benefits are to be anticipated from presenting moral rule under that attractive aspect which it has when undistorted by superstition and asceticism. 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 pleasure 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 two such fathers symbolize the controls of morality as it is and morality as it should be."

This comparison, however, does not hold good of all forms of rigorism. Kant's moral law knows neither inclination nor disinclination. It neither attracts by rewards nor terrifies by punishments. It is neither the father who adds unsympathetic bearing to stern supervision, nor the father who helps the enjoyment of his children and watches their games. It is sublime above all traffic with the inclinations. And it may still be asked whether Kant was "so far from the track of truth" when he sought the ethical criterion in the law-abiding, duty-abiding sentiment, and maintained the supremacy of that sentiment with that enthusiasm which inspired his famous apostrophe to duty: "Duty, thou sublime, thou lofty name; which embracest within thee naught beloved bringing flattery; commanding submission, though threatening nothing to move the will, but only setting up a law which of itself finds entry into the breast, and wins for itself unwilling reverence, if not always obedience; before which all desires are dumb, even should they work against it in secret. What origin is worthy of thee, and where shall I seek the roots of thy noble descent, which proudly spurns all kinship with the desires?"

But, if we accept the system of Herbert Spencer, the rigoristic conception of Kant appears superfluous and even injurious. The doctrine of natural development affords a glimpse of the promised land, of a future wherein virtue and happiness will mean the same thing, wherein no antagonism will be conceivable between duty and inclination. No ethics can cheer us to unresting strife by a nobler goal, none can hold out a sublimer prospect. A beautiful faith is that in the upward movement of humanity. It renders easy the battles, the dangers, the countless sacrifices, which lie in the way.

But, notwithstanding the merits of the work under consideration, in certain principal utterances, and in its distinguished contributions to relative ethics, the fundamental principle of absolute ethics, the ethical criterion of action, appears to belong as yet to the number of those problems most needing solution. The last word is not yet spoken; but the results placed in our possession so far, justify the assumption that the evolutionary system of Herbert Spencer will materially assist the thorough reform of ethics, by its critical and positive preparatory work.

COST OF LIFE.

By JOHN PRATT.

NOTHING so forcibly strikes the attentive observer of natural phenomena as the prodigal expenditure of force and matter—the immense over-supply of seed; the enormous waste of sun-force in irrigation; the incalculable power, never to be utilized, represented in tidal action, and in atmospheric, oceanic, and river currents. If we extend our observation to the solar system and the inconceivable spaces intervening between that and the neighboring systems, the imagination fails to grasp the relation between the force that is utilized and that which is wasted. A million carried to the tenth power as a multiple, would fail to represent the waste of natural forces, as compared with the rudest Newcomen pumping-engine of the earliest type. This is familiar science, yet the expansion of the idea may present some points of novelty.

It is obvious that the whole system of planets, representing so many minute points in space, receive only an almost infinitesimally small proportion of the light and heat evolved by the sun. Some physicists are fond of giving the exact figures, but this is presenting the inconceivable. Siemens has made a very unsatisfactory effort to show that the force is conserved. He has made but few converts to his theory. It is the purpose of this monograph merely to expand the received idea of waste, by showing that the recipients of the prodigal bounty of the great giver of all good in our solar system—the sun—are far fewer than is usually supposed.

Before the spectroscope taught us that the reign of chemism is co-extensive with that of physics, many conjectures were indulged in by astronomers as to the inhabitability of the planets in general. It was taken for granted that there was probably an endless variety in the forms, composition, and even original substance of matter. Vegetation and animalism probably assumed wonderful shapes, and were capable of existing amid conditions not only altogether different from the terrestrial, but altogether incompatible with life on this earth. This conception, unphilosophical *a priori*, and indirectly the fruit of the wonder-instinct and that bias inherited, according to Comte, from the theological *régime*, has been swept away, and the reign of law extended to the mystic dream-lands of the universe. No thinker so loosely hinged now as to imagine life without a certain degree of heat, light, and without oxygen, hydrogen, carbon, and all the chemical elements, and that too in protean forms. Nay, more, the forms and succession of life must be, wherever found, substantially such as we are familiar with. If Venus has human inhabitants, they are not one-eyed Cyclops, nor does vegetation bury its leaves in the ground and spread its roots in the air. Organs, and functions, and instinct are there also, subject to the grand laws of selection and development. Further, the absence of conditions essential to the sustenance of life on our globe would be equally fatal in any other. This brings up the question in hand—the scarcity, as a part of the problem of the cost, of life.

What planets are inhabited? Let us begin with the giant worlds on the verge of the system. In the first place, as might have been conjectured even before the revelations of the spectroscope, from their great volume of light as compared with their distances from the sun, all of these great bodies are self-luminous. They are at least incandescent, and doubtless Jupiter and Saturn are in a fluid, perhaps gaseous state. There can not be the slightest doubt that they are no more fit for life than the sun itself. Will they ever become the habitations of living things? Ignoring their distance from the sun, which to an inhabitant of Saturn would have about the apparent magnitude that Jupiter has to us, there are other considerations which set that question at rest.

The volume of Jupiter, for example, is about 1,280, Saturn 991, Uranus 80, times that of the Earth. The density of Jupiter being about 1·40 and that of the Earth 5·48, it follows that the attraction exerted by Jupiter is, roughly, 300 times that of the Earth. A man who weighs 150 pounds on the Earth, if transported to Jupiter, would shake the ground with a ponderous tread of 45,000 pounds, or 22½ tons! His own weight would at once crush him into a mere pulp. A hickory-nut, falling from a bough, would crash through him like a Minié-ball. Again, water would weigh fifteen times as much as quicksilver. A moderate wave would shiver to atoms the strongest iron-clad, a rivulet would quickly form cañons miles deep, and ordinary hailstones would destroy every living thing. If we suppose the existence of an atmosphere, even no more profound than our own, its weight would be a third that of water, and its pressure 4,500 pounds to the square inch—sufficient to crush a rhinoceros or the boiler of a steam-engine. In motion, as a moderate breeze, it would sweep away not only every work of man, but the very hills and mountains. The same condition, in less degree, may be predicated of the lesser of the giant planets, and Jupiter is only selected as the most striking example.

Putting aside the hundreds of known, and the thousands and millions of unknown asteroids, as obviously unfit for life, let us next consider the case of Mars. The relative mass of Mars being only about $\frac{1}{60}$ that of the Earth, it follows, as a necessary consequence of the laws of gravitation, that our typical man would only weigh about 2½ pounds on the surface of that planet. Individual locomotion would be wonderfully facilitated, but its conditions would be reversed. The familiar dream of flying by a mere upward movement of the limbs might easily be realized in Mars, but an 80-ton locomotive would not propel a train of empty cars, and mechanical work of all kinds would be practically impossible. Niagara Falls, in such a planet, with water approximating the weight of air, would scarcely furnish power for a mill. A rifle-ball might be caught in the hand without harm. It is obvious that, with an atmosphere of the density of our own, animal and vegetable life, and every artificial work, representing so many structures of gossamer, would disappear like magic at the first breeze. But no such atmosphere as ours is possible with Mars. Even supposing it to equal our own in altitude, its pressure would be only about one fourth of a pound to the inch. Life is impossible in such an atmosphere, as is shown by a far less tenuity at the summits of lofty mountains. But, even if gravitation were not deficient, the distance of Mars from the sun entitles him to considerably less than half our supply of light and heat; a disadvantage immensely aggravated by his very eccentric orbit. Croll has shown how the shifting eccentricity of the earth's orbit, by adding three weeks to the duration of winter, brought about the glacial epochs, and covered nearly the whole earth with ice at various eras. Conceive, then, the thermometer in the Martial torrid regions touching 50°, and that even under the hypothesis, rendered impossible by the very laws of gravitation, of an atmosphere as dense as our own! Nothing can be more certain than that there is no liquid in Mars, and no life.

The same set of conditions, in exaggerated degree, exist in the minor superior planets, Ceres, Pallas, Juno, etc., while the asteroids are as much out of the question as the comets and meteors. In regard to the Jovian and Saturnian satellites, only probable conjecture can be indulged. We do not know with sufficient accuracy the degree of heat and light received from their primaries, to judge of those conditions, but all the obstacles flowing out of deficient gravitation predicated of Mars exist in equal degree in these satellites, the largest of which is inferior to Mars in dimensions.

In regard to our own moon much more definite information is accessible, though little need be said of its present life-conditions. Its bi-monthly axial revolution, its long, more than torrid day and antarctic night render it unnecessary to consider the question. But the mass of this satellite being about a third less than even that of Mars, interposes, and has ever interposed, the same everlasting mechanical obstacles to life there as in Mars. Atmosphere the moon may once have possessed, but it must always have been insufficient for life, insufficient to secure the stability of water, which, even if it continued in a liquid condition, would be swept—so light was it—in vast tides over the highest mountains. For the rest, if there be a man in the moon, it is interesting to know that he weighs less than two pounds, and can jump a mile, more or less.

Mercury, with a temperature of boiling water in the frigid zones and red-hot iron at the equator, may be a good place for a Calvinist to send his wicked neighbor, in imagination, but it can not be placed among the list of inhabited worlds. At last, then, out of all the vast, the countless myriads of circling orbs that do homage to our sun, only two remain to be considered—the Earth and Venus.

Venus, although too near the sun to render it likely that her tropical regions are habitable by man, is, so far as can be judged from her general physical condition, by no means destitute of life. If there be truth in the nebular hypothesis, Venus is younger than the Earth, and is therefore perhaps not evolutionized as to the highest forms. As to this, speculation would be little better than conjecture. Enough, that of Venus it can not be said, as of the other planets, with a certitude derived from the exact sciences, that there is no life in her.

The insignificant little globe called the Earth furnishes the only assurance of the higher forms of life, and, with the one exception of a globe even less than ours, of life in any stage of evolution. The Earth is not the millionth part of the known matter of our system, and, compared with the space occupied by that system, is far more insignificant than the smallest fleck of foam in the ocean. This tiny island in space does indeed teem with life ; but, if this life were distributed equally through the space given to its production, thousands of miles would intervene between every individual form.

So much for the space and energy expended in the evolution of vitality. The same immense expenditure, the same apparent disproportion discloses itself when we consider the time that has been consumed in the process. Here we are again confronted by figures approximating eternity. Life has existed on the Earth millions of years, and mammalian life hundreds of thousands of years. Yet such periods are insignificant in comparison with the cosmogony of the planets. The duration of the highest order of life, under the refined conditions of a high type of civilization, is but of yesterday comparatively, but it has taken so enormous a period to ripen that we can no more conceive of it than of eternity. A space so vast that it is a tedious journey for light to traverse, and a lapse of time so great that a snail might have made the circuit with ease in the morning of it, have been necessary to give birth to one Shakespeare! All this space, and all this time, and all this immortal energy have as yet barely sufficed to develop a few organisms capable of a glimmering comprehension of the forces which have evolved them. All the rest, if the accepted theories of gravitation and light and heat are not wholly illusory or misunderstood, is waste space, waste matter, waste energy. Life is far more rare and far more costly in our solar system than diamonds in the earth.

But why not? Space is boundless, matter is infinite in quantity, and time is limitless, past and to come. Where the treasure is exhaustless, the question of cost is only interesting from a speculative point of view. This as regards the past.

One of the elements of cost—time—has an interesting bearing on the future of the universe. Some scientists have of late indulged in presages more despondent than philosophical. According to this school, the dissipation of energy into space will finally result in the death of matter. Matter, being indestructible, will exist forever, but its soul will perish; first the vital form, then electricity, light, and heat, and finally even atomic vibration—leaving all cosmic bodies mere cadavers, like the terrestrial moon. This view has been combated by special theories, like that of Siemens, but not with great success. But there is a large aspect of the question which, though it seems to have escaped the attention of thinkers, at once sets it at rest, and demonstrates that energy and life are immortal. Bacon says of eternal duration, that, dividing it into past and future, it is of no consequence where we draw the line; a billion years ago, or a billion years hence, or the present, the two parts are still equal to each other and to the whole; thus contradicting all the laws of quantity. If this be a paradox, it has the peculiarity of being irrefutable, since it is impossible to conceive of any greater eternity than either the past or the future. Assuredly it can not be maintained that the future eternity is greater than the past. Assuming, then, this postulate, and that energy in all phases has been eternal in the past, it follows, with a force that commands unhesitating assent, that it will be eternal in the future. Whatever is, has been; whatever will be, has been. Energy has had one eternity in which to dissipate itself. What one eternity has not sufficed to bring about, will never be consummated. It may be interesting, but it is not essential to the demonstration, to investigate the method by which energy dissipated becomes once more potential. Perhaps the most tenable theory is, that it will be accomplished by the collision of dead worlds with each other, and the resulting mechanical evolution of light and heat. According to this view, attraction is the grand reservoir of the generic energy of the universe, on which all matter may draw when its differentiated force has been dissipated. But, be this as it may, the fruitful union of matter and energy in the infinite past is a stable guarantee that they will never be divorced.

ON SCIENCE-TEACHING IN THE PUBLIC SCHOOLS.*

THE repeated appointment, by this body, in successive years, of committees to look into the scientific education of the public schools, must be taken as showing that such an inquiry is regarded as both legitimate and important. Yet the duties of such a committee have not been defined by the Association, nor have any of our predecessors opened the way to a consideration of the subject. It was probably expected that we would furnish a digest of information from many quarters, as to what sciences are taught in the public schools, with what facilities, and to what extent ; accompanied by such recommendations regarding the increase of scientific studies as the results might suggest. But our course has not proved to be so clear. We have been arrested at the outset by a question of the quality of the science-teaching in these schools which demands the first consideration. There are certain radical deficiencies in current science-teaching, the nature and extent of which must be understood before any measures of practical improvement can be intelligently taken up. We shall here confine ourselves to this preliminary inquiry.

The investigation has interest from the immense extent and rapidly increasing influence of the American public schools. There are now nearly a hundred and fifty thousand of these schools, supported at an annual expense of probably seventy or eighty million dollars. Maintained by State authority, they are firmly established in the respect and confidence of the community. Under the influence of normal schools, teachers' institutes, systematic superintendence, school boards, regulative legislation, and an extensive literature devoted spe-

* Preliminary report of the committee, appointed at the Saratoga meeting of the American Association for the Advancement of Science, on "Science-Teaching in the Public Schools," read at the Boston meeting, in August, 1880, and published in the "Transactions" of the Association.

cially to education, they have become organized into a system which is gradually growing settled and unified in its methods. With unbounded means and unlimited authority, these schools have undertaken to form the mental habits of the great mass of the youth of this country. They prescribe the subjects of study, the modes of study, and the extent and duration of studies for all the pupils that come under their charge. The sphere of their operations is, moreover, steadily extending. They are everywhere encroaching upon the province of higher education, everywhere trenching upon private schools, and diminishing the interest in home education.

It may be assumed that the time has fully come when this system must be measured by the standards of science, and approved or condemned by the degree of its conformity to what these standards require. Science has become in modern times the great agency of human amelioration, the triumphs of which are seen on every hand and felt in all experience. Grave subjects are brought successively under its renovating and reconstructive influence; and latest and most important among them is the subject of education. Our inquiry now is how far the public-school system has availed itself of the valuable aid that science offers in the proper cultivation of the minds of the young.

The interest and necessity of such an investigation will hardly be denied; but there may be a query as to its relevancy to the appropriate work of this society. The making of science popular was not among the objects for which our Association was formed. Not that its founders were unmindful of the importance of widely diffusing the results of research; but they recognized that the interests of science are so vast as to be only efficiently promoted by division of labor. Under the operation of this principle it was made the distinctive purpose of the Association to contribute to the extension of original science by the discovery of new scientific truth, leaving its dissemination to the schools, the press, and the various agencies of public enlightenment. Nor does your committee understand that it is now proposed to depart from this policy; for the inquiry before us is really most pertinent to our special objects. It certainly can not be a matter of indifference to this body, from its own point of view, how science is dealt with in the great system of schools which has undertaken the task of molding the youthful mind of the country. We aim to advance science by the promotion of original investigation, which depends upon men prepared for the work. Do the schools of the nation, by their modes of scientific study, favor or hinder this object? Do they foster the early mental tendencies that lead to original thought; or do they thwart and repress them? We have an undoubted concern in this matter, and it is, moreover, strictly identical with that of the community at large; for there can be no better test than this of the real character of the school system. When we ask whether a mode of teaching and a manner of study are calculated to awaken the spirit of inquiry, to cultivate the habit of investigation, and rouse independent thought, our question goes to the root of all true education.

All sciences are the products of a method of thinking, and it is that method which concerns us when we propose to regard it as a means of mental cultivation. Science is an outgrowth of common knowledge, and the scientific method is but a development of the ordinary processes of thought that are employed by everybody. The common knowledge of people is imperfect because their observations are vague and loose, their reasoning hasty and careless, their minds warped by prejudice and deadened by credulity, and because they find it easier to invent fanciful explanations of things than to discover the real ones. For thousands of years the knowledge of nature was rude and stationary because the habits of thought were so defective. But, with a growing desire to understand how the world around is constituted, men improved their processes of thinking. They began, and were compelled to begin, by questioning accepted facts, and doubting current theories. The first step was one of self-assertion, implying that degree of mental independence which led men to think for themselves. They learned to make their own observations and to trust them against authority. It was found, as a first and indispensable condition of gaining clear ideas, that the mind must be occupied directly with the subject to be investigated. In this way scientific inquiry at length grew into a method of forming judgments which was characterized by the most vigilant and disciplined precautions against error. Of the mental processes involved in research it is unnecessary here to speak; we are only concerned to know that the scientific method is simply a systematic exercise in truth-seeking, and is the only mode of using the human mind when it is desired to attain the most accurate and perfect form of knowledge. The whole body of modern scientific truth, disclosing the order of Nature and guiding the development of civilization, must be taken as an attestation of the validity of the scientific method of thought by which these results have been established. We here get rid of all cramping limitations. The scientific method is applicable to all subjects whatever that involve constancy of relations, causes and effects, and conform to the operation of law. It is applicable wherever evidence is to be weighed, error got rid of, facts determined, and principles established. Our public schools, unhappily, make but little use of this method in the work of mental cultivation, and we shall find some explanation of this by referring to the way they grew up.

The American public-school system originated in the theory that the State owes to every child the rudiments of a common education, or an elementary knowledge of reading, writing, and arithmetic, as implements of after mental improvement. But it was early found difficult to separate this primary use of tools from the acquisition of knowledge.

Mr. Everett said, "I will thank any person to show why it is expedient and beneficial in the community to make public provision for teaching the elements of learning, and not expedient or beneficial to make similar provision to aid the learner's progress toward the mastery of the most difficult branches of science and the choicest refinements of literature." Under the influence of such considerations the rudimentary studies rapidly developed into courses of study embracing a variety of subjects. This led to the systematizing of instruction and the grading of schools, so that in nearly all the towns of the United States the public schools have been divided into primaries for the younger pupils and grammar-schools for older pupils; while within twenty-five years a third grade has arisen known as the high-schools for the most advanced students. In each division there are sub-grades, and, wherever improvements in public-school education are attempted, the principle of gradation is fundamental. So essential is it considered, that no aid is granted from the Peabody fund except to graded schools. As regards the plan of studies adopted, there was no guiding principle. All sorts of subjects, and these for all sorts of reasons, were taken up, and among them the sciences which are now regular parts of public-school study. Classes are formed in physics, chemistry, mineralogy, geology,. physiology, botany, and zoölogy. There are text-books upon all these branches, graded to the varying capacities of learners. Teachers prepare in them, and in many cases apparatus is provided, and there are lectures with experiments, specimens, maps, and charts for illustrations.

The old ideal of a school is a place where knowledge is got from books by the help of teachers, and our public-school system grew up in conformity with this ideal. The early effect of grading was to fix and consolidate imperfect methods. The sciences were assimilated to the old practice, and the science-teaching falls short at just the points where it was inevitable that it should fall short. The methods of school-teaching, and the habits of the teachers, had grown rigid under the *régime* of book-studies. As a consequence the science-teaching in the public schools is generally carried on by *instruction*. Through books and teachers the pupil is filled up with information in regard to science. Its facts and principles are explained as far as possible, and then left in the memory with his other school acquisitions. He learns the sciences much as he learns geography and history. Only in a few exceptional schools is he put to any direct mental work upon the subject-matter of science, or taught to think for himself.

As thus treated the sciences have but little value in education. They fall below other studies as means of mental cultivation. Arithmetic rouses mental reaction. The rational study of language, by analytical and constructive tasks and the mastery of principles, strengthens the mental processes; but the sciences are not employed to train the faculties in the various ways to which they are severally adapted. They are not made the means of cultivating the observing powers, stimulating inquiry, exercising the judgment in weighing evidence, nor of forming original and independent habits of thought. The pupil does not know the subjects he professes to study by actual acquaintance with the facts, and he therefore becomes a mere passive accumulator of second-hand statements. But it is the first requirement of the scientific method, alike in education and in research, that the mind shall exercise its activity directly upon the subject-matter of study. Otherwise scientific knowledge is an illusion and a cheat. As science is commonly pursued in book descriptions, the learners can not even identify the things they read about. As remarked by Agassiz, "The pupil studies Nature in the school-room, and when he goes out-of-doors he can not find her." This mode of teaching science, which is by no means confined to the public schools, has been condemned in the most unsparing manner by all eminent scientific men as a "deception," a "fraud," an "outrage upon the minds of the young," and "an imposture in education."

Nor has this criticism of bad practices been without its effect. We are met by the statement that much has been done in the public schools to escape the evils of mere book-science. The method of object-lessons has been extensively introduced into primary schools with the professed purpose of cultivating the powers of observation in childhood. It is claimed that this is a beginning in science; and, as it brings the mind into action upon things, is a corrective of the inordinate study of words. But object-teaching has not yielded what was expected of it, and is in no true sense a first step in science. Nothing is gained educationally by barely having an object in hand when it is talked about. Myriads of objects are present to the senses of people, but no insight follows. The observing faculties must be tasked if they are to be trained. The pupil is not to have the properties of objects pointed out, but he is to find them out. Science will do its work of educating the observing faculties only as they are quickened and sharpened by exercise in discrimination. The scientific aim is to replace vague confused impressions by clear and accurate ideas. Skill in the detection of nice distinctions is only gained by prolonged and careful practice. Object-lessons afford no such cultivation. We do not say that they are useless, but they are not the A B C of science, and do not as a matter of fact open the way to the proper study of the special sciences. This is their test and their condemnation. When the primary pupils have gone over their prescribed course of object-lessons and are passed on to a higher grade, strange to say the "objects" are suddenly dropped as if the objective method had been exhausted. In the technical phrase *perceptive* education is to be replaced by *conceptive* education. Instruction in elementary science is now to be carried on by what is known as oral-teaching. This method, as extensively practiced in the grammar grades of the public schools, is everywhere growing in favor, and we are once more told that it is a successful revolt against book-studies. It is chiefly applicable to the sciences, and its cardinal idea is instruction without a text-book. This looks fair, but it is delusive. The method does not remove the book that the pupil may come at the phenomena, but it removes the book that the teacher may take its place. Oral-teaching is class-instruction, in which information is imparted in a familiar manner with the view of awakening the interest of the class. But, so far as real science is concerned, it is doubtful if this method is not worse than the one it replaces. Following the maxim of certain German educators, that "the teacher is the school," it was assumed that when apathy prevails in the school-room it is solely the teachers' fault. Oral exercises enable them to escape this reproach by giving animation to school-work. It is said that this is a "live system" in contrast to the old humdrum routine of lessons and recitations. But science gets no real help. There is only the substitution of a superficial class-activity for the more deliberate work of the individual pupil. More mental effort is required on his part to get a lesson from a book than to listen to a lesson given by the teacher. The teacher is to do everything, and stands in the place not only of the book but of the pupil also. Is this not a step backward in education? The teacher is magnified at the expense of close study, and science is cheapened by the method. Oral-teaching implies a fertility, a versatility, and a proficiency in scientific knowledge on the part of teachers which that class of persons does not possess. It is a premium on tutorial smattering and cramming by which the voluble teacher with superficial acquisitions and a ready memory becomes the model teacher. There may be benefits in this method, but science does not gain them. Judicious oral assistance, as in the physical, chemical, or natural history laboratory, given by a competent master to a pupil at work, is invaluable for stimulus and guidance; but the aid must be discreet, and the skillful teacher will not talk too much. But where it is all talk and no work, and text-books are filtered through the very imperfect medium of the ordinary teacher's mind, and the pupil has nothing to do but to be instructed, every sound principle of education is outraged, and science is only made ridiculous.

This failure to gain the benefits of real scientific study has its source deep in the constitution of the public schools. In dealing with masses of children, classification became necessary, which gave rise, as we have seen, to grading and an elaborate mechanical system. The working of children in lots seems to be a necessity of the public schools, but it strengthens the practice of verbal instruction, recitations, and lesson-giving. It is well fitted to impress the public with the idea that there is much done in the schools. There are a prescribed routine of operations and a display of order that are admired. But teacher and learner are subordinated to the system. It is machine-work, and machines make no allowances. Gradation assumes and enforces a uniformity among pupils which is not according to the facts. Wide personal differences of capacity, aptitude, attainment, and opportunity, not only exist among children, but they are the prime data of all efficient mental cultivation. In the graded schools, just in proportion to the perfection of the mechanical arrangements, individuality disappears. Special original capacity, the main thing, counts for nothing. The mind can not be trained in such circumstances to originate its own judgments. The exercise of original mental power, or independent inquiry, is the very essence of the scientific method, and with this the practice of the public schools is at war. Moreover, a system which deals with the average mind, and does not get at the individual mind, breaks down at the point where all true education really begins, that is, in promoting self-culture. The value of educational systems consists simply in what they do to incite the pupil to help himself. Mechanical school-work can give instruction, but it can not develop faculty, because this depends upon self-exertion. Science, if rightly pursued, is the most valuable school of self-instruction. From the beginning men of science have been self-dependent and self-reliant because self-taught; and it is a question whether they have been most hindered or helped by the schools. De Candolle, in his valuable book on the conditions which favor the production of scientific men, says that the discoverers, the masters of scientific method, have chiefly appeared in small towns where educational resources have been scanty; and that they have often been most helped by the very poorness of their teaching, which threw them back upon themselves. It was to their advantage that the schools were not so perfect as to extinguish individuality and thus destroy originality.

Our strictures are here upon the general working of the public-school system; but we recognize that there are many exceptional teachers who do what they can to deal with science in the true spirit, while multitudes of instructors are chafing under present restrictions and groping after something better. The bad system is, moreover, continued chiefly from the lack of knowledge as to the possibilities of a better. But the better method of teaching science has been proved entirely practicable. The institution where we meet and many other science schools have shown it. A large number of teachers have demonstrated that various branches of science can be taught to the young by the true as well as by the false method. What is now most urgently needed is to gather from these experiences practical plans of improvement in science-teaching for the benefit of those who desire better guidance than they now have.

In his address as Rector of the University of Aberdeen, Professor Huxley said, "I would not raise a finger to introduce more book-work into every art curriculum in the country." We concur in this view, as applied to the present science-teaching in our public schools. We would not raise a finger to extend it.

President Barnard, of Columbia College, in a public address reprobating in severe terms the common method of teaching science as being an inversion of the true order of cultivating the mental faculties, referred to the great benefits which must arise "when our systems of education shall have been remodeled from top to bottom." That result may come about in the fullness of time, but it is wise to expect only a slow and gradual improvement. Vice-President Grote, in his St. Louis address, pointed out the guiding principle in this case as a substitution of real knowledge for second-hand information by a necessary law of mental advancement. In obedience to this principle, the cultivators of original science should do what they may to raise the standard of our prevalent science-teaching; and we respectfully ask that the Association will assign to a committee the duty of reporting at our next meeting on the best modes of improving the teaching of science in our public schools.

E. L. YOUMANS,
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} *Committee.*

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

I.—INTRODUCTORY SUGGESTIONS.

THE philosopher who first perceived and announced the fact that all the physical doings of man consist simply in changing the places of things made a very profound generalization, and one that is worthy of more serious consideration than it has received.

All our handicraft, however great may be the skill employed, amounts to no more than this. The miner moves the ore and the fuel from their subterranean resting-places, then they are moved into the furnace, and by another moving of combustibles the working of the furnace is started; then the metals are moved to the foundries and forges, then under hammers, or squeezers, or into melting-pots, and thence to molds. The workman shapes the bars, or plates, or castings, by removing a part of their substance, and by more and more movings of material produces the engine, which does its work when fuel and water are moved into its fireplace and boiler.

The statue is within the rough block of marble; the sculptor merely removes the outer portions, and thereby renders his artistic conception visible to his fellow-men.

The agriculturist merely moves the soil in order that it may receive the seed, which he then moves into it, and, when the growth is completed, he moves the result, and thereby makes his harvest.

The same may be said of every other operation. Man alters the position of physical things in such wise that the forces of Nature shall operate upon them and produce the changes or other results that he requires.

My reasons for this introductory digression will be easily understood, as this view of the doings of man and the doings of Nature displays fundamentally the business of human education, so far as the physical proceedings and physical welfare of mankind are concerned.

It clearly points out two well-marked natural divisions of such education : education or training in the movements to be made, and education in a knowledge of the consequences of such movements—i. e., in a knowledge of the forces of Nature which actually do the work when man has suitably arranged the materials.

The education ordinarily given to apprentices in the workshop, or the field, or the studio—or, as relating to my present subject, the kitchen—is the first of these ; the second, and equally necessary, being simply and purely the teaching of physical science as applied to the arts.

I can not proceed any further without a protest against a very general (so far as this country is concerned) misuse of a now very popular term—a misuse that is rather surprising, seeing that it is accepted by scholars who have devoted the best of their intellectual efforts to the study of words. I refer to the word *technical* as applied in the designation "technical education."

So long as our workshops are separated from our science-schools and colleges, it is most desirable, in order to avoid continual circumlocution, to have terms that shall properly distinguish between the work of the two, and admit of definite and consistent use. The two words are ready at hand, and, although of Greek origin, have become by analogous usage plain, simple English. I mean the words *technical* and *technological.*

The Greek noun *techne* signifies an art, trade, or profession, and our established usage of this root is in accordance with this signification. Therefore "technical education" is a suitable and proper designation of the training which is given to apprentices, etc., in the strictly technical details of their trades, arts, or professions. When we require a name for the science or the philosophy of anything, we obtain it by using the Greek root *logos*, and appending it in English form to the Greek name of the general subject, as geology, the science of the earth ; anthropology, the science of man ; biology, the science of life, etc.

Why not, then, follow this general usage, and adopt "technology" as the science of trades, arts, or professions, and thereby obtain consistent and convenient terms to designate the two divisions of education—technical education, that given in the workshop, etc.; and technological education, that which should be given as supplementary to all such technical education?

In accordance with this, the papers I am here commencing will be a contribution to the technology of cookery, or to the technological education of cooks, whose technical education is quite beyond my reach.

The kitchen is a chemical laboratory, in which are conducted a number of chemical processes, by which our food is converted from its crude state to a condition more suitable for digestion and nutrition, and made more agreeable to the palate.

It is the *rationale* or *ology* of these processes that I shall endeavor to explain; but at the outset it is only fair to say that in many instances I shall not succeed in doing this satisfactorily, as there still remain some kitchen mysteries that have not yet come within the firm grasp of science. The *whole* story of the chemical differences between a roast, a boiled, and a raw leg of mutton, has not yet been told. You and I, gentle reader, aided by no other apparatus than a knife and fork, can easily detect the difference between a cut out of the saddle of a three-year-old Southdown and one from a ten-months-old meadow-fed Leicester; but the chemist in his laboratory, with all his re-agents, test-tubes, beakers, combustion-tubes, potash-bulbs, etc., etc., and his balance turning to one-thousandth of a grain, could not physically demonstrate the sources of these differences of flavor.

Still, I hope to show that modern chemistry can throw into the kitchen a great deal of light that shall not merely help the cook in doing his or her work more efficiently, but shall elevate both the work and the worker, and render the kitchen far more interesting to all intelligent people who have an appetite for knowledge, as well as for food, than it can be while the cook is groping in rule-of-thumb darkness—is merely a technical operator unenlightened by technological intelligence.

In the course of these papers I shall draw largely on the practical and philosophical work of that remarkable man, Benjamin Thompson, the Massachusetts prentice-boy and schoolmaster; afterward the British soldier and diplomatist, Colonel Sir Benjamin Thompson; then colonel of horse and general aide-de-camp of the Elector Charles Theodore, of Bavaria; then major-general of cavalry, Privy Councilor of State, and head of War Department of Bavaria; then Count Rumford of the Holy Roman Empire, and order of the White Eagle; then Military Dictator of Bavaria, with full governing powers during the absence of the Elector; then a private resident in Brompton Road, and founder of the Royal Institution in Albemarle Street; then a Parisian *citoyen*, the husband of the "Goddess of Reason," the widow of Lavoisier; but above all a practical and scientific cook, whose exploits in economic cookery are still but very imperfectly appreciated, though he himself evidently regarded them as the most important of all his varied achievements.

His faith in cookery is well expressed in the following, where he is speaking of his experiments in feeding the Bavarian army and the poor of Munich. He says: "I constantly found that the richness or quality of a soup depended more upon the proper choice of the ingredients, and a proper management of the fire in the combination of these ingredients, than upon the quantity of solid nutritious matter employed; much more upon the art and skill of the cook than upon the sums laid out in the market."

A great many fallacies are continually perpetrated, not only by ignorant people, but even by eminent chemists and physiologists, by inattention to what is indicated in this passage. In many chemical and physiological works may be found elaborately minute tables of the chemical composition of certain articles of food, and with these the assumption (either directly stated, or implied, as a matter of course) that such tables represent the practical nutritive value of the food. The illusory character of such assumption is easily understood. In the first place, the analysis is usually that of the article of food in its raw state, and thus all the chemical changes involved in the process of cookery are ignored.

Secondly, the difficulty or facility of assimilation is too often unheeded. This depends both upon the original condition of the food and the changes which the cookery has produced—changes which may double its nutritive value without effecting more than a small percentage of alteration in its chemical composition, as revealed by laboratory analysis.

In the recent discussion on whole-meal bread, for example, chemical analyses of the bran, etc., are quoted, and it is commonly assumed that, if these can be shown to contain more of the theoretical bone-making or brain-making elements, they are, therefore, in reference to these requirements, more nutritious than the fine flour. But, before we are justified in asserting this, it must be made clear that these ordinarily rejected portions of the grain are as easily digested and assimilated as the finer inner flour.

I think I shall be able to show that the practical failure of this whole-meal bread movement (which is not a novelty, but only a revival) is mainly due to the disregard of the cookery question; that whole-meal prepared as bread by simple baking is less nutritious than fine flour similarly prepared; but that whole-meal otherwise prepared may be, and has been, made more nutritious than fine white bread.

Count Rumford supplies us with important data toward the solution of this difficulty.

Another preliminary example. A pound of bread or biscuit contains more solid nutritive matter than a pound of beefsteak, but does not, when eaten by ordinary mortals, do so much nutritive work. Why is this?

It is a matter of preparation—not exactly what is called cooking, but equivalent to what cooking should be. It is the preparation which has converted the grass-food of the ox into another kind of food which we can assimilate very easily.

The fact that we use the digestive and nutrient apparatus of sheep, oxen, etc., for the preparation of our food is merely a transitory barbarism, to be ultimately superseded when my present subject is sufficiently understood and applied to enable us to prepare the constituents of the vegetable kingdom in such a manner that they shall be as easily assimilated as the prepared grass which we call beef and mutton, and which we now use only on account of our ignorance of "The Chemistry of Cooking."

II.—THE BOILING OF WATER.

As this is one of the most rudimentary of the operations of cookery, and the most frequently performed, it naturally takes a first place in treating the subject.

Water is boiled in the kitchen for two distinct purposes: 1. For the cooking of itself; 2. For the cooking of other things. A dissertation on the difference between raw water and cooked water may appear pedantic, but, as I shall presently show, it is considerable, very practical, and important.

The best way to study any physical subject is to examine it experimentally, but this is not always possible with every-day means. In this case, however, there is no difficulty.

Take a thin* glass vessel, such as a flask, or, better, one of the "beakers," or thin, tumbler-shaped vessels, so largely used in chemical laboratories; partially fill it with ordinary household water, and then place it over the flame of a spirit-lamp, or Bunsen's, or other smokeless gas-burner. Carefully watch the result, and the following will be observed: First of all little bubbles will be formed, adhering to the sides of the glass, but ultimately rising to the surface, and there becoming dissipated by diffusion in the air.

This is not boiling, as may be proved by trying the temperature with the finger. What, then, is it?

It is the yielding back of the atmospheric gases which the water has dissolved or condensed within itself. These bubbles have been collected and by analysis proved to consist of oxygen, nitrogen, and carbonic acid, obtained from the air; but in the water they exist by no means in the same proportions as originally in the air, nor in con-

* In applying heat to glass vessels, thickness is a source of weakness or liability to fracture, on account of the unequal expansion of the two sides, due to inequality of temperature, which, of course, increases with the thickness of the glass. Besides this, the thickness increases the leverage of the breaking strain.

stant proportions in different samples of water. I need not here go into the quantitative details of these proportions, nor the reasons of their variation, though they are very interesting subjects.

Proceeding with our investigation, we shall find that the bubbles continue to form and rise until the water becomes too hot for the finger to bear immersion. At about this stage something else begins to occur. Much larger bubbles, or rather blisters, are now formed on the bottom of the vessel, immediately over the flame, and they continually collapse into apparent nothingness. Even at this stage a thermometer immersed in the water will show that the boiling-point is not reached. As the temperature rises, these blisters rise higher and higher, become more and more nearly spherical, finally quite so, then detach themselves and rise toward the surface; but the first that make this venture perish in the attempt—they gradually collapse as they rise, and vanish before reaching the surface. The thermometer now shows that the boiling-point is nearly reached, but not quite. Presently the bubbles rise completely to the surface and break there. Now the water is boiling, and the thermometer stands at 212° Fahr. or 100° Cent.

With the aid of suitable apparatus it can be shown that the atmospheric gases above named continue to be given off along with the steam for a considerable time after the boiling has commenced; the complete removal of their last traces being a very difficult, if not an impossible, physical problem.

After a moderate period of boiling, however, we may practically regard the water as free from these gases. In this condition I venture to call it cooked water. Our experiment so far indicates one of the differences between cooked and raw water. The cooked water has been deprived of the atmospheric gases that the raw water contained. By cooling some of the cooked water and tasting it the difference of flavor is very perceptible; by no means improved, though it is quite possible to acquire a preference for this flat, tasteless liquid.

If a fish be placed in such cooked water it swims for a while with its mouth at the surface of the water, for just there is a film that is reacquiring its charge of oxygen, etc., by absorbing it from the air; but this film is so thin and so poorly charged, that after a short struggle the fish dies for lack of oxygen in its blood, drowned as truly and completely as a living, breathing animal when immersed in any kind of water.

Spring and river water that have passed through or over considerable distances in calcareous districts suffer another change in boiling. The origin and nature of this change may be shown by another experiment as follows: Buy a pennyworth of lime-water from a druggist, and procure a small glass tube of about quill-size, or the stem of a fresh tobacco-pipe may be used. Half fill a small wine-glass with the lime-water, and blow through it by means of the tube of the tobacco-pipe. Presently it will become turbid. Continue the blowing, and the turbidity will increase up to a certain degree of milkiness. Go on blowing with "commendable perseverance," and an inversion of effect will follow: the turbidity diminishes, and at last the water becomes clear again.

The chemistry of this is simple enough. From the lungs a mixture of nitrogen, oxygen, and carbonic acid is exhaled. The carbonic acid combines with the soluble lime and forms a carbonate of lime which is insoluble in mere water. But this carbonate of lime is to a certain extent soluble in water saturated with carbonic acid, and such saturation is effected by the continuation of blowing.

Now take some of the lime-water that has been thus treated, place it in a clean glass flask, and boil it. After a short time the flask will be found incrusted with a thin film of something. This is the carbonate of lime, which has been thrown down again by the action of boiling in drawing off its solvent, the carbonic acid. This crust will effervesce if a little acid is added to it.

In this manner our tea-kettles, engine-boilers, etc., become incrusted when fed with calcareous waters, and most waters are calcareous; those supplied to London, which is surrounded by chalk, are largely so. Thus the boiling or cooking of such water effects a removal of its mineral impurities more or less completely. Other waters contain such mineral matter as salts of sodium and potassium. These are not removable by mere boiling.

Usually we have no very strong motive for removing either these or the dissolved carbonate of lime, or the atmospheric gases from water, but there is another class of impurities of serious importance. These are the organic matters dissolved in all water that has run over land covered with vegetable growth, or, more especially, which has received contributions from sewers or any other form of house-drainage. Such water supplies nutriment to those microscopic abominations, the *mirococci*, *bacilli*, *bacteria*, etc., which are now shown to be connected with blood-poisoning—possibly do the whole of the poisoning business. These little pests are harmless, and probably nutritious, when cooked, but in their raw and wriggling state are horribly prolific in the blood of people who are in certain states of what is called "receptivity." They (the bacteria, etc.) appear to be poisoned or somehow killed off by the digestive secretions of the blood of some people, and nourished luxuriantly in the blood of others. As nobody can be quite sure to which class he belongs, or may presently belong, or whether the water supplied to his household is free from blood-poisoning organisms, cooked water is a safer beverage than raw water.

The requirement for this simple operation of cooking increases with the density of our population, which on reaching a certain degree renders the pollution of all water obtained from the ordinary sources almost inevitable.

Reflecting on this subject, I have been struck with a curious fact that has hitherto escaped notice, viz., that, in the country which over all others combines a very large population with a very small allowance of cleanliness, the ordinary drink of the people is boiled water flavored by an infusion of leaves. These people, the Chinese, seem, in fact, to have been the inventors of boiled-water beverages. Judging from travelers' accounts of the state of the rivers, rivulets, and general drainage and irrigation arrangements of China, its population could scarcely have reached its present density if Chinamen were drinkers of raw instead of cooked water.

III.—COOKING UNDER WATER.

Next to the boiling of water for its own sake, as treated in my last, comes the boiling of water as a medium for the cooking of other things. Here, at the outset, I have to correct an error of language which, as too often happens, leads by continual suggestion to false ideas. When we speak of "boiled beef," "boiled mutton," "boiled eggs," "boiled potatoes," we talk nonsense; we are not merely using an elliptical expression, as when we say "the kettle boils," which we all understand to mean the contents of the kettle, but we are expounding a false theory of what has happened to the beef, etc.—as false as though we should describe the material of the kettle that has held boiling water as boiled copper or boiled iron. No boiling of the food takes place in any such cases as the above-named—it is merely heated by immersion in boiling water; the changes that actually take place in the food are essentially different from those of ebullition. Even the water contained in the meat is not boiled in ordinary cases, as its boiling-point is higher than that of the surrounding water, owing to the salts it holds in solution.

Thus, as a matter of chemical fact, a "boiled leg of mutton" is one that has been cooked, but not boiled; while a roasted leg of mutton is one that has been partially boiled. Much of the constituent water of flesh is boiled out, fairly driven away as vapor during roasting or baking, and the fat on its surface is also boiled, and, more or less, dissociated into its chemical elements, carbon and water, as shown by the browning, due to the separated carbon.

As I shall presently show, this verbal explanation is no mere verbal quibble, but it involves important practical applications. An enormous waste of precious fuel is perpetrated every day, throughout the whole length and breadth of Britain and other countries where English cookery prevails, on account of the almost universal ignorance of the philosophy of the so-called boiling of food.

When it is once fairly understood that the meat is not to be boiled, but is merely to be warmed by immersion in water raised to a maximum temperature of 212°, and when it is further understood that water can not (under ordinary atmospheric pressure) be raised to a higher temperature than 212° by any amount of violent boiling, the popular distinction between "simmering" and boiling, which is so obstinately maintained as a kitchen superstition, is demolished.

The experiment described in my last showed that immediately the bubbles of steam reach the surface of the water and break there—that is, when simmering commences—the thermometer reaches the boiling-point, and that however violently the boiling may afterward occur, the thermometer rises no higher. Therefore, as a medium for heating the substance to be cooked, simmering water is just as effective as "walloping" water. There are exceptional operations of cookery, to be described hereafter, wherein useful mechanical work is done by violent boiling; but in all ordinary cookery, simmering is just as effective. The heat that is applied to do more than the smallest degree of simmering is simply wasted in converting water into useless steam. The amount of such waste may be easily estimated. To raise a given quantity of water from the freezing to the boiling point demands an amount of heat represented by 180° in Fahrenheit's thermometer, or 100° Centigrade. To convert this into steam, 990° Fahr. or 500° Cent. is necessary—just five and a half times as much.

On a properly-constructed hot-plate or sand-bath, a dozen saucepans may be kept at the true cooking temperature, with an expenditure of fuel commonly employed in England to "boil" one saucepan. In the great majority of so-called boiling operations, even simmering is unnecessary. Not only is a "boiled leg of mutton" not itself boiled, but even the water in which it is cooked should not be kept boiling, as we shall presently see.

In order to illustrate some of the changes which take place in the cooking of animal food, I will first take the simple case of cooking an egg by means of hot water. These changes are in this case easily visible and very simple, although the egg itself contains all the materials of a complete animal. Bones, muscles, viscera, brain, nerves, and feathers of the chicken—all are produced within the shell, nothing being added, and little or nothing taken away.

When we open a raw egg, we find, enveloped in a stoutish membrane, a quantity of glairy, slimy, viscous, colorless fluid, which, as everybody now knows, is called *albumen*, a Latin translation of its common name, "*the white*." Within the white of the egg is the yolk, largely composed of that same albumen, but with other constituents added—notably a peculiar oil. At present I will only consider the changes which cookery effects on the main constituent of the egg, merely adding that this same albumen is one of the most important, if not the one most important, material of animal food, and is represented by a corresponding nutritious constituent in vegetables.

We all know that when an egg has been immersed during a few minutes in boiling water, the colorless, slimy liquid is converted into the white solid to which it owes its name. This coagulation of albumen is one of the most decided and best understood changes effected by cookery, and therefore demands especial study.

Place some fresh, raw white of egg in a test-tube, or other suitable glass vessel, and in the midst of it immerse the bulb of a thermometer. (Cylindrical thermometers, with the degrees marked on the glass stem, are made for such laboratory purposes.) Place the tube containing the albumen in a vessel of water, and gradually heat this. When the albumen attains a temperature of about 134° Fahr., white fibers will begin to appear within it; these will increase until about 160° is attained, when the whole mass will become white and nearly opaque. It is now coagulated, and may be called solid. Now examine some of the result, and you will find that the albumen thus only just coagulated is a tender, delicate, jelly-like substance, having every appearance to sight, touch, and taste of being easily digestible. This is the case.

Having settled these points, proceed with the experiment by heating the remainder of the albumen (or a new sample) up to 212°, and keeping it for a while at this temperature. It will dry, shrink, and become horny. If the heat is carried a little further, it becomes converted into a substance which is so hard and tough that a valuable cement is obtained by simply smearing the edges of the article to be cemented with white of egg, and then heating it to a little above 212°.*

This simple experiment teaches a great deal of what is but little known concerning the philosophy of cookery. It shows in the first place that, so far as the coagulation of the albumen is concerned, the cooking temperature is not 212°, or that of boiling water, but 160°, i. e., 52° below it. Everybody knows the difference between a tender, juicy steak, rounded or plumped-out in the middle, and a tough, leathery abomination, that has been so cooked as to shrivel and curl up. The contraction, drying up, and hornifying of the albumen in the test-tube represent the albumen of the latter, while the tender, delicate, trembling, semi-solid, that was coagulated at 160°, represents the albumen in the first.

But this is a digression, or rather anticipation, seeing that the grilling of a beefsteak is a problem of profound complexity that we can not solve until we have mastered the rudiments. We have not yet determined how to practically apply the laws of albumen coagulation as discovered by our test-tube experiment to the cooking of a breakfast-egg.—*Knowledge.*

* "Egg-cement," made by thickening white of egg with finely-powdered quicklime, has long been used for mending alabaster, marble, etc. For joining fragments of fossils and mineralogical specimens, it will be found very useful. White of egg alone may be used, if carefully heated afterward.

OUR MARRIAGE AND DIVORCE LAWS.

By GORDON A. STEWART.

THE worst of our social evils, personal wrongs, and political sins arise from the ununiform operation of our marriage and divorce laws. The loose manner in which a contract of marriage may be entered into and the reckless facility with which a marriage contract may be dissolved are a disgrace to our high civilization and professed Christianity. However learned commentators and jurists may differ as to the correct definition of marriage, it is not only a partially executed agreement to marry, but is a contract continuous in its obligations governing the status of the parties, until it is dissolved by the death of one of the parties, or by one of them obtaining a divorce for some wrongful or invalidating act committed by the other.

In nearly all of the States marriage is recognized as a civil contract only, and has no ecclesiastical obligation so far as society and the State are concerned. The contracting parties are subjects of the law. The person performing the ceremony by which the contract is publicly acknowledged by the parties, whether he be magistrate, parson, or layman, becomes a civil officer by authority of the law for that occasion. Generally, however, the marriage contract is solemnized by a clergyman, agreeably to the rules and regulations of the religious denomination to which he belongs, and for which one or the other of the parties has a religious attachment or preference ; or, because a religious solemnization in church gives a better opportunity to gratify the desire for social rivalry and display. But perhaps most persons, especially when young and looking forward to a long future of connubial happiness, consider the act of marriage more as a religious rite than a civil contract, and hence the forms and ceremonies of the Church accord more agreeably with the sentiment of love and affection than the business-like and informal words of the magistrate, who, in response to their acknowledgment of intention to marry, simply pronounces them man and wife. This sentiment, no doubt, is largely the result of a lingering belief in marriage as a divine institution and a sacrament of the Church, as taught when the ecclesiastical court had exclusive jurisdiction of marriage and divorce. It is perhaps not until later, not until they have become dissatisfied with the conditions of the solemn obligation they had agreed to faithfully perform through life, that they discover it is simply a civil contract that binds them, and from which the law has generously provided unlimited means of escape.

Lawful marriage is the basis of the family relation, and the family relation is the fundamental principle of association upon which the superstructure of society and the State is built. And yet there is no contract of the value of twenty dollars, subject to the verdict of a jury or the decision of a court, that is so easily avoided and so shamefully dissolved as the contract of marriage. The facts show that the law and the courts enforce the obligations of a delinquent debtor with more severity than the obligations of this contract upon which the happiness of the family, the morality of society, and the perpetuity of the State depend. The marriage contract is of a higher inspiration, and has a broader obligation, than a mere contract for the payment of money, or for the transfer of property, or for co-operation in business. It is one in which society is more deeply interested, one by which society is more seriously affected; and society has the right to demand that the mutual obligations shall be faithfully kept and lawfully enforced.

This lack of uniformity in the laws, both in their formulation and execution, is the result of the diversity of sources from which they emanate. Each State is its own authority, and determines for itself the conditions upon which the marriage relation of its people may be entered into or dissolved; and, perhaps, the social and moral sentiment of the people of a State can not be more equitably determined than by observing the character and use of its laws governing marriage and divorce; forthe various degrees of restriction and laxity in marriage and divorce have marked the progress and decline of all peoples and nations ever since the days when Adam and Eve went out of paradise and Moses wrote the law on Mount Sinai. Several States still retain upon their statute-books the common-law prohibition of marriage between persons related by consanguinity, or affinity, nearer than the third degree; while other States have progressed to that degree of liberality on the road to individual freedom and universal happiness which permits a person to marry, if not his grandmother, at least the daughter of his wife by a former husband. So we find that while two persons within certain degrees of relationship may lawfully marry in one State, they are prohibited from marrying by the laws of another State; and that while a marriage between certain persons is voidable only in one State, it is absolutely void under a similar law in another State.

It would be interesting to review at length the marriage and divorce laws of the several States, and note their want of uniform operation; but, for the purposes of this article, which must be brief, I shall confine myself to a comparative notice of the laws of two or three States only. In Ohio, "male persons of the age of eighteen years, and female persons of the age of sixteen years, not nearer kin than second-cousins, and not having a husband or wife living, may be joined in marriage," provided that if the male person is under the age of twenty-one, and the female person is under the age of eighteen, they shall first obtain the consent of their parents, respectively. The marriage may be solemnized by an ordained minister of any religious congregation who has first obtained a license authorizing him to solemnize marriages; or by a justice of the peace in his county; or by the several religious societies agreeably to the rules and regulations of their respective churches. If the parties are married by the rules of any church, notice of the marriage must first be published in the presence of the congregation on two separate days of worship, the first notice to be at least ten days previous to such marriage, and in the county in which the female resides. And, in order that record evidence of a marriage may always exist, a license to marry must first be obtained from the probate court before the marriage can be legally solemnized; and a certificate of such marriage, signed by the minister or justice of the peace solemnizing the same, must be filed by the person so officiating with the court where the license issued. This certificate must be filed with the court within three months from date of marriage, under a penalty of fifty dollars fine for neglect to do so, and the court must make a record of the certificate of marriage under a like penalty. These last provisions do not apply to parties who are married by the rules of any church.

In New York, marriage, so far as its validity in law is concerned, is expressly declared to be a civil contract, to which the consent of the parties, who must be capable in law of contracting, is essential. Marriage between parents and children, and grandparents and grandchildren, of every degree, and between brothers and sisters of the half or whole blood, are declared to be incestuous and absolutely void. So a second or other subsequent marriage contracted by any person during the lifetime of any former husband or wife of such person, is absolutely void, unless the marriage of such former husband or wife shall have been annulled for some cause other than the adultery of such person, or unless such former husband or wife shall have been finally sentenced to imprisonment for life. But for causes existing at the time of marriage, where either of the parties is incapable of contracting for want of age or understanding, or from physical causes, or where consent has been obtained through force or fraud, the marriage is void only from the time its nullity shall be declared by a court of competent authority. So, if any person, whose husband or wife shall have absented himself or herself for the space of five consecutive years without being known to such person to be living during that time, shall marry during the lifetime of such absent husband or wife, the marriage shall be void only from the time its nullity is pronounced by a court of competent authority. The law authorizing a legal separation, or a limited divorce, in New York, has been repealed, and the only causes arising after marriage for which a legal marriage can be annulled are adultery and imprisonment for life; and a pardon to the person sentenced to imprisonment for life will not restore to him or her the rights of a previous marriage. In a case of divorce for adultery the complainant may marry again during the life of the defendant; but no defendant convicted of adultery can marry again until the death of the complainant, unless the court in which the judgment of divorce was rendered shall modify such judgment on satisfactory proof that the complainant has remarried, that five years have elapsed since the divorce was granted, and that the conduct of the defendant since the dissolution of the marriage has been uniformly good.

No formality is necessary for the solemnization of marriages in New York. But, for the purpose of being registered and authenticated, the statute provides that marriages may be solemnized by ministers of the gospel and priests ; and when solemnized by them the ceremony must be according to the forms and customs of the church or society to which they belong. Marriages may also be solemnized by mayors, recorders, and aldermen of cities, judges of the county court, justices of the peace, and by justices and judges of courts of record. When solemnized by a magistrate, no particular form is required, except that the parties shall declare in the presence of the magistrate and attending witnesses that they take each other for husband and wife. It is the duty of the officiating minister or magistrate to enter the names, ages, and residences of the parties, and the witnesses to the marriage, in a book to be kept for that purpose, and he shall upon application furnish to the parties a certificate of such marriage. This certificate, if presented to the clerk of the city or town where the marriage was solemnized, or where either of the parties resides, shall be filed by such clerk and entered in a book. The entry, or a certified copy thereof, or the marriage certificate, shall be received as evidence of such marriage. The provisions of the law regulating the solemnization of marriages, however, do not apply to the people called Quakers, nor to Jews, who are married according to the regulations of their respective churches.

In Connecticut the statute declares that no man shall marry his mother, grandmother, daughter, granddaughter, sister, aunt, niece, step-mother or step-daughter ; that no woman shall marry her father, grandfather, son, grandson, brother, uncle, nephew, step-father, or step-son ; and that, if any man or woman shall marry within the degrees aforesaid, such marriage shall be void. It provides further that no persons shall be married until one of them shall inform the register of the town, or the town-clerk, in which the marriage is to be celebrated, of the name, age, color, occupation, birthplace, residence, and condition—whether single, widowed, or divorced—of each. Such register, or town-clerk, shall thereupon issue his certificate that the parties therein named have complied with the law, which certificate shall be a license for any person authorized to solemnize marriages to give in marriage, in said town only, the parties therein named ; but no such certificate shall be issued if either of the parties is a minor, under the control of a parent or a guardian, until such parent or guardian shall give to the register, or town-clerk, his written consent ; and any register, or town-clerk, who shall knowingly issue such certificate without such consent, shall forfeit to the State one hundred dollars; and any person who shall join any persons in marriage without having received such certificate shall forfeit a like sum of one hundred dollars. Every person who shall join any persons in marriage shall certify upon the license certificate the fact, time, and place of such marriage, and return it to the register of the town where it was issued, before or during the first week of the month next succeeding such marriage, and upon failure thereof shall forfeit ten dollars. The certificate shall be *prima facie* evidence of such marriage. All judges, justices of the peace, and ordained or licensed clergymen while in the ministry, may join persons in marriage, and all marriages attempted to be celebrated by any other person shall be void; but all marriages which shall be solemnized according to the forms and usages of any religious denomination in the State shall be valid.

While the laws of these three States differ—and, perhaps, no two States in the Union agree as to who are competent to contract marriage—the provisions of the statutes of each regulating its solemnization would seem to be sufficient to protect society against hasty and indiscriminate alliances, to guard either party against fraud, and to furnish record evidence in any case where proof of marriage might be required. And yet, upon the provisions of the statutes defining *who* may solemnize marriages, the greatest confusion prevails throughout the Union between the courts and the law. In Connecticut, we have seen that "all marriages attempted to be celebrated by any other person" (than those named) "shall be void." In Ohio and New York, and in many other States, where no words of nullity are expressed in the statutes, such marriages are held valid.

But in Massachusetts, and in several other States, it has been held, where no words of nullity are expressed, that such marriages are not valid. And yet, it is generally accepted as the law, on principle, notwithstanding the marriage is celebrated without license, and the ceremony performed by an unauthorized person, that if the parties simply by mutual consent agree to marry, and live together as man and wife, such consent and cohabitation are valid and binding between the parties, and the issue thereof are entitled to all the rights of legitimate children. To reverse this common-law doctrine by general statutory provisions might work hardship in some individual cases; but its existence works more harm to society and bastardizes more children than would the enactment of stringent marriage laws, for parties would then be more careful and not enter into such relation without proof of marriage. Marriage is not a contract to be entered into in haste and repented of at leisure. It is of more importance to the parties, and far more to society, than the acquirement of a good title to a piece of real estate. Yet no one would think it a hardship to comply with the law for the proper execution and registration of a deed of conveyance, and no court would hold, as a general rule, that a valid title passed, although the statute governing the transfer had not been complied with.

In these three States, and in most of the States, the laws regulating the solemnization of marriages except from their general provisions certain religious denominations. This exception was an early spasm of religious toleration, entirely out of date in this tolerant age. Marriage being a civil contract between two persons, its conditions should be performed by them, of whatever religious faith they may be, the same as they would have to perform the conditions of any other civil contract or legal obligation. The exception is anti-constitutional, in establishing a religious distinction even as against the Catholic Church, which still holds marriage as a divine institution, and its celebration a sacrament of the Church. No such exception is made in the execution of any other legal contract or in favor of other religious sects, and no hardship or violation of conscience or religious belief could follow the abolition of this incongruity. As members of society and citizens of the State, all persons should conform to the same civil law, leaving the individual parties free to supplement the civil ceremony with a religious one, according to the rules of the religious society to which they belong.

There is a peculiarity in the marriage contract, that does not enter into any other contract in the ordinary commercial transactions of life. While others may be, it must be between one man and one woman only. The contract does not end with the marriage ceremony ; its conditions are for life, and continue until dissolved by death or divorce. Once it might have been considered to end with the solemnization, and to take on the form of a status, but that was in those days when on the " nuptial day " all the identity of the woman, her personality, individuality, right of property, and control of offspring, were merged in the man, and he became her lord and master, leaving her without the right of appeal to any civil authority for the redress of any wrong. But the barbarism of those days is fading away, and the light of a new civilization is dawning, though still confused here and there by old forms and prejudices. When woman shall stand before the law equal with man in all her personal, property, and political rights, then indeed will marriage be a contract sanctioned by nature and approved by God. All the instincts of nature favor marriage, all the passions, desires, and affections of the human heart enter into it, and the highest development of the human race depends upon it. Yet, as a part of the contract, the law of divorce enters in ; and, while it is over-rigid in some States, in others its laxity almost neutralizes the fundamental idea of the continuance and perpetuity of the marriage obligation.

As a relic of that " peculiar institution," with its concubinal practice between whites and blacks, South Carolina preserves its old laws which allow no cause for divorce. In New York there is one cause only. In Ohio and other States there are many ; but in Connecticut, Indiana, Illinois, North Carolina, and Maine, there is any cause that a discontented and dishonest party may allege, or that a judge in his discretion, influenced by sympathy or corrupt motives, may approve. In these extremes of the law, we have the tyranny of bigotry and the liberty of license, this opening the gates of temptation to the licentiousness of man, and the other driving in the victims. Surely there is a happy medium sufficiently circumscribed to restrain the vicious and dishonest, and yet liberal enough to afford relief to the innocent and injured ! Thus, it will be seen that uniformity in the operation of the divorce laws, as a part of the marriage contract, is made necessary by the facility with which divorces are now "made easy, and without publicity." The cases where a husband or wife has abandoned home and family, and gone into a neighboring State to procure a divorce that could not be obtained at home, are so frequent and notorious, that the public conscience has ceased to be more shocked over such an occurrence than over a bank-president's embezzlement, or a willful murder. And yet society should be shocked to the very depths of humiliation, for the histories of the majority of such cases show that they are instigated by the basest motives of the human heart. For some fancied or real grievance that could easily be explained by love, or remedied by law ; for the slightest incompatibility that could exist between any two independent individuals, and which might be softened by intelligent forbearance, but which must be endured by all under any form of contract ; or, from a sensual desire to form another marriage relation, or for apparent causes that have no deeper root of evil than fashionable folly, petty jealousy, and irritability of temper—the laws of many of the States offer a way for the dissolution of the marriage contract. It is, however, to the credit of our humanity that the noble and enduring men and women of our race—those upon whom the world must ever rely for the true advancement of man toward social perfection and individual happiness—seldom or never resort to the courts, even of their own State, for release from a contract which may have become onerous or even disgraceful to bear. Under the present liberal laws, regulating the relation of husband and wife, in some of the more progressive States, the parties stand so nearly equal before the law as individuals, in their personal and property rights, that there can not be the same excuses for resorting to divorce as a remedy for a real or supposed wrong, and certainly not the necessity for the assignment of so many statutory causes, as in former years. And while there should be other causes than adultery assigned for divorce, there is no other cause by which the family and society can be so deeply injured ; no other cause that might not be adjusted between the parties, or removed by law, the same as if the marriage relation did not exist, or for which the innocent party might not suffer just as severely in his or her relation to society as in the relation of husband or wife.

Although New York has experimented with both a prohibitory and a liberal policy of divorce, long years of experience have demonstrated that the peace and happiness of the family and the purity of public morals are best subserved by a restrictive policy ; yet no State in the Union can boast of a larger personal freedom of its citizens, or a higher standard of intelligence and morality. The percentage of illiteracy is comparatively small ; woman is held in the highest esteem, and on all school questions has the equal right of suffrage ; she is better protected in her personal and property rights than elsewhere ; and, so far as the domestic relations are concerned, no State has a happier or a more contented people. The rural population is prosperous and happy in its Arcadian simplicity ; and even in the great commercial metropolis of the State, where the opportunity for temptation and crime, corruption, and luxurious licentiousness, is so great, the intelligence and morals of the people are equal to those of any city in the world. Notwithstanding this, the laws of other States and the decisions of the courts make marriage in New York, as elsewhere, a contract subject to the caprice or dishonesty of either of the parties.

Parties who legally marry know the conditions of the contract into which they have entered. In New York they know that, as a part of the contract, so long as they reside in the State there is one cause only, except death, for its dissolution. And so long as one of the parties to a marriage continues to reside in the State in which the contract was made, and under the protection of its laws, no other State, into which the other party may have removed for the purpose of obtaining a divorce, should assume jurisdiction of the contract, or change its terms, so as to annul it for any other cause than that which existed in the State where the contract was made, and then only after obtaining personal service upon the non-resident defendant. It is questionable, as a matter of individual right, whether any State into which the parties may have mutually agreed to remove should assume jurisdiction to set aside the marriage contract for any other cause than could be assigned in the State in which the contract was made. Certainly one State should respect the laws of another, as it would have its own laws respected by the other. But the question of jurisdiction and domicile in interstate divorce has perplexed the courts almost endlessly. The general principle of law that the domicile of the wife remains with or follows the husband is limited by the reasons on which it rests, and must be varied according to the circumstances of the case, so that for the purpose of divorce each party is said to have a separate domicile. When one of the parties removes into another State for the purpose of divorce, and, after gaining a legal residence there, commences proceedings for divorce, how can the court, if marriage is a contract, get personal service upon the defendant so as to affect the rights of this non-resident party? Or, if marriage is a status, and the court takes cognizance only of the condition of the plaintiff, *it*, the condition of the plaintiff, being within the jurisdiction of the court, why is it necessary to bring the non-resident party into court even by constructive service? Divorce in either case will not change the relation of the non-resident party to the laws of the State in which he or she resides; it might, if it were the woman who obtained the divorce, leave the husband a married man without a wife, or, if it were he who obtained the divorce, leave her a married woman without a husband; and if the one thus left should marry again, though the marriage should be held legal, he or she might be punished under the laws of the State for bigamy or adultery. Such is the right of sovereignty each State has over its own subjects. But no State should take jurisdiction to dissolve a marriage contract between parties not situated in a way to render the sentence of dissolution binding, on general principles of law, upon every other State. Yet it is so often done that the cases in one State to set aside divorces obtained in another State are notoriously frequent. There is no subject so intermixed with so much legal rubbish and confusion, none in relation to which there is so much diversity of law and judicial conflict and uncertainty, as that relating to marriage, whether considered as a contract or a status, and none to which the statesman should more earnestly address himself to relieve it of these absurd legal perplexities. But how can uniformity be attained after so many long years of confusion?

Congress should pass a law establishing uniform rules of marriage and divorce throughout the United States. It should declare that the marriage contract is of that kind within the meaning of the Constitution which declares that "no State shall pass any law impairing the obligation of contracts." Where both the parties are domiciled in the same State, it should leave them subject to the laws of the State in which they reside; but, when they become "citizens of different States" for the purpose of divorce, it should require the suit to be brought in the United States courts; and perhaps when woman, as a citizen, becomes co-equal with man before the law, it will in such cases be obliged to do so. This would give the courts jurisdiction of both parties, or the status of both parties, without resorting to legal subterfuge or fiction; and would, where the suit was between "citizens of different States," preserve the individual sovereignty and dignity of the two States. It would also harmonize the foregoing provision of the Constitution which declares that "no State shall pass any law impairing the obligation of contracts," with the provision which also declares that "full faith and credit shall be given in each State to the *public acts*, records, and judicial proceedings of every other State"—a harmony that has never heretofore existed. The obligation to give "full faith and credit" to the "public acts" and "judicial proceedings" of a State is reciprocal between States; how then, when the "public acts" of two States are in conflict on the subject of divorce, can one State, in a judicial proceeding by a resident of its own, determine the relation of a citizen of another State to *its laws?* How can it impair the obligation of a contract or annul a status between parties, over one of whom it has no jurisdiction, and at the same time give "full faith and credit" to the "public acts" of the other State?

That Congress has the constitutional power to pass a law establishing uniform rules of marriage and divorce in the District of Columbia and all the Territories of the United States is beyond question. That it has not the power to pass a law establishing such rules throughout the United States can only be asserted. "Congress shall have power to establish a uniform rule of naturalization and uniform *laws* on the subject of *bankruptcies* throughout the United States"; and who can conceive of a person being more of a bankrupt in home and fortune than one who has a faithless wife or husband? Certainly in that view, with the marriage declared a contract within the meaning of the Constitution and its violation a species of bankruptcy, a general bankrupt law might give the courts jurisdiction to relieve a faithful husband or dutiful wife of the onerous conditions of a contract by the assignment of such assets as a worthless wife or husband to a generous and forgiving public.

There is another mode by which uniformity in the marriage and divorce laws of the States might be attained, whether the opinions of the judiciary could ever be harmonized or not, and that without impinging on the delicate question of State rights. Let Congress appoint commissioners to prepare a code of marriage and divorce laws for the District of Columbia and Territories of the United States, and invite each of the States to appoint a commissioner in its own behalf to unite with the commissioners appointed by Congress in forming a commission to codify and prepare a system of marriage and divorce, which, when passed by Congress and adopted by the several States, or any of them, shall have a uniform operation in the District of Columbia and Territories, and throughout the United States, or in those States adopting it. That there is an urgent necessity for Congress alone, or for Congress and the States united, to move earnestly in this matter, is not only seen in the ineffectual efforts of Congress every year to suppress polygamy, which is fast spreading from Utah into the other Territories, but also in an almost similar condition of society in the States, brought about by the ununiform laws and the conflicting decisions of the courts.

It is discreditable to civilization not to reverse a decision or principle of law, though of long standing, which is more evil in its continuance than inconvenient in its reversal or repeal. A thing which has outlived its influence for good, or a principle that has no longer an application to the progress of the age, in religion or law, should be abandoned. The spirit of the Constitution and the principles of interstate jurisdiction adjudicated under it have been insidiously directed, since the foundation of the government, to the national protection of and non-interference with a local institution which no longer exists. The reasons upon which those principles were based and the status in whose interest the decisions were formulated into law having passed away, it is time that the judicial mind should readjust itself to the demands of a newer condition of life and a higher civilization. But the conservative judicial mind is the last *phase of energy* in which the theory of evolution evolves, and "general principles of law" handed down by judicial prejudice from generation to generation are the last to give way in matters of progress and reform, not only when the reasons on which they were based no longer exist, but when other and better reasons demand a change.

There is another phase of this question which assumes a peculiar interest at the present time. It is that the marriageable portion of seven eighths of the citizens of the United States is interdicted from intermarrying with any one of the marriageable portion of the other one eighth of the citizens. Not that any one of the marriageable portion of the seven eighths, or of the one eighth, competent to contract marriage, is prohibited from marrying; but if love, admiration, pecuniary interest, or convenience, should move one of the marriageable portion of the seven eighths to desire in marriage one of the marriageable portion of the one eighth who reciprocates the love, admiration, pecuniary interest, or convenience of the other, the law interferes and makes such marriage a criminal offense! Why? Because of a prejudice held by the seven eighths against the one eighth—held for the reason that all of the one eighth are related in a near or remote degree to a race that was for centuries held as slaves to the other. It is a prejudice, not so much against "color" as against "previous condition"—color being a legal designation to identify the individual with the proscribed race.

Marriage is a natural right into which the question of color does not enter except as an individual preference expressed by the parties to the marriage. It is so recognized by the laws of all nations except our own, though in a few States this natural right is now acknowledged by statute law. In Ohio the statute declares that "a person of *pure white* blood, who intermarries with any negro, or person having a distinct and visible admixture of African blood, and any negro or person having a distinct and visible admixture of African blood, who intermarries with any person of *pure white* blood, shall be fined not more than one hundred dollars, or imprisoned not more than three months, or both." And the judge who knowingly issues the license and the person who knowingly solemnizes the marriage are subject to the same penalties. It is possible, however, on the common-law principle, that a marriage of this kind, followed by the parties living together as man and wife, would be held valid, though they would be subject to the penalties of the law. But in a number of other States—mostly

Southern—such a marriage is declared absolutely void, and the parties living together under it are punishable by imprisonment in the penitentiary for "lascivious cohabitation." In these States the international and interstate rule, that a marriage legally contracted in one State is valid in every other State, is outraged and defied; and parties lawfully married in a State which does not prohibit the intermarriage of white and colored persons removing into these States are not recognized as husband and wife, but are made subjects of a law punishing fornication and adultery.

Before emancipation there was no legal marriage between slaves—a slave not being competent to enter into a contract—so that the relation of husband and wife depended wholly upon the will and caprice of the master. And the children of such marriages were neither legitimate nor illegitimate, coming into the world independent of all marriage laws. For this reason it would have been illogical in those States to have made it a penal offense for a white man and a slave woman, either through love, lustful passion, or desire of increase of property, to beget children of mixed white and colored blood, though the large numbers of persons of mixed color in the Southern States show that it was practiced to a profitable degree. But since the conditions of slavery have ceased to exist, and the freedmen have become citizens of the United States, endowed by the Constitution with all the political and civil rights enjoyed by their former masters, including the natural right of marriage, the reasons upon which the former black laws were based can have no application to the present social rights of these people. Still, the prejudice, deeply rooted in the interest of slavery, exists; and the cases recently before the Supreme Court under the civil-rights law, to test the constitutionality of the State laws punishing marriage between white and colored persons, have been decided on collateral issues in favor of that prejudice. Thus the laws of several States and the ruling of the highest tribunal in the land interrupt the natural law of selection and development. But the question is not at rest; it must be met—met as it now is, and as it will appear in the future. And if those States and the courts will not respond to the demands of the higher civilization of the age which recognizes this fundamental social law, Congress should clearly recognize and define the equal married rights of the citizens of the United States in the District of Columbia and the Territories, without regard to "race, color, or previous condition of servitude."

According to the last census, the population of the United States is reported at fifty millions, in round numbers. The report is very exact in giving the age, sex, and place of birth of each individual, native and foreign, and much other information valuable to the student of ethnology and the migration of peoples. But it is neglectful of one of the most important questions of races. It divides the population into two races, "white" and "colored," giving the number of the former at over forty-three millions, and the number of the latter at over six millions; and, in every reference to the distribution of population for causes, it fails to distinguish between the black negro and colored white, but includes them as one. It fails to tell how many of the six millions of "colored" are of pure negro blood, how many are mulattoes, quadroons, octoroons, or of a less degree than pure white. It fails to tell how many of the mixed blood are of pure white fathers, or pure white mothers—information necessary for the prediction of the future progress, endurance, and social position of the "colored race." This neglect, both in the last and preceding census reports, if not willful, is not creditable to the science side of our Government.

Before the war, citizenship was qualified by the word "white" in the Constitutions of the several States, but there was no uniformity in the definition of the word. Some States held that a person who had more white blood than black blood in his veins was white within the meaning of their Constitutions. Other States held that a person who had less than three fourths or seven eighths of white blood was black, and still other States held that anything less than pure white was black. But since the adoption of the fourteenth amendment, which declares that "all persons born or naturalized in the United States are citizens of the United States and the State in which they reside," and that "no State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States," this qualification of citizenship by the word "white" has no application, so far as the civil and political rights of the citizen are concerned. Nevertheless, wherever the law affects the social or semi-social relations of the citizen, his rights are qualified, and the word white excludes from the equal privileges and protection of the law all citizens having the least particle of colored blood in their veins. In one of the recent civil-rights cases decided by the Supreme Court—a case of the marriage of a white woman with a colored man—the court held that the State law punishing the parties was not in conflict with the fourteenth amendment, or with the civil-rights law founded on it, for the reason that the State law applies the same punishment to both offenders, the white and the black, without distinction! True, the punishment was equal without distinction of color, as it would have been in a case of larceny. But the law in prohibiting the marriage could not be constitutional, because it abridges the privileges of the citizen on account of color; it denies to the colored male citizen the equal privilege and protection of the law extended to the white male citizen—the right to marry a white woman. It also denies the white female citizen the equal privilege and protection of the law granted the colored female citizen—the right to marry a colored man.

However much the prejudice of the law and the courts may give an enforced unity to the negro race and the "colored whites," there is no ignoring the physical fact that a person who is seven eighths white, or who is but one thirty-second part colored, is not black. Of the six millions of blacks, "black" according to the United States census and the decisions of the courts, perhaps nearly two millions are of a mixed color, more white than black. Many of them are descendants of the most distinguished white blood in the history of the nation. To what race do they belong? By State laws and the decision of the Supreme Court they belong to the negro or the American-African race. By the law of nature they belong, either to the Anglo-American race, or are a race within themselves. It is no longer a doubtful question; their constant increase in numbers shows that they are eugenesic, and capable of maintaining within themselves a race of their own. Can such a people as this mixed race, imbued with the instincts, capabilities, and ambitions common to their white blood, be forever thrust back upon the negro race? Is the race-conflict so irrepressible in this country that they can not ever be merged in the white race? Or is it wiser for science and the law to recognize, in the process of the formation of races, that they are strictly a distinct and intermediate race? Already, in proportion to numbers, as many of them stand as high in intellectual development as white persons of the same class. And as the great mass of mankind, white and black, must ever be laborers and followers, and as all the avenues of trade and commerce, learning, culture, and civil and political distinctions, are open to all, this "mixed race" must eventually become sharp competitors for the supremacy in this country. What the result may be to this republic is a problem for the publicist, the scientist, and the statesman to solve.

EVOLUTION.

By H. H. BOYESEN.

I.

BROAD were the bases of all being laid
On pillars sunk in the unfathomed deep
Of universal void and primal sleep.
Some mighty will there was, in sooth, that swayed
The misty atoms which inhabited
The barren, unillumined fields of space;
A breath, perchance, that whirled the mists apace,
And shook the heavy indolence that weighed
Upon the moveless vapors. Oh, what vast,
Resounding undulations of effect
Awoke that breath! What dizzying æons passed
Ere yet a lichen-patch the bare rock flecked!
Thus rolls with boom of elemental strife
The ancestry e'en of the meanest life.

II.

I am the child of earth and air and sea!
My lullaby by hoarse Silurian storms
Was chanted; and through endless changing forms
Of plant and bird and beast unceasingly
The toiling ages wrought to fashion me.
Lo, these large ancestors have left a breath
Of their strong souls in mine, defying death
And change. I grow and blossom as the tree,
And ever feel the deep-delving earthy roots
Binding me daily to the common clay.
But with its airy impulse upward shoots
My life into the realms of light and day;
And thou, O Sea, stern mother of my soul,
Thy tempests sing in me, thy billows roll!

III.

A sacred kinship I would not forego
Binds me to all that breathes; through endless strife
The calm and deathless dignity of life
Unites each bleeding victim to its foe.
What life is in its essence, who doth know?
The iron chain that all creation girds
Encompassing myself and beasts and birds,
Forges its bond unceasing from below—
From water, stone, and plant, e'en unto man.
Within the rose a pulse that answered mine
(Though hushed and silently its life-tide ran)
I oft have felt; but when with joy divine
I hear the song-thrush warbling in my brain,
I glory in this vast creation's chain.

IV.

I stood and gazed with wonder blent with awe
Upon the giant footprints Nature left
Of her primeval march in yonder cleft;
A fern-leaf's airy woof, a reptile's claw,
In their eternal slumber there I saw
In deftly-wrought sarcophagi of stone.
What humid tempests, from rank forests blown,
Whirled from its parent stem yon slender straw?
What scaly creature of a monstrous breed
Bore yonder web-foot through the tepid tide?
Oh, what wide vistas thronged with mighty deed
And mightier thought have here mine eyes descried!—

Come, a fraternal grasp, thou hand of stone!
The flesh that once was thine is now mine own.

V.

Sublime is life, though in beginnings base
At first enkindled. In this clod of mold
Beats with faint spirit-pulse the heart of gold
That warms the lily's cheek; its silent grace
Dwells unborn 'neath this sod. Fain would I trace
The potent mystery which, like Midas' hand,
Thrills the mean clay into refulgence grand;
For, gazing down the misty aisles of space
And time, upon my sight vast visions throng
Of the imperial destiny of man.
The life that throbbed in plant and beast ere long
Will break still wider orbits in its van—
A race of peace-robed conquerors and kings,
Achieving evermore diviner things.

—*From "Idyls of Norway."*

THE BOUNDARIES OF ASTRONOMY.

II.

THE NEBULAR HYPOTHESIS.

By ROBERT S. BALL, F.R.S.,
ASTRONOMER-ROYAL OF IRELAND.

THE whole range of astronomy presents no speculations which have attracted more attention than the celebrated nebular hypotheses of Herschel and of Laplace. We shall first enunciate these speculations, and then we shall attempt to indicate how far they seem to be warranted by the actual state of scientific knowledge. In one of his most memorable papers, Sir William Herschel presents us with a summary of his observations on the nebulæ, arranged in such a manner as to suggest his theory of the gradual transmutation of nebulæ into stars. He first shows us that there are regions in the heavens where a faint diffused nebulosity is all that can be detected by the telescope. There are other nebulæ in which a nucleus can be just discerned; others again in which the nucleus is easily seen; and still others where the nucleus is a brilliant, star-like point. The transition from an object of this kind to a nebulous star is very natural, while the nebulous stars pass into the ordinary stars by a few graduated stages. It is thus possible to enumerate a series of objects, beginning at one end with the most diffused nebulosity, and ending at the other with an ordinary fixed star or group of stars. Each object in the series differs but slightly from the object just before it and just after it. It seemed to Herschel that he was thus able to view the actual changes by which masses of phosphorescent or glowing vapor became actually condensed down into stars. The condensation of a nebula could be followed in the same manner as we can study the growth of the trees in a forest by comparing the trees of various ages which the forest contains at the same time. In attempting to pronounce upon the positive evidence available in the discussion of Herschel's theory, we encounter a well-known difficulty. To establish this theory, it would be necessary to watch the actual condensation of one single nebula from the primitive gaseous condition down to the stellar points. It may easily be conceived that such a process would require a vast lapse of time, perhaps enormously greater than the period between the invention of the telescope and the present moment. It may at all events be confidently asserted that the condensation of a nebula into a star is a process which has never been witnessed. Whether any stages in that process can be said to have been witnessed is a different matter, on which it is not easy to speak with precision. Drawings of the same nebula, made at different dates, often exhibit great discrepancies. In comparing these drawings, it must be remembered that a nebula is an object usually devoid of distinct outline, and varying greatly in appearance with different telescopic apertures. Take, for instance, the very splendid nebula in Orion, which is one of the most glorious objects that can be seen in a telescope. There can be no doubt that the drawings made at different times do exhibit most marked differences. Indeed, the differences are sometimes so great that it is hard to believe that the same object is depicted. It is well to look also at drawings made of the same object at the same time, but by different observers and with different telescopes. Where we find contemporary drawings at variance—and they are often widely at variance—it seems hard to draw any conclusion from drawings as to the presence or the absence of change in the shape of the nebula.

There are, however, good grounds for believing that nebulæ really do undergo some changes, at least as regards brightness; but whether these changes are such as Herschel's theory would seem to require is quite another question. Perhaps the best authenticated instance is that of the variable nebula in the constellation of Taurus, discovered by Mr. Hind in 1852. At the time of its discovery this object was a small nebula about one minute in diameter, with a central condensation of light. D'Arrest, the distinguished astronomer of Copenhagen, found, in 1861, that this nebula had vanished. On the 29th of December, 1861, the nebula was again seen in the powerful refractor at Pulkova, but, on December 12, 1863, Mr. Hind failed to detect the nebula with the telescope by which it had been originally discovered. This instrument had, however, only half the aperture of the Pulkova telescope. In 1868, O. Struve, observing at Pulkova, detected another nebulous spot in the vicinity of the place of the missing object, but this has also now vanished. Struve does not, however, consider that the nebula of 1868 is distinct from Hind's nebula, but he says :

What I see is certainly the variable nebula itself, only in altered brightness and spread over a larger space. Some traces of nebulosity are still to be seen exactly on the spot where Hind and D'Arrest placed the variable nebula. It is a remarkable circumstance that this nebula is in the vicinity of a variable star, which changes somewhat irregularly from the ninth to the twelfth magnitude. At the time of the discovery, in 1861, both the star and the nebula were brighter than they have since become.

This is the best authenticated history of observed change in any nebula. It must be admitted that the changes are such as would not be expected if Herschel's theory were universally true.

Another remarkable occurrence in modern astronomy may be cited as having some bearing on the question as to the actual evidence for or against Herschel's theory. On November 24, 1876, Dr. Schmidt noticed a new star of the third magnitude, in the constellation Cygnus. The discoverer was confident that no corresponding object existed on the evening of the 20th of November. The brilliancy of the new star gradually declined, until, on the 13th of December, Mr. Hind found it of the sixth magnitude. The spectrum of this star was carefully studied by many observers, and it exhibited several bright lines, which indicated that the star differed from other stars by the possession of vast masses of glowing gaseous material. This star was observed by Dr. Copeland, at the Earl of Crawford's observatory, on September 2, 1877. It was then below the tenth magnitude, and of a decidedly bluish tint. Viewed through the spectroscope, the light of this star was almost completely monochromatic, and appeared to be indistinguishable from that which is often found to come from nebulæ. Dr. Copeland thus concludes :

Bearing in mind the history of this star from the time of its discovery by Schmidt, it would seem certain that we have an instance before us in which a star has changed into a planetary nebula of small angular diameter. At least it may be safely affirmed that no astronomer, discovering the object in its present state, would, after viewing it through a prism, hesitate to pronounce as to its present nebulous character.

It should, however, be added that Professor Pickering has since found slight traces of a continuous spectrum, but the object has now become so extremely faint that such observations are very difficult. This remarkable history might be adduced if we wished to procure evidence of the conversion of stars into nebulæ, but for the nebular theory we require evidence of the conversion of nebulæ into stars.

Care must be taken not to exaggerate the inferences to be drawn from the two instances I have quoted, viz., the variable nebula in Taurus and the new star in Cygnus. I think it more likely that both of these are to be regarded as exceptional phenomena. It is certainly true that they are perhaps the most remarkable instances in which changes in nebulæ have actually been witnessed; but the probability is that the only reason why they have been witnessed is because they were very exceptional. Those who have observed the nebulæ for many years are well assured of the general permanence of their appearance. The nebulæ we have referred to are chosen out of thousands. The ordinary nebulæ appear just as constant as the ordinary bright stars. Every one expects to see Vega in the constellation Lyra; and with equal confidence every astronomer counts on seeing the celebrated annular nebula when he directs his telescope to the same constellation. This permanence is very probably merely due to the stupendous distances at which these objects are placed. Only gigantic changes could be detected, and for these, gigantic periods of time would be required. We are bound to believe that heated bodies radiate their heat; and, if so, they must contract. This general law, which pervades all Nature, so far as we know it, seems to be the real basis—indeed, the only basis—on which the nebular theory of Herschel can be maintained. Up to the present, it must be admitted that this theory has received no direct telescopic confirmation.

The nebular theory by which Laplace sought to account for the origin of the solar system seems, from the nature of the case, to be almost incapable of receiving any direct testimony. We shall here enunciate the theory in the language of Professor Newcomb:

The remarkable uniformity among the directions of the revolutions of the planets being something which could not have been the result of chance, Laplace sought to investigate its probable cause. This cause, he thought, could be nothing else than the atmosphere of the sun, which once extended so far out as to fill all the space now occupied by the planets. He conceives the immense vaporous mass forming the sun and his atmosphere to have had a slow rotation on its axis. The mass, being intensely hot, would slowly cool off, and as it did so would contract toward the center. As it contracted, its velocity would, in obedience to one of the fundamental laws of mechanics, constantly increase, so that a time would arrive when, at the outer boundary of the mass, the centrifugal force due to the rotation would counterbalance the attractive force of the central mass. Then those outer portions would be left behind as a revolving ring, while the next inner portions would continue to contract, until at their boundary the centrifugal and attractive forces would be again balanced, when a second ring would be left behind, and so on. Thus, instead of a continuous atmosphere, the sun would be surrounded by a series of concentric revolving rings of vapor.

Now, how would these rings of vapor behave? As they cooled off, their denser materials would condense first, and thus the ring would be composed of a mixed mass, partly solid and partly vaporous, the quantity of solid matter constantly increasing and that of vapor diminishing. If the ring were perfectly uniform this condensing process would take place equally all around it, and the ring would thus be broken up into a group of small planets like that which we see between Mars and Jupiter. But we should expect that, in general, some portions of the ring would be much denser than others, and the denser portion would gradually attract the rarer portions around it, until instead of a ring we should have a single mass, composed of a nearly solid center, surrounded by an immense atmosphere of fiery vapor. This condensation of the ring of vapor around a single point would have produced no change in the amount of rotary motion originally existing in the ring; the planet surrounded by its fiery atmosphere would therefore be in rotation, and would be, in miniature, a reproduction of the case of the sun surrounded by his atmosphere with which we set out. In the same way that the solar atmosphere formed itself first into rings, and then these rings condensed into planets, so, if the planetary atmosphere were sufficiently extensive, they would form themselves into rings, and these rings would condense into satellites. In the case of Saturn, however, one of the rings was so perfectly uniform that there could be no denser portion to draw the rest of the ring around it, and thus we have the well-known rings of Saturn.

It will thus be seen that one of the principal features in the solar system for which the nebular theory has been invoked is the fact that the planets all revolve round the sun in the same direction. It will therefore be natural to take up first the discussion of this subject, and to inquire how far the common motion of the planets can be claimed in support of Laplace's nebular theory. The value of this argument is very materially influenced by another consideration of a somewhat peculiar character. If it were quite immaterial to the welfare of the planetary system whether all the planets moved the same way, or whether some moved one way and some another, then the nebular hypothesis would be entitled to all the support which could be derived from the circumstances of the case. Take, for instance, the eight principal planets—Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune. All these planets move in the same way around the sun. The chances against such an occurrence are 127 to 1. The probability that the system of eight planets have been guided to move in the same direction by some cause may be taken to be 127 to 1. If we include the two hundred minor planets, the probability would be enormously enhanced. The nebular theory seems a reasonable explanation of how this uniformity of movements could arise, and therefore the advocates of the nebular theory may seem entitled to claim all this high degree of probability in their favor. There is, however, quite a different point of view from which the question may be regarded. There are reasons which imperatively demand that the planets (at all events the large planets) shall revolve in uniform directions, which lie quite outside the view taken in the nebular theory. If the big planets did not all revolve in the same direction, the system would have perished long ago, and we should not now be here to discuss the nebular or any other hypothesis.

It is well known that, in consequence of the gravitation which pervades the solar system, each of the planets has its movements mainly subordinated to the attraction of the sun. But each of the planets attracts every other planet. In consequence of these attractions the orbits of the planets are to some extent affected. The mutual actions of the planets present many problems of the highest interest, and, it should be added, of the greatest difficulty. Many of these difficulties have been overcome. It is the great glory of the French mathematicians to have invented the methods by which the nature of the solar system could be studied. The results at which they arrived are not a little remarkable. They have computed how much the planets act and react upon each other, and they have shown that in consequence of these actions the orbit of each planet gradually changes its shape and its position. But the crowning feature of these discoveries is the demonstration that these changes in the orbits of the planets are all periodic. The orbits may fluctuate, but those fluctuations are confined within very narrow limits. In the course of ages the system gradually becomes deformed, but it will gradually return again to its original position, and again depart therefrom. These changes are comparatively so small that our system may be regarded as substantially the same even when its fluctuations have attained their greatest amplitude. These splendid discoveries are founded upon the actual circumstances of the system, as we see that system to be constituted. Take, for instance, the eccentricities of the orbits of the planets around the sun. Those eccentricities can never change much; they are now small quantities, and small quantities those eccentricities must forever remain. The proof of this remarkable theorem partly depends upon the fact that the planets are all revolving around the sun in the same direction. If one of the planets we have named were revolving in an opposite direction to the rest, the mathematical theory would break down. We would have no guarantee that the eccentricities would forever remain small as they are at present. In a similar manner, the planets all move in orbits whose planes are inclined to each other at very small angles. The positions of those planes fluctuate, but these fluctuations are confined within very narrow limits. The proof of this theorem, like the proof of the corresponding theorem about the eccentricities, depends upon the actual conditions of the planetary system as we find it. If one of the planets were to be stopped, turned round, and started off again in the opposite direction, our guarantee for the preservation of the planes would be gone. It therefore follows that, if the system is to be permanently maintained, all the planets must revolve in the same direction.

In this connection it is impossible not to notice the peculiar circumstances presented by the comets. By a sort of convention, the planets have adopted, or, at all events, they possess, movements which fulfill the conditions necessary if the planets are to live and let live; but the comets do not obey any of the conditions which are imposed by the planetary convention. The orbits of the comets are not nearly circles. They are sometimes ellipses with a very high degree of eccentricity; they are often so very eccentric that we are unable to distinguish the parts of their orbits which we see from actual parabolas. Nor do the directions in which the comets move exhibit any uniformity; some move round the sun in one direction, some move in the opposite direction. Even the planes which contain the orbits of the comets are totally different from each other. Instead of being inclined at only a very few degrees to their mean position, the planes of the comets hardly follow any common law; they are inclined at all sorts of directions. In no respect do the comets obey those principles which are necessary to prevent constitutional disorder in the planetary system. The consequences of this are obvious, and unfortunate in the highest degree—for the comets. A comet possesses no security for the undisturbed enjoyment of its orbit. Not to mention the risk of actual collision with the planets, there are other ways in which the path of a comet may experience enormously great changes by the disturbances which the planets are capable of producing. How is it that the system has been able to tolerate the vagaries of comets for so many ages? Solely because the comets, though capable of suffering from perturbations, are practically incapable of producing any perturbations on the planets. The efficiency of a body in producing perturbations depends upon the mass of the body. Now, all we have hitherto seen with regard to comets tends to show that the masses of comets are extremely small. Attempts have been made to measure the masses of comets. Those attempts have always failed. They have failed because the scales in which we have attempted to weigh the comets have been too coarse to weigh anything of the almost spiritual texture of a comet. It is unnecessary to go as far as some have done, and to say that the weight of a large comet may be only a few pounds or a few ounces. It might be more reasonable to suppose that the weight of a large comet was thousands of tons, though even thousands of tons would be far too small a weight to admit of being measured by the very coarse balance which is at our disposal.

The enduring stability of the planetary system is thus seen to be compatible with the existence of comets solely because comets fulfill the condition of being almost imponderable in comparison with the mighty masses of the planetary system. The very existence of our planetary system is a proof of the doctrine that the masses of the comets are but small. Indeed, to those who will duly weigh the matter, it will probably appear that this negative evidence as to the mass of the comets is more satisfactory than the results of any of the more direct attempts to place the comets in the weighing-scales. If we restate the circumstances of the solar system, and if we include the comets in our view, it will appear how seriously the existence of the comets affects the validity of the argument in favor of the nebular hypothesis which is derived from the uniformity in the directions of the planetary movements. If we include the whole host of minor planets, we have for the population of the solar system something under three hundred planets, and an enormous multitude of comets. It will probably not be an overestimate if we suppose that the comets are ten times as numerous as the planets. The case, then, stands thus: The solar system consists of some thousands of different bodies; these bodies move in orbits of the most varied degrees of eccentricity; they have no common direction; their planes are situated in all conceivable positions, save only that each of these planes must pass through the sun. Stated in this way, the present condition of the solar system is surely no argument for the nebular theory. It might rather be said that it is inconceivable on the nebular theory how a system of this form could be constructed at all. Nine tenths of the bodies in the solar system do not exhibit movements which would suggest that they were produced from a nebula: the remaining tenth do no doubt exhibit movements which seem to admit of explanation by the nebular theory; but, had that tenth not obeyed the group of laws referred to, they would not now be there to tell the tale. The planetary system now lives solely because it was an organism fitted for survival. It is often alleged that the comets are not indigenous to the solar system. It has been supposed that the comets have been imported from other systems. It has also been urged with considerable probability that perhaps many comets may have had their origin in our sun and have been actually ejected therefrom. I do not now attempt to enter into the discussion of these views, which are at present problematical; let me pass from this part of the subject, with the remark that, until the nature and origin of comets be better understood, it will be impossible to appraise with accuracy the value of the argument for the nebular hypothesis which has been based on the uniformity of the directions in which the planets revolve around the sun.

There are, however, other circumstances in the solar system which admit of explanation by the nebular theory. It is a remarkable fact that the Earth, Mars, Jupiter, and Saturn are all known to rotate upon their axes in the same direction as their revolutions around the sun. The nebular theory offers an explanation of this circumstance. It does not appear that this common rotation of the planets is absolutely necessary for the stability of the system. Should it further be proved that there is no other agency at work which would force the planets to rotate in the same direction, then it must be admitted that the nebular theory receives very substantial support.

There is another way in which we can examine the evidence on behalf of the nebular hypothesis. There are certain actions going on at present in the solar system; and by reasoning backward from these present actions we are led to believe that in extremely early times the condition of things may have resembled that which is supposed by the nebular hypothesis. Let us begin with the consideration of our sun, which is, as we know, daily radiating off light and heat into space. This heat is poured off in all directions; a small portion of it is intercepted by the earth, but this portion is less than one two-thousand-millionth part of the whole; the planets also, no doubt, each intercept a small portion of the solar radiation; but the great mass of radiated heat from the sun entirely escapes. This heat is supposed not to be restored to the sun. The sun certainly must receive some heat by the radiation from the stars; but this is quite infinitesimal in comparison with the stupendous radiation from the sun. We therefore conclude that the sun's heat is being squandered with prodigal liberality.* We also know that the store of heat which the sun can possess, though no doubt enormously great, is still limited in amount. It is, indeed, a question of very great interest to decide what are the probable sources by which the sun is able to maintain its present rate of expenditure. The sun must have some source of heat in addition to that which it would possess in virtue of its temperature as an incandescent body. If we suppose the sun to be a vast incandescent body, formed of materials which possess the same specific heat as the materials of which our earth is composed, the sun would then cool at the rate of from 5° to 10° per annum. At this rate the sun could not have lasted for more than a few thousand years before it cooled down. We are therefore compelled to inquire whether the sun may not have some other source of heat to supply its radiation beyond that which arises merely from the temperature.

Of the various sources which have been suggested, it will here only be necessary to mention two. It has been supposed that the heat of the sun may be recruited by the incessant falling of meteoric matter upon the sun's surface. If that matter had been drawn only by the sun's attraction from the remote depths of space, it would fall upon the sun with an enormously great velocity, amounting to about 300 miles a second. It follows from the principle of the equivalence between heat and mechanical energy that a body entering the sun with this velocity would contribute to the sun a considerable quantity of heat. It is known that small meteoroids abound in the solar system; they are constantly seen in the form of shooting-stars when they dash into our atmosphere, and it can hardly be doubted that myriads of such bodies must fall into the sun. It does not, however, seem likely that enough matter of this kind can enter the sun to account for its mighty radiation of heat. It can be shown that the quantity of matter necessary for this purpose is so large that a mass equal in the aggregate to the mass of the earth would have to fall into the sun every century if the radiation of the sun were to be defrayed from this source. That so large a stream of matter should be perennially drawn into the sun is, to say the least, highly improbable. But it is

* A remarkable theory has recently been put forward by Dr. Siemens, according to which the sun's radiant energy is ultimately restored to the sun. Even the possibility of some such theory being true most seriously affects the above arguments in favor of the nebular hypothesis.

quite possible to account for the radiation of the sun on strictly scientific principles, even if we discard entirely the contributions due to meteoric matter. As the sun parts with its heat it must contract, in virtue of the general law that all bodies contract when cooling; but in the act of contraction an amount of heat is produced. By this the process of cooling is greatly retarded. It can, indeed, be shown that, if the sun contracts so that his diameter decreases one mile every twenty-five years, the amount of heat necessary to supply his radiation would be amply accounted for. At this rate many thousands of years must elapse before the diminution in the sun's diameter would be large enough to be appreciable by our measurements.

Looking back into the remote ages, we thus see that the sun was larger and larger the further back we project our view. If we go sufficiently far back, we seem to come to a time when the sun, in a more or less completely gaseous state, filled up the whole solar system out to the orbit of Mercury, or earlier still, out to the orbit of the remotest planet. If we admit that the present laws of Nature have been acting during the past ages to which we refer, then it does not seem possible to escape the conclusion that the sun was once a nebulous mass of gas such as the nebular theory of Laplace would require.

It will also throw some light upon this retrospective argument for the nebular theory if we briefly consider the probable past history of the earth. It is known that the interior of the earth is hotter than the exterior. It has been suggested that this interior heat may arise from certain chemical actions which are at present going on. If this were universally the case, the argument now to be brought forward could not be entertained. I believe, however, most physicists will agree in thinking that the interior heat of the earth is an indication that the earth is cooling down from some former condition in which it was hotter than it is at present. The surface has cooled already, and the interior is cooling as quickly as the badly conducting materials of the earth will permit. We are thus led to think of the earth as having been hotter in past time than at present. The further we look back the greater must the earth's heat have been. We can not stop till the earth was once red-hot or white-hot, till it was molten or a mass of fiery vapor. Here, again, we are led to a condition of things which would certainly seem to harmonize with the doctrines of the nebular theory.

The verdict of science on the whole subject can not be expressed better than in the words of Newcomb:

> At the present time we can only say that the nebular hypothesis is indicated by the general tendencies of the laws of Nature; that it has not been proved to be inconsistent with any fact; that it is almost a necessary consequence of the only theory by which we can account for the origin and conservation of the sun's heat; but that it rests on the assumption that this conservation is to be explained by the laws of Nature as we now see them in operation.

Should any one be skeptical as to the sufficiency of these laws to account for the present state of things, science can furnish no evidence strong enough to overthrow his doubts until the sun shall be found growing smaller by actual measurement, or the nebulæ be actually seen to condense into stars and systems.

DARWIN AND COPERNICUS.*

By Professor E. DU BOIS-REYMOND.

THE losses by death which natural science has sustained during the past year are unusually heavy. The fertile and ingenious mathematician who for more than a generation held a leading position among French men of science as the publisher of one of the best-known mathematical journals ; the chemist who, by the first organic synthesis, helped to dispel the illusion of vital energy ; the physiologist who solved one of the oldest problems of humanity—are men whose death leaves a void not easily filled up. But the luster of even such names as Liouville, Wöhler, and Bischoff pales before that of the first on our list, Charles Darwin. Nearly every learned society in existence has publicly deplored his loss. As this Academy has not hitherto found a fitting opportunity for doing so, it is necessary to add a few words to the formal mention of his decease, to show that we also appreciate the greatness of the man and of the loss science has sustained in him.

To say anything fresh concerning him will only be possible when the lapse of time and the progress of science have opened up new points of view ; and the speaker, who has often had occasion to discuss Darwin before this Academy, finds it especially difficult not to repeat himself, the more so as opinions of his work are still somewhat apt to be influenced by personal feeling.

Darwin seems to me to be the Copernicus of the organic world. In the sixteenth century Copernicus put an end to the anthropocentric theory by doing away with the Ptolemaic spheres and bringing our earth down to the rank of an insignificant planet. At the same time he proved the non-existence of the so-called empyrean, the supposed abode of the heavenly hosts, beyond the seventh sphere, although Giordano Bruno was the first who actually drew the inference.

Man, however, still stood apart from the rest of animated beings—not at the top of the scale, his proper place, but quite away, as a being absolutely incommensurable with them. One hundred years later Descartes still held that man alone had a soul, and that beasts were mere automata. Notwithstanding all the labor of naturalists since the days of Linnæus, notwithstanding the resurrection of vanished genera and species by Cuvier, the theory of the origin and interdependence of

* Address delivered at the anniversary meeting of the Berlin Academy of Sciences.

living things, which was almost universal five-and-twenty years ago, was only equaled in arbitrariness, artificiality, and absurdity by the celebrated theory of Epicycles, which caused Alfonso of Castile to exclaim, "If God had asked my advice when he created the world, I should have managed things much better."

"*Afflavit Darwinius et dissipata est*," would, alluding to the above-mentioned theory, be a fitting inscription for a medal in honor of the "Origin of Species." For now all things were seen to be due to the quiet development of a few simple germs; graduated days of creation gave place to one day on which matter in motion was created; and organic suitability was replaced by a mechanical process, for as such we may look on natural selection, and now for the first time man took his proper place at the head of his brethren.

We may compare Copernicus's student-days at Bologna with Darwin's voyage in the Beagle, and his retired life at Frauenburg with Darwin's in his Kentish home, up to the time when the appearance of Mr. Wallace's work caused him to break his long silence. Here, happily for Darwin, the parallel ends. Many circumstances combined in Darwin's case to render his task easier and insure his ultimate triumph. Botany and zoölogy, morphology, the theory of evolution, and the study of the geographical distribution of plants and animals, had advanced far enough to allow of general conclusions being drawn from them; Lyell's sound sense had freed geology from the hypotheses which disfigured it, and introduced the idea of uniformity into science. The doctrine of the conservation of energy had been put on a new basis, and extended so that in combination with astronomical observation it gave rise to entirely new views of the history and duration of the universe. The doctrine of vital energy had been proved to be untenable on closer investigation. An unusually dry season had some years earlier led to the discovery of the so-called lake-dwellings in the bed of one of the Swiss lakes, whereby prehistoric research was quickly extended and developed. Though many links are still missing, we may fairly consider the knowledge of the existence of primeval man as the beginning of the long-looked-for connection between him and the anthropoids on the one hand, and between them both and their common progenitors on the other. In a word, the time had come for the publication of the "Descent of Man"; that is why an opinion on the nature of man, which differs from all former ones fully as much as the system of Copernicus, of which it is the complement, differs from that of Ptolemy, found such ready and general acceptance.

How different was the fate of Copernicus! "Copernicus," says Poggendorff, "is, and will ever remain, a brilliant star in the firmament of science; but he rose at a time when the horizon was almost entirely obscured by the mists of ignorance. . . . The Ptolemaic system was too ancient and too much venerated to be easily displaced." Copernicus's teaching met with but scant appreciation for the first fifty years after its publication; even Tycho Brahe opposed it; it can therefore scarcely cause surprise that Luther rejected it, that Giordano Bruno died at the stake for his advocacy of it, while the less steadfast Galileo was forced to renounce it.

Notwithstanding the pessimism of our speculative philosophers, who deny all progress because they contribute nothing toward it, Darwin's lot was happier than that of the great reformer of astronomy. While Copernicus could only feast his eyes on the first printed copy of his work as he lay on his death-bed, because he had not dared to publish it sooner, although he had completed it some years before, Darwin survived the appearance of his nearly a quarter of a century. He witnessed the fierce struggles its appearance at first gave rise to; its ever-increasing acceptance and its final triumph, to which he, cheerful and active to the last, greatly contributed by a long series of admirable works.

While the Holy Inquisition persecuted the followers of Copernicus with fire and sword, Charles Darwin lies buried in Westminster Abbey among his peers, Newton and Faraday.

WHISTLING.

BY T. F. THISELTON DYER.

IN whatever way regarded, either as a graceful accomplishment or as the spontaneous expression of light-heartedness, whistling has in our own and foreign countries generally attracted considerable attention. Why it should have been invested with so much superstitious awe it is difficult to say, but it is a curious fact that the same antipathy which it arouses among certain classes of our own countrymen is found existing in the most distant parts of the earth, where, as yet, civilization has made little or imperceptible progress. Thus Captain Burton * tells us how the Arabs dislike to hear a person whistle, called by them *el sifr*. Some maintain that the whistler's mouth is not to be purified for forty days; while, according to the explanation of others, Satan touching a man's body causes him to produce, what they consider, an offensive sound † The natives of the Tonga Islands, Polynesia, hold it to be wrong to whistle, as this act is thought to be disrespectful to God.‡ In Iceland, the villagers have the same objection to whistling, and so far do they carry their superstitious dread of it that "if one swings about him a stick, whip, wand, or aught that

* "First Footsteps in East Africa," 1856, p. 142.

† Carl Engel, "Musical Myths and Facts," 1876, i, 91.

‡ "Mariner and Martin: An Account of the Natives of the Tonga Islands," 1818, ii, 131.

makes a whistling sound, he scares from him the Holy Ghost"; while other Icelanders, who consider themselves free from superstitions, cautiously give the advice: "Do it not; for who knoweth what is in the air?" However eccentric these phases of superstitious belief may appear to us, yet it must not be forgotten that very similar notions prevail at the present day, in this country. A correspondent of "Notes and Queries" (1879, fifth series, xii, 92), for instance, relates how one day, after attempting in vain to get his dog to obey orders to come into the house, his wife tried to coax it by whistling, when she was suddenly interrupted by a servant, a Roman Catholic, who exclaimed in the most piteous accents, "If you please, ma'am, don't whistle—every time a woman whistles, the heart of the blessed Virgin bleeds!" In some districts of North Germany the villagers say that if one whistles in the evening it makes the angels weep. Speaking, however, of ladies in connection with whistling, it is a wide-spread superstition that it is at all times unlucky for them to whistle, which, according to one legend, originated in the circumstance that, while the nails for our Lord's cross were being forged, a woman stood by and whistled. Curiously enough, however, one very seldom hears any of the fair sex indulging in this recreation, although there is no reason, as it has been often pointed out, why they should not whistle with as much facility as the opposite sex. One cause, perhaps, of the absence of this custom among women may be, in a measure, due to the distortion of the features which it occasions. Thus we know how Minerva cast away, with an imprecation, the pipe, which afterward proved so fatal to Marsyas, when she beheld in the water the disfigurement of her face caused by her musical performance. There are numerous instances on record, nevertheless, of ladies whistling at public entertainments, and charming their audiences with the graceful ease with which they performed such airs as "The Blue Bells of Scotland" or "The Mocking-Bird." Indeed, not many years ago, at a grand provincial concert, two sisters excited much admiration by the clever and artistic way in which they whistled a duet.

Referring to whistling performances, Addison, in one of the earlier numbers of the "Spectator," gives an amusing account of a contest, where a prize of a guinea was to be conferred on the successful competitor who could not only whistle the best, but go through his tune without laughing, and that in spite of the ludicrous antics of a certain merry-andrew, whose special duty it was to try as far as possible to discompose each of the competitors by making grimaces. On the occasion in question, the competitors were an under-citizen, remarkable for his wisdom—a plowman endued "with a very promising aspect of inflexible stupidity"—and a footman, who, having captivated his audience by whistling "a Scotch tune and an Italian sonata," carried off the prize. Strutt, in his "Sports and Pastimes," relates the remarkable performance of a whistler, who, assuming the name of Rossignol, exhibited at the end of the last century his talent on the stage of Covent Garden Theatre, and attracted for some time considerable notice.*

Anyhow, the universality of the prejudice against women whistling is an acknowledged fact, and there are few localities where one may not hear the familiar rhyme :

> "A whistling wife and a crowing hen
> Will call the old gentleman out of his den."

Of course there are various versions, as, for instance, in Northamptonshire, where the peasantry say :

> "A whistling woman and a crowing hen
> Are neither fit for God nor men."

The Cornish saying is to the same effect : "A whistling woman and a crowing hen are the two unluckiest things under the sun." Similar also is the French proverb, "*Une poule qui chante le coq et une fille qui siffle portent malheur dans la maison.*" The same superstition prevails among the seafaring community ; and Mr. Henderson† relates how, a few years ago, when a party of friends were about to go on board a vessel at Scarborough, the captain caused no small astonishment by declining in the most emphatic way to allow one of them to enter it : "Not that young lady," he cried out ; "she whistles." By a curious coincidence, the vessel was lost on her next voyage ; so, had the young lady formed one of the party, the misfortune would certainly have been attributed to her. After all, it seems hard that, if the mere act of whistling can help to cheer a man, such a soothing influence should be denied to a woman. "If whistling," says a writer in the "Phrenological Journal," "will drive away the blues and be company for a lonesome person, surely women have much more need of its services than their brothers, for to them come many more such occasions than to men. There is a physical advantage in whistling which should excuse it against all the canons of propriety or 'good form.' It is often remarked that the average girl is so narrow-chested, and in that respect compares so unfavorably with her brother, which may be due in some measure to the habit of whistling which every boy acquires." An eminent medical authority says : "All the men whose business it is to try the wind-instruments made at the various factories before sending them off for sale are, without exception, free from pulmonary affections. I have known many who, when entering upon this calling, were very delicate, and who, nevertheless, though their duty obliged them to blow for hours together, enjoyed perfect health after a certain time." As the action of blowing wind-instruments is the same as that of whistling, the effects should be the same. Whistling has been popularly styled the "devil's music," the reason, in all probability, being

* See an article entitled "Mouth Music" in "Book of Days," i, 751.

† "Folk-lore of the Northern Counties," 1879, p. 43.

that, when persons are up to anything wrong and likely to be caught, they assume an air of indifference by whistling. As the daily music of boys, however, it may be attributed to want of thought; and so Cowper, in his description of the "Postman" ("Task," book iv), says:

"He whistles as he goes, light-hearted wretch,
Cold and yet cheerful; messenger of grief
Perhaps to thousands, and of joy to some,
To him indifferent whether grief or joy."

In Shield's opera of "The Farmer," the singer—"now a saucy footman"—thus reverts to his boyhood:

"A flaxen-headed cowboy, I whistled o'er the lea,
And then a little plowboy, as happy as could be."

Dryden, too, says in his "Cymon and Iphygenia":

"He whistled as he went, for want of thought."

And the same idea was perhaps in Milton's mind—

"While the plowman near at hand,
Whistles o'er the furrowed land."

Gay, also, wrote in the same strain:

"The plowman leaves the task of day,
And trudging homeward, whistles on the way."

The act of "whistling in one's fist," which is much in use among the lower orders, especially when they are desirous of sending the sound some distance, consists in bringing the thumbs of both hands together, leaving the hands and closed fingers to form a hollow space; then, by blowing through the narrow aperture left between the thumbs, a very loud and shrill whistle is produced. In Lincolnshire, in my school-days, says a correspondent of "Notes and Queries" (fourth series, ii, 213), this form of whistling used to be called the "thieves' whistle"—a name, by-the-by, which is still employed in London. Indeed, few subjects have given rise to a greater variety of popular every-day sayings than whistling. Thus the expression, to "pay for one's whistle"—a favorite phrase with George Eliot—means to gratify one's fancy. Again, a thing worthy of notice is said in common parlance to be "worth the whistle"; the reference obviously being to the ordinary way of calling up a dog. Heywood, for instance, in one of his proverbs, says, "It is a poor dog that is not worth the whistling." Shakespeare, too, makes Goneril say to Albany, in "King Lear" (Act iv, scene 2):

"I have been worth the whistle."

Then there is the phrase, "To pay too dearly for one's whistle," implying that, after a person has paid dearly for something he fancied, he finds it does not answer his expectations. The allusion, says Dr. Brewer, in his "Dictionary of Phrase and Fable," is to a story told by

Dr. Franklin of his nephew, who set his mind on a common whistle, which he bought of a boy for four times its value. Franklin says the "ambitious who dance attendant on court, the miser who gives this world and the next for gold, the libertine who ruins his health for pleasure, the girl who marries a brute for money, all in the long run pay too much for their whistle." Once more, the old hackneyed proverbs "To wet one's whistle" and "To whistle for more" allude to the whistle drinking-cups of days gone by. It appears that, in the sixteenth and seventeenth centuries, silversmiths devoted a large amount of invention to the production of drinking-tankards, which took the form of men, animals, birds, etc., of most grotesque design.* According to one popular device, the cup had to be held in the hand to be filled, and retained there till it was emptied, as then only it could be set on the table. The drinker having swallowed the contents, blew up the pipe at the side, which gave a shrill whistle, and announced to the drawer that more liquor was required. Hence, too, no doubt, originated the phrase "whistle-drunk." Fielding relates how Squire Western, when supping one night at a friend's house, "was indeed whistle-drunk," for before he had swallowed the third bottle he became so entirely overpowered that, though he was not carried off to bed till long after, the parson considered him as absent.

The idea of ghosts whistling is still far from extinct in England, and enters largely into the folk-lore of our peasantry; a superstition which has been associated with the "Seven Whistlers," supposed by some to be phantom-birds. Thus, among the colliers of Leicestershire, we are told how, when trade is brisk and money plentiful, disposing them for a drinking-frolic, they are said to hear the warning voice of the "Seven Whistlers"—birds sent purposely, as they affirm, by Providence to warn them of an impending danger, and on hearing the signal not a man will descend into the pit until the following day.† Wordsworth, it may be remembered, in one of his sonnets, couples the "Seven Whistlers" with the "Gabriel hounds," those weird, mysterious specter-dogs which with such fiendish yellings haunt the midnight air:

> "The poor old man is greater than he seems:
> He the seven birds hath seen that never part,
> Seen the seven whistlers in their nightly rounds,
> And counted them; and oftentimes will start,
> For overhead are sweeping Gabriel's hounds."

The superstitious fear attaching to these whistlers is noticed by Spenser in his "Faerie Queen" (book ii, canto xii, stanza 36), where, "among the nation of unfortunate and fatal birds" that flocked about Sir Guyon and the Palmer, it is thus alluded to:

> "The whistler shrill, that whoso hears doth die."

* Chambers's "Book of Days," ii, 455.

† "Nature," June 22, 1871, 140; "Notes and Queries," fourth series, viii, 68.

It has been suggested that the whistler is the green plover to which Sir Walter Scott refers in "The Lady of the Lake," where he relates how—

"In the plover's shrilly strains
The signal whistle's heard again"—

its ominous shrill whistle which startles, with dreadful awe, the midnight traveler as he journeys along some lonely road, sounding far more like a human note than that of a bird. In illustration of this view we may quote the following anecdote related by a correspondent of "Notes and Queries" (fourth series, viii, 268), which, however, supports the popular theory of the birds in question being supernatural beings: "One evening a few years ago, when crossing one of our Lancashire moors in company with an intelligent old man, he was suddenly startled by the whistling overhead of a covey of plovers. My companion remarked that when a boy the old people considered such a circumstance a bad omen, 'as a person who heard the wandering Jews,' as he called the plovers, 'was sure to be overtaken by some ill-luck.' On questioning my friend about the name given to the birds, he said, 'There is a tradition that they contain the souls of those Jews who assisted at the crucifixion, and in consequence were doomed to float in the air forever.' When he arrived at the foot of the moor, a coach by which I had hoped to reach my destination had already started, thereby causing me to continue my journey on foot. The old man reminded me of the omen." To quote a further anecdote recorded by another correspondent of the same journal, we are told how during a thunder-storm which passed over the neighborhood of Kettering on the evening of September 6, 1871—on which occasion the lightning was very vivid—an unusual spectacle was witnessed: immense flocks of birds were flying about, uttering doleful, affrighted cries as they passed over the locality, and for hours they kept up a continual whistling like that made by sea-birds. "The following day," adds the writer, "as my servant was driving me to a neighboring village, this phenomenon of the flight of birds became the subject of conversation, and, on asking him what birds he thought they were, he told me they were what were called the 'Seven Whistlers,' and that whenever they were heard it was considered a sign of some great calamity, and that the last time he heard them was before the great Hartley Colliery explosion; he had also been told by soldiers that if they heard them they always expected a great slaughter would take place soon. Curiously enough, on taking up the newspaper on the following morning, I saw headed in large letters, 'Terrible Colliery Explosion at Wigan,' etc. This, I thought, would confirm my man's belief in the "Seven Whistlers." Among the pieces of folk-lore connected with whistling may be mentioned that of sailors whistling for a wind on a calm day; an expedient which they believe seldom fails. Thus Longfellow, in his "Golden Legend," speaks of this notion:

"Only a little hour ago,
I was whistling to St. Antonio
For a capful of wind to fill our sail,
And, instead of a breeze, he has sent a gale."

Sir Walter Scott, too ("Rokeby," ii, 11), says:

"What gales are sold on Lapland's shore!
How whistle rash bids tempests roar!"

Among the numerous anecdotes connected with whistling, it may be remembered that in the train of Anne of Denmark, when she went to Scotland with James VI, was a gigantic Dane of matchless drinking capacity. He possessed an ebony whistle which, at the beginning of a drinking-bout, he would lay on the table, and whoever was last able to blow it was by general consent considered to be the "champion of the whistle." It happened, however, that during his stay in Scotland the Dane was defeated by Sir Robert Laurie, of Maxwelton, who, after three days and three nights of hard drinking, left the Dane under the table, and "blew on the whistle his requiem shrill." The whistle remained in the family seven years, when it was won by Sir Walter Laurie, son of Sir Robert. The last person who carried it off was Alexander Ferguson, of Craig-darroch, son of "Annie Laurie," so well known. Burns has immortalized the subject in a poem entitled "The Whistle," from which we quote the following stanzas:

"I sing of a whistle, a whistle of a worth,
I sing of a whistle, the pride of the North,
Was brought to the court of our good Scottish king,
And long with this whistle all Scotland shall ring.
Old Loda, still rueing the arm of Fingal,
The god of the bottle sends down from his hall;
'This whistle's your challenge—to Scotland get o'er,
And drink them to hell, sir, or ne'er see me more!'" etc.

The Russians in the Ukraine tell a queer story about a whistling robber of olden times, who evidently was a person of gigantic proportions, for he was in the habit of sitting on nine oak-trees at once. One of the nicknames given to him was "Nightingale," on account of his extraordinary whistling powers. Should an unwary traveler come across his path, he would whistle so melodiously that his victim would quickly faint away, whereupon he stepped forward and killed him outright. At last, however, a well-known hero, by name Ilja Marometz, determined to subdue the robber, and, having shot him with an arrow, took him prisoner, carrying him off to the court of the Grand Prince Vladimir. Even there he proved dangerous, for when the grand prince, merely from curiosity, commanded him to whistle, the grand princess and all the royal children being present, the man commenced whistling in such an overpowering manner that soon Vladimir with his whole family would inevitably have been dead had not one of his brave courtiers, perceiving the danger, got up and shut the whistler's mouth.*

We must not omit to mention the celebrated "Whistling Oyster," which about forty years ago created such a sensation at the small oyster and refreshment rooms situated in Vinegar Yard, near Catherine Street, Strand. "It appears," says a writer in the "Daily Telegraph," "that about the year 1840, the proprietor of the house in question, which had then, as it has now, a great name for the superior excellence of its delicate little 'natives,' heard a strange and unusual sound proceeding from one of the tubs in which the shell-fish lay, piled in layers one over the other, placidly fattening upon oatmeal, and awaiting the inevitable advent of the remorseless knife. Mr. Pearkes, the landlord, listened, hardly at first believing his ears. There was, however, no doubt about the matter. One of the oysters was distinctly whistling, or, at any rate, producing a sort of 'sifflement' with its shell. It was not difficult to detect this phenomenal bivalve, and in a very few minutes he was triumphantly picked out from among his fellows, and put by himself in a spacious tub with a bountiful supply of brine and meal. The news spread throughout the town, and for some days the fortunate Mr. Pearkes found his house besieged by curious crowds. That this Arion of oysters did really whistle is beyond all question. How he managed to do so is not upon record." As may be imagined, the jokes to which this fresh wonder of creation gave rise were unlimited; and Thackeray was in the habit of relating an amusing story of his own experience in connection with it. It appears that he was one day in the shop when an American came in to see this startling freak of nature; after hearing the talented mollusk go through its usual performance, he walked contemptuously out, remarking at the same time that "it was nothing to an oyster he knew of in Massachusetts, which whistled 'Yankee Doodle' right through, and followed its master about the house like a dog." Douglas Jerrold surmised that the oyster had undoubtedly "been crossed in love, and now whistled to keep up appearances, with an idea of showing that it didn't care." The subsequent fate of this interesting creature, says Mr. Walford,† "is a mystery—whether he was eaten alive, or ignominously scalloped, or still more ignominiously handed over to the tender mercies of a cook in the neighborhood, to be served up in a bowl of oyster-sauce as a relish to a hot beefsteak. In fact, like the 'Lucy' of Wordsworth—

'. . . none can tell
When the oyster ceased to be.'

But it is somewhat singular that so eccentric a creature should have existed in the middle of London, and in the middle of the nineteenth century, and that no history of his career should be on record." Last-

* Carl Engel, "Musical Myths and Facts," i, 92, 93.

† "Old and New London," iii, 284.

ly, although whistling would seem to be as natural an act as that of laughing, yet we are told by Mr. Shortland that it was formerly unknown among the New-Zealanders.* When, too, on one occasion a native of Burmah observed an American missionary whistling, he exclaimed in astonishment, "Why! he makes music with his mouth!" a remark which the missionary noted down in his journal with this note: "It is remarkable that the Burmese are entirely ignorant of whistling." †—*Gentleman's Magazine.*

SKETCH OF PROFESSOR BENJAMIN SILLIMAN, LL. D.

THE name of Professor Benjamin Silliman is intimately connected with the progress of science in the United States during the former half of this century, and is identified with the beginning of the study of American geology.

BENJAMIN SILLIMAN was born in North Stratford (now Trumbull), Connecticut, on the 8th of August, 1779. His oldest American ancestor on the father's side was believed to have been an emigrant from Holland, but there are reasons for presuming that he belonged to an Italian Protestant family that took refuge in Switzerland, and one of whose members afterward came to America, possibly sojourning for a short time in Holland. His grandfather was a graduate from Yale College, a Judge of the Superior Court of the colony, a member of the Governor's Council, and influential in public affairs. His father served with credit during the Revolutionary War as a brigadier-general, and enjoyed the confidence of Washington. On his mother's side he was descended from John Alden and Priscilla Muggins, of the Mayflower. After attending for a time the public school of his neighborhood, he prepared for college under the tuition of his pastor, the Rev. Andrew Eliot, and entered Yale College in 1792, the youngest but one in his class. He spent the year after his graduation at home, caring for his mother's farm; the next year he took charge of a select school in Wethersfield, Connecticut, and entered the law-office of the Hon. Simeon Baldwin, in New Haven, whence, after completing his three years' course in law, he was admitted to the bar in 1802. While still a law-student—in September, 1799—and when he had just reached the age of twenty, he was appointed a tutor in Yale College.

Up to this time classical instruction had received the predominant share of attention at Yale College, "theological, ethical, and metaphysical subjects were much cultivated, and logic was also a prominent topic"; mathematics was appreciated; much interest had been aroused

* "Traditions of the New-Zealanders," p. 134.

† Howard Malcolm, "Travels in Southeastern Asia," 1839, i, 205.

in astronomy; physics was less cared for, and chemistry had been "scarcely mentioned." Mr. Silliman was considering a proposition to settle down at the practice of the law in Georgia, when in July, 1801, President Dwight informed him that the corporation of the college had several years before resolved to establish a professorship of chemistry and natural history as soon as the funds would admit of it. The time had come when the resolution could be carried into effect, but it was impossible to find in this country a man properly qualified to discharge the duties of the office, while there were reasons that made the appointment of a foreigner inexpedient. The president saw no way but to select a suitable young man at home, and give him time to qualify himself for the professorship; and he had fixed upon Mr. Silliman as the person whom he would propose to the corporation. Mr. Silliman was inclined from the first to consider the offer favorably, because, as he has recorded in his "Reminiscences," "the study of Nature appeared very attractive. In her works there is no falsehood, although there are mysteries to unveil, which is a very interesting achievement. Everything in Nature is straightforward and consistent. There are no polluting influences; all the associations with these pursuits are elevated and virtuous, and point toward the infinite Creator." The professorship was instituted in 1802, with a provision that such time as might be agreed upon should be given the professor-elect to decide whether he would accept the appointment, and Mr. Silliman was chosen professor. Philadelphia then "presented more advantages in science than any other place in the country," and he went there first. Here he enjoyed the instruction, with experiments, of Dr. James Woodhouse, of the Medical College, and had as a fellow-boarder Robert Hare, who had just perfected his oxyhydrogen blow-pipe, and was much occupied with the subject, and enlisted his new friend in his service. He also attended the lectures of Dr. Barton on botany and of Dr. Caspar Wistar on anatomy and surgery, and met Dr. Priestley at the house of the latter. He received valuable suggestions from Dr. Maclean, of Princeton, whom he visited in his transits to and from Philadelphia; and thus he learned to regard the eminent professor as his earliest master in chemistry, and Princeton as his first starting-point in that pursuit, although he had not an opportunity to attend any lectures there. Having attended two winters in Philadelphia, he returned to New Haven and began to write his lectures. His first lecture was delivered April 4, 1804, when he was twenty-four and a half years old, to a class which included, among other men who afterward became distinguished, John C. Calhoun, Bishop Gadsden, and John Pierpont; the subject was the history and progress, nature and objects, of chemistry. Four lectures were given in a week—sixty in the course—and some notices of mineralogy were included.

In the mean time, the corporation of the college had voted to spend ten thousand dollars in Europe during the ensuing year, in the purchase of books and philosophical and chemical apparatus. Professor Silliman applied for the privilege of going as purchasing agent, suggesting that his salary, which would be continued, and the agent's commission would pay his expenses, and he would, at the same time, have an opportunity of improving in his profession. His proposition was accepted; armed with a multitude of letters of introduction, the general effect of which he found to be equivalent to an order—"Sir: Please to give the bearer a dinner, and charge the same to yours," etc.—he spent a year in Europe. He performed experiments with Frederick Accum, the German chemist, and attended the lectures of Dr. George Pearson on chemistry, materia medica, and therapeutics, in London; heard Drs. Hope, Gregory, and Murray, in chemistry and geology; subscribed to Dr. Munroe's and attended Dr. Barclay's courses in anatomy, at Edinburgh; visited the Continent, and made the acquaintance of the most eminent scientific men of the day. Geological science at that time, he says, in his "Reminiscences," "did not exist among us, except in the minds of a very few individuals, and instruction was not attainable in any public institutions." In Edinburgh there were learned and eloquent geologists and lecturers, and ardent and successful explorers, and the contest between the Wernerians and the Huttonians was at its height. Professor Silliman was interested in the discussions, and, giving his attention to the subject, reached a standard of attainment in geology which he believed he could not have gained at home. He read the arguments on both sides, and came to the conclusion on which geologists are generally now tacitly agreed, that "both theories were founded in truth, and that the crust of the earth had been formed and greatly modified by the combined, or sometimes antagonistic and conflicting, powers of fire and water."

Professor Silliman had already attended to the care of the modest collections of minerals belonging to the college. There were a few metallic ores which had been named by Dr. Adam Seybert, of Philadelphia; a small collection which Dr. Semper had brought from England, containing some beautiful specimens, particularly in the lime family; and his own collections made in the mines of Derbyshire and Cornwall, in England, and local specimens obtained in his rambles among the trap-rocks of the Scottish capital, with a purchased suite of Italian polished marbles, all of which "when arranged, labeled, and described in illustration of the mineral portion of the chemical lectures, served to awaken an interest in the subject of mineralogy, and to produce both aspirations and hopes looking toward a collection which should by-and-by deserve the name of a cabinet." One of the first things to be done after returning home was to study the geology of the vicinity of New Haven, in the light of the knowledge that had been gained in Edinburgh. The result of this survey was a report, printed in the first volume of the "Transactions" of the Connecticut Academy of Arts and Sciences, in which an attentive reperusal by the author fifty-two years afterward suggested very few alterations and disclosed no important errors. The cabinet of Mr. Benjamin D. Perkins was shortly afterward purchased for a thousand dollars, and in 1810 the splendid cabinet of Colonel George Gibbs was deposited in the college. The latter cabinet, which attracted visitors from all parts of the country, was bought fifteen years afterward. While Professor Silliman was engaged in arranging it, the Rev. Dr. Ely accosted him: "Why, dominie, is there not danger that with these physical attractions you will overtop the Latin and the Greek?" Professor Silliman replied: "Sir, let the literary gentlemen push and sustain their departments. It is my duty to give full effect to the sciences committed to my care."

An "American Journal of Mineralogy" had been started by Dr. Archibald Bruce, of New York, in 1810, but had been suspended after the publication of four numbers. Professor Silliman, at the suggestion of Colonel Gibbs, and with the approbation of Dr. Bruce, started, in 1818, a journal intended to include the entire circle of the physical sciences and their applications. This was "Silliman's" (now the "American") "Journal of Science," which is still continued under the direction of the son and son-in-law of its founder.

The courses of popular lectures on scientific subjects which were conducted by Professor Silliman in the different cities of the United States, originated in 1808, when a course in chemistry for ladies and gentlemen was proposed to him, and gladly assented to, as a scheme in the interest of scientific progress. A class of about forty-five persons was formed, and listened to the instruction given them apparently with complete satisfaction, for it appeared afterward, the lecturer remarks, in speaking of the matter, that the course "turned on female hinges," and "sentiment lubricated the joints. . . . It was my province to explain the affinities of matter, and I had not advanced far in my pleasing duties before I discovered that moral affinities, also moving without my intervention, were playing an important part." One of the affinities involved the professor, and his marriage to Miss Harriet Trumbull, daughter of the second Governor Trumbull, and one of his hearers, followed in the course of the next year. Many years afterward he was invited to deliver a course in Hartford—the first out of New Haven; then followed courses in Lowell, Boston (where "the Orthodox and Unitarian influence was united in his favor," and where he returned to lecture in several successive years afterward), other New England towns, and New York. In 1843 he lectured in Pittsburg, where he received most "vivid demonstrations of kind and gratified feelings"; the next year in Baltimore, where he found that "people who came for once, staid"; and afterward in Baltimore again, Mobile, New Orleans, Natchez, at Washington before the Smithsonian Institution, and in St. Louis. The calls to lecture continued actively through twenty-three years, from 1834 to 1857. In summing up the results of these courses, Professor Silliman expressed a feeling of satisfactory assurance that he had popularized science; that at no period of his life had his efforts been more useful, both to his country and his family; and that there was no part of his professional career which he reflected upon with more satisfaction.

He was accustomed to explain the success of his lectures, and the uninterrupted interest they attracted, by stating that he always prepared them "with all possible care, and arranged every experiment and illustration so as to insure success. Then I could stand before the largest audience without anxiety or embarrassment; could, without manuscript, clearly state and explain my subject, and, when the proof became necessary, I could perform the experiments successfully and even beautifully, and exhibit the specimens which some other truth demanded, to insure conviction."

In 1830 Professor Silliman made a visit of exploration to the valley of Wyoming and its coal formations, where he examined some hundred mines and localities of coal, extending through forty miles in length; in 1832–'33 he was engaged, under a commission from the General Government, in a scientific examination on the subject of the culture and manufacture of sugar; and in 1836 he made a tour of investigation among the gold-mines of Virginia.

In 1840 an association of geologists was formed in Philadelphia for the purpose of promoting the progress of their science and its applications in this country, and Professor Silliman was chosen its first president. This society was in time succeeded by the "American Association of Geologists and Naturalists," and the latter eventually became the "American Association for the Advancement of Science."

In 1849 Professor Silliman, having reached the age of seventy years, tendered a resignation of his professorship, to take effect at the end of the ensuing academic year. The corporation, only half accepting his resignation, requested him to continue his lectures in the department of mineralogy and geology, should his life and health be spared. Later, at the request of the corporation, he reconsidered his resignation, and continued in the full occupation of his professorship till 1853, when, "wishing to go out before he should be compelled by infirmity, and to march out of the camp with colors flying," he retired finally. "Thus," he remarks in his journal, after referring to the public notices that were taken of his retirement during commencement-week, "I have finished my regular connection with Yale College, after having been almost fifty-four years an officer of the institution—three years a tutor, fifty-one a professor, and almost fifty a lecturer. . . . I seem to have attended my own academic funeral, and many to be the mourners on the occasion." The corporation requested him to continue as a professor emeritus, with the right to vote in the academical and medical faculties. His professorship was divided, and he had the satisfaction of seeing his son placed in the chair of Chemistry, and his son-in-law, Professor Dana, in that of Geology and Mineralogy. The name of Silliman was given to both chairs.

Professor Silliman was still to continue a prominent figure before the public, kept so by other events than those connected with science and the affairs of the college. A few months after his resignation the Kansas-Nebraska controversy rose to its height, and the Republican party was born amid the convulsions it excited. Professor Silliman had always abhorred slavery, and he saw in these disputes great moral issues, and the question of the equal rights of citizens of all the States to settle in the Territories and defend themselves there. His active interest in these matters, and the works by which he showed it, called out bitter partisan reprobation, and this in turn invoked eloquent and deserved eulogies of his pure character and his attainments in science from Senators Foster and Dixon in the United States Senate.

Professor Silliman kept even pace with the progress of science and scientific ideas as they were developed through all his career, and let his religious faith shine at the same time with a light of even brilliancy. The possibility that there was a conflict or could be a conflict does not seem even to have occurred to him. From his earliest college-days, piety and a firm devotion in religious faith seem to have formed a prominent side of his character; yet he never hesitated to accept the most startling discovery, when it proved deserving acceptance. "Now, at eighty-two and a half years of age," he says, March 1, 1862, "I can truly declare that, in the study and exhibition of science to my pupils and my fellow-men, I have never forgotten to give all the honor and glory to the infinite Creator, happy if I might be the honored interpreter of a portion of his works, and of the beautiful structure and beneficent laws discovered therein by the labors of many illustrious predecessors. For this I claim no merit. It is the result to which right reason and sound philosophy, as well as religion, would naturally lead. While I have never concealed my convictions on these subjects, nor hesitated to declare them on all proper occasions, I have also declared my belief that while natural religion stands as the basis of revelation, consisting as it does of the facts and laws which form the domain of science, science has never revealed a system of mercy commensurate with the moral wants of man. In Nature, in God's creation, we discover only laws—laws of undeviating strictness, and sure penalties annexed for their violation. There is associated with natural laws no system of mercy; that dispensation is not revealed in Nature, and is contained in the Scriptures alone. With the double view just presented, I feel that Science and Religion may walk hand in hand." "For his own part," says Professor Fisher, from whose rich biography we have drawn freely in the composition of this sketch, "he felt that the Bible was a revelation from God. . . . Not being in the habit of resorting to the Scriptures for information in physical science, he had valued its early pages for the pure and sublime theism which they inculcated. . . . Nor did he deem it necessary to suppose that the author of Genesis, however instructed by a higher light, was himself cognizant of the truths of geology, especially the truth of the great antiquity of the globe, and the length of time consumed in the geological changes." The idea of the length of geological time, as presented in his lectures, was novel to the majority of his auditors, and evidently shocked the prejudices of many of them, but he maintained it with vigor, and generally left a good impression regarding it in the end. Concerning the opponents of these ideas among the clergy, he wrote to Dr. Hitchcock in 1837: "I believe, with you, if they were masters of our subject, they would think as we do. Some of them are candid and forbearing; others find no insuperable difficulties; others are silent because they feel that they do not understand the matter; but a few are loud, confident, and uncharitable, while it is obvious they know not whereof they affirm, . . . but I see a strong purpose on the part of some to hold no terms with geology, and to insist upon the literal and limited understanding of the history; but they will find themselves deserted, for the matter will in time come right." Of a particular attack on the geological theory he wrote to Professor Hitchcock: "You and I *know* that any attempt to impair geological evidence, or to reconcile it with the popular view of time, must be abortive. No matter how violent or bitter our assailant may be, doubtless he will be more so in proportion to his ignorance of geology and to the strength of his prejudices."

Mrs. Silliman died in January, 1850, and Professor Silliman was married a second time, in the following year, to Mrs: Sarah I. Webb, of Woodstock, Connecticut. His death was apparently induced by a neuralgic attack which he incurred from attending a meeting on behalf of the Sanitary Commission, on the 13th of November, 1864. He was confined to the house for several days, but seemed afterward to recover, and made several calls in the neighborhood; but on the 24th—Thanksgiving-day—he died, instantly and without a struggle, just as he had remarked that he might perhaps go out to church. The disease from which he died was supposed to be an affection of the heart.

Professor Silliman, says his biographer, Professor Fisher, would have been the last to claim that he had that rare insight of genius which divines the secrets of Nature. His whole turn was more practical than speculative. "His perceptions were quick, his judgment sound, and all his mental operations were marked by good sense." His qualities "well fitted him for his peculiar work, and that was to collect and diffuse scientific truth. . . . Nor is he without merit as an investigator, although his distinction does not lie here. He was never very careful to claim for himself the credit of scientific discovery. At the same time, he took delight in bringing honor to the discoveries of others." He prepared an edition of Henry's "Chemistry," which appeared in 1808, with the modest announcement, "To which are added notes by a professor in this country." While this work was going through the press, a remarkable meteor passed over New England (December, 1807), and exploded over Weston, Connecticut, where several stones fell to the ground. He visited the scene, and, besides publishing a popular account of the facts in the "Connecticut Herald," made them the subject of a scientific examination and report before the Philosophical Society of Philadelphia, which was afterward republished in the "Memoirs" of the Connecticut Academy of Arts and Sciences, and read aloud in the Philosophical Society of London, and in the Academy of Sciences in Paris. His two visits to Europe (the second one was in 1851) were followed by books of travels, both of which were received with great satisfaction, while the earlier one (1810) was highly commended, abroad as well as at home, as one of the best works of its class. He was the first to obtain potassium in this country, and the first to notice and record the effect of a powerful battery in volatilizing carbon and transferring it from the positive to the negative pole in a state of vapor. An account of his experiments with the oxyhydrogen blow-pipe was published in the "Memoirs" of the Connecticut Academy of Arts and Sciences in 1813. He published an account of a journey between Hartford and Quebec in 1820, an edition of Bakewell's "Geology" in 1829, and a text-book on chemistry, in two volumes, in 1830. It was largely through his influence that the Scientific School, started by the younger Professor Silliman in 1842, which was afterward endowed by the gentleman whose name it bears as the Sheffield Scientific School, was adopted by the college as one of its departments, in 1846 and 1847. Professor Silliman was for many years in regular correspondence with the most eminent scientific men of Europe, among whom may be named Berzelius, Robert Bakewell, Humboldt, Carl Ritter, Lyell, Sir R. I. Murchison, Richard Owen, Daubeny, Herschel, and Dr. Mantell. Some of these he never knew personally, but was brought into communication with them through a common interest in science.

CORRESPONDENCE.

WRITTEN AND UNWRITTEN CONSTITUTIONS.

Messrs. Editors:

A PERUSAL of your article in the March number of "The Popular Science Monthly," entitled "Law against Right," left an unpleasant impression on my mind, occasioned by the depreciatory criticisms upon lawyers with which it abounds. I am the more surprised at this, as, during many years' attentive reading of the "Science Monthly" I have had occasion to note the fairness and general freedom from invective which pervade your method of dealing with all questions discussed. It is not my purpose to express any opinion upon the merits or demerits of the law of copyright as it exists either in this country or in England, the subject which seems to have inspired your article. I only desire to say a word in behalf of lawyers as a professional class, and to express the opinion (and I say it after an active practice of nearly forty years in several different States, and some travel and observation abroad) that the lawyers in this country, under written constitutions, are no more given to "quibbles, devices, and sharp interpretations of law," than those of other countries.

While lawyers are responsible for the manner of presenting their clients' cases in court, judges for a proper interpretation of the laws, and jurors for such an application of the law to the facts of the case as will result in a rightful verdict, neither are directly responsible for the condition of the law itself, but must take it and apply it as they find it. Right here comes in the difficulty as to written as compared with unwritten constitutions of which you complain. It is no doubt true that in this country judges are bound by the fundamental written law, but they are not bound to sacrifice its main underlying purpose upon a given subject to the mere letter. The principle is as firmly rooted in our jurisprudence as in that of any country, that the mere technical letter of the text must give way to the clear purpose of the ordinance or law as gathered from a reasonable interpretation of the whole of the law bearing upon the particular subject; but where the meaning is clearly apparent it must prevail: if it is right, there is no ground for complaint; if wrong, the people here constitute the only tribunal to correct the error, and they alone should be held responsible for any resulting injustice, and not the lawyers or judges who are bound by their oaths to apply the law as they find it. The great body of the law is, of course, both here and in England, statutory; as to this the distinction as to written and unwritten law does not exist, and I hazard the opinion that as to this the administration of justice in England is not more elastic or less technical than here.

The main drift of your article tends to the point that unwritten constitutions provide a more ready means of attaining the ends of justice than written constitutions. The latter may afford some temporary advantages, but upon the whole I think the view you present is erroneous.

The science of law has had its conflicts with ignorance, prejudice, and false ethics, like most other departments of human thought, and I think it has made some progress, and quite as much progress in America as in Europe. The substitution of written for unwritten constitutions may be attended with some temporary evils and delays of justice, but upon the whole it can not be denied that they furnish more effectual barriers against the encroachments of arbitrary power upon the liberties of the people than mere traditional precedents which may be swept away under the spur of popular clamor, or set aside under the pressure of a ministerial or administrative crisis. The fundamental law should be in such condition that it will resist the pressure when the greatest strain comes upon it, for it is then that it is especially wanted. When the ship of state is sailing under clear skies and over smooth seas it matters little whether there is any constitution, written or unwritten; but when the stress does come, and either people or ruler *wants* to break down the barriers which the lessons of history and human experience have set up in the form of a constitution, it is then of supreme importance that the restraining power of the fundamental law should be an iron hand and not an elastic gutta-percha string, to be stretched at pleasure. Now, which is most likely to effect this purpose, the written letter, from the meaning of which there is no escape, or those traditional precedents which go under the name of unwritten constitutions, and which the ingenuity of man can readily torture into a construction favorable to the purpose of temporary usurpation?

The tendency of the times is to favor not only written constitutions but the codification of law, remedial and otherwise. The great body of the common law, as we all know, is not the work of Legislatures but the creation of judges, which has long obtained in this country, and upon the superstructure of which judges have gone on building, creating a vast fabric of case-law, so voluminous and unwieldy that no mortal man, no matter how great his ability or attainments, can within the limits of human life fully master it. To remedy this, the evolution of the science of law has developed a method of collecting together, from the vast libraries of reported ca es and judge-made laws, the settled principles therein contained, and of reducing them to a carefully arranged and harmonious system known as codes. This codification, when enacted by the Legislature, becomes the written law of the land, and takes the place of the uncertain elastic line of precedents founded on cases, and which, resting in the "bosom of judges," might be colored by their prejudices or warped by their interests or passions. If these views are correct, instead of unwritten law, either fundamental or statutory, furnishing the best means of promoting the ends of justice, the reverse is true, and the science of jurisprudence must advance along the paths of written laws, inflexible in their terms, and from which there is no escape other than through prescribed and appropriate methods of amendment.

CHARLES R. STREET.

HUNTINGTON, SUFFOLK COUNTY, N. Y., *March* 26, 1883.

RECLAMATION.

Messrs. Editors:

IN the April number of "The Popular Science Monthly," page 795, Mr. H. H. Bates cites Maxwell's article, in the "Philosophical Magazine" for 1877, page 453. More than five years before the publication of Maxwell's note, I had shown ("Proc. Am. Phil. Soc.," xii, 394) that the ratio of the vivial of wave-propagation to the vivial of its oscillating particles is 5 : 9, and that the ratio is determined by the secondary center of oscillation between the ethereal center of gravity and the ethereal center of linear oscillation. Maxwell gave no reason for his deduction, and his executors have been unable to find any among his papers.

PLINY EARLE CHASE.

HAVERFORD COLLEGE, PA., *April* 7, 1883.

EDITOR'S TABLE.

SCIENCE, LITERATURE, AND THEOLOGY.

THE discussion of the relations of these great elements of thought proceeds vigorously. "Line upon line and precept upon precept" accumulate; while the last instructive line respecting science and literature comes from the London "Times," and the last weighty precept concerning science and theology from the President of Harvard University.

In connection with the meeting of the civil engineers, held recently in London, the "Times" of that city makes the following significant declarations, which it is desirable to place upon permanent record, both as the deliberate utterance of an influential organ of public opinion and because of the incontestable truth of the statement itself. The "Times" says:

"Meetings such as that of Saturday evening remind us not merely of the services of a particular branch of science to mankind, but of the remarkable determination of human activity to scientific pursuits which is characteristic of the present age. Literature no longer holds the place it once did in the minds of men; nor does it command, as it once did, the services of the most powerful intelligences. The protest against an education wholly or chiefly consisting of the study of the classics is the result of a profound change in the conditions of life. Men have not deliberately and as a result of abstract reasoning discarded one set of studies in favor of another. On the contrary, they have discovered, often to their great chagrin, that a complete intellectual displacement has taken place. That which was taken up under protest, as a thing too closely connected with utilitarian pursuits to be quite worthy of a man of intellect, has now pressed into its service the chief intellectual power of the country. The tide of intellectual effort sets strongly in the direction of science, just as at an earlier period it set in the direction of letters. The teachers and leaders of the day, the real dominant forces of the age, are the men of science, the investigators of natural phenomena, not the thinkers, philosophers, or metaphysicians who formerly gave their name to sects, and made all the world their partisans. Nothing is more remarkable than the profound respect of the scientific conception associated with the name of Darwin, not on science only, but on literature, art, morals, and, in short, upon life. Some will tell us that all this is a lamentable result of the materialism of the age; but we naturally ask how it happens that some centuries of a non-scientific or literary culture left us a prey to the materialism it is supposed to antidote? It is untrue, moreover, that material interest has been the great impelling force. The great discoveries of science have usually been made by men seeking no material reward, and, as a matter of fact, receiving very little. Science pursues her own way for the most part, and her discoveries are afterward utilized by men eagerly seeking for the means of material enrichment. Even when it is a question of so practical a thing as a new dye, it will be found that the chemist, searching into the properties and combinations of matter, comes upon the secret unawares, while the manufacturer and the dyer reap the profits. It is, indeed, only upon these terms that Nature yields up her secrets."

Quite in the spirit of the foregoing, though in a different and more special direction, is the article of President Eliot, of Harvard, in the "Princeton Review" for May, "On the Education of Ministers." President Eliot declares that the education of the clerical profession has fallen so far behind the age as to be out of relation with it, and to have consequently lost its ancient commanding influence, and even resulted in the degeneration of the clerical character. In the early part of his able article he shows the eminent position formerly occupied by the clergy as intellectual leaders. They were founders of colleges, and the largest professional class among the students. While a hundred years ago in Harvard, Yale, and Princeton the clerical graduates were respectively 29, 32, and 45 per cent, they have now fallen so far behind that "in the six years from 1871 to 1876 the percentage of ministers among the graduates of the same institutions was, in Harvard, 5¾; in Yale, 7; in Princeton, 17." President Eliot then glances at the great changes that have gone forward in society during the last hundred years, profoundly affecting the beliefs of men on many important questions, and bringing new and extensive knowledge to bear upon practical and every-day problems in relation to social affairs. Coincident with these movements, the temper of the public mind has undergone a wonderful change within a century upon several points which vitally affect the clerical profession. In the first place, the weight of all authority has greatly diminished, and the sources of recognized authority are quite different from what they were a century ago. The priest, like the secular ruler, has lost all that magical or necromantic quality which formerly inspired the multitude with awe; and the divine right of the minister is as dead among Protestants in our country as the divine right of kings. . . . Again, the people in these days question all things and all men, and accept nothing without examination. They have observed that discussion often elicits truth, that controversy is useful on many difficult subjects, and that in some circumstances many heads are better than one; hence they have learned to distrust all *ex cathedra* teaching, and to wait for the consent of many minds before giving their adhesion to new doctrines. We hardly realize how very recently the masses have acquired these invaluable habits, or how profoundly these habits have affected the position of the minister."

But it is in the recent progress of science that President Eliot finds the influence by which the position of the clerical profession is most profoundly affected in these times. On this subject he says: "We come now, in the fourth place under this head, to the most potent cause of change in the relative position of the ministry within this century, namely, the rise and development of physical and natural science. The immense acquisitions of actual knowledge which have been amassed in this new field, the great increase of man's power over nature, the consequent changes in each man's relations to his fellow-men and to the physical earth, including the wonderful expansion of his interests and sympathies, his emancipation from superstitions, and the exaltation of his prospects and hopes, are all facts of the utmost moment to the race; but it is not these facts, tremendous though they are, which most concern us in the present discussion. The important point for us now to observe is that, during the growth of natural science, a new method or spirit of inquiry has been gradually developed, which is characterized by an absolute freedom on the part of the inquirer from the influence of prepossessions or desires as to results. This spirit seeks only the fact, without the slightest regard to consequences; any twisting or obscuring of the fact to accommodate it to a preconceived theory, hope, or wish, any tampering with the actual result of investigation, is the unpardonable sin. It is a spirit at once humble and dauntless, patient of details, drawing indeed no distinction between great and small, but only between true and false; passionless, but energetic, venturing into pathless wastes to bring back a fact, caring only for truth, candid as a still lake, expectant, unfettered, and tireless.

"The achievements of scientific inquirers, animated by this spirit of sincerity and truth, have been so extraordinary within the past sixty years, and this candid spirit is in itself so admirable, that the educated world has accepted it as the only true inspiration of research in all departments of learning. No other method of inquiry now commands respect. Even the ignorant have learned to despise the process of searching for proofs of a foregone conclusion. Apologetics have ceased to convince anybody, if they ever did. Thus the civilized world has set up a new standard of intellectual sincerity, and Protestant theologians and ministers must rise to that standard if they would continue to command the respect of mankind. How different was the situation of the profession when diplomacy was the only other learned calling! Even the legal profession, as it was gradually differentiated from the clerical, made no such sharp requisition of mental honesty and independence. It is the electric light of science which has made white and transparent the whole temple of learning. These remarks imply that ministers, as a class, and as a necessary consequence of the ordinary manner of their education and induction into office, are peculiarly liable to be deficient in intellectual candor; and that is what I, in common with millions of thoughtful men, really think; and I think further that this belief on the part of multitudes of educated men, most of whom are silent on the subject, is a potent cause of the decline of the ministry during the past forty years. The fault is quite as much that of the churches or sects as of the individual ministers; for almost every church or sect endeavors to tie its members, and particularly its ministers, to a creed, a set of articles or a body of formulas. These bonds are put on by most ministers at an early age, and must be worn all their lives, on peril of severing beloved associations, or, perhaps, losing a livelihood. The study, reading, and experience of fifty years are supposed to work no essential change in the opinions of the youth. The creed or the articles may be somewhat vague and elastic, but can not honestly be stretched much. Now, the lay world believes in the progress of knowledge, because it has witnessed progress; and it is persuaded that there must be incessant progress in theological science as well as in all other branches of learning. It does not see metaphysicians, physicians, historians, chemists, zoölogists, or geologists, committing themselves in youth to a set of opinions which is to last them a lifetime, or even a day; on the contrary, they see all these classes of scholars avowedly holding their present opinions subject to change upon the discovery of new facts, or of better light upon old facts, and, as a rule, actually modifying their opinions in important respects between youth and age. Indeed, fixity of opinion is hardly respectable among scholars. If it be said that there can be no progress in theology, because revelation was a fixed historical quantity, the answer is, that revelation, like creation, must be fluent; or, in other words, that the interpretation of revelation to the mind of man must be like the interpretation of creation, ever flowing, shifting, and, if the mind of man improves, improving. No other profession is under such terrible stress of temptation to intellectual dishonesty as the clerical profession is, and at the same time the public standard of intellectual candor has been set higher than ever before. This is the state of things which deters many young men of ability and independence from entering the profession, and causes the acknowledged dearth of able ministers."

HEBER NEWTON AND THE HERESY-HUNTERS.

These observations of President Eliot find an apt illustration in the case of the Rev. Heber Newton, which is now attracting a good deal of public attention. Intelligence and liberality have undoubtedly made great headway, and put the theological profession out of joint with the enlightenment of the times; but there is a pious-ignorant class of great influence that is not to be overlooked. Is it indeed so certain whether intelligence or stupidity is in the saddle in the popular theological arena? Certain foolish fanatics have combined to hunt the Rev. Heber Newton out of the Episcopal Church, on the old charge of heresy. And what is the pretext of this action? Why, the reverend gentleman appears to have been doing a little thinking on his own account—the mortal sin of theology! They say he made a solemn bargain, a vow, that he would do no independent thinking, have no opinions of his own, but simply re-echo the authorized creed, and that, having now begun to inquire, he is no longer fit to remain in the Christian Church.

Mr. Newton has ventured to think and to speak about the use and abuse of the Christian Scriptures—a proper subject, one would suppose, for a clerical teacher. He has opinions, sincere opinions, which he deems important, about the inspiration of the Bible, and how that phrase is to be understood. Now, it is incontestable that there has grown up an interesting and important accumulation of knowledge about the Bible in recent years, and knowledge determines opinion, in spite of all the theology in the world. And so it comes about that Mr. Newton, having convictions upon the inspiration of the Bible, must suppress them, and thus go along in comfortable hypocrisy, or express them, and be turned out of the Church. This was the dark age policy, with certain grim accompaniments; but is the stupid bigotry of by-gone ages still in the Episcopal saddle? We shall see.

Meantime, we venture to suggest that the heresy-hunters widen a little the scope of their operations; for, if they are going to make thorough work in purging the Church from all advanced opinion, and turn out everybody who blinks at the literalness of the verbal creed, they will have plenty of business, and can find a good many more cases quite as bad as that of Mr. Newton. We are told that the case is simply one of breach of contract. Enterprising editors, to whom an ecclesiastical trial would be as much of a godsend as the Saratoga horse-races, are especially solicitous about Heber Newton's contract to preach certain things which he is bound and sworn to preach while he remains in the Church.

Now, suppose these heresy-hunters institute an inquiry as to the extent of clerical dereliction in maintaining acknowledged Christian foundations. There can not be the slightest doubt as to the fundamental importance of a belief in hell, in our system of orthodox theology. It is the basal, and topmost, and all-impelling idea. The conception of hell is the corner-stone of the orthodox edifice, the key-stone of the orthodox arch; and, what the fires under the boiler are to the steam-engine, that are the fires of hell to the orthodox "scheme of salvation." The idea pervades the Christian theology and hymnology, and has been preached, sung, and prayed now for some eighteen hundred years, the proclaimed object of the whole theological system being to save men from hell! Such being the theological import and historic prominence of the doctrine, which is explicitly conserved in the creeds, and solemnly avowed by all orthodox clergymen, would it not be well to look a little into the growth of modern heresy regarding it in the very bosom of the Church? How is it about the enforcement of the hell-fire contracts? It would be interesting to know how many times the fundamental hell-doctrine is referred to in the course of ordinary pulpit ministration, and how it is slurred over and put aside and ignored as if the preachers were ashamed to allude to it. We think an inquest of this sort would reveal the fact that there is a good deal more reservation, and private interpretation, and playing fast and loose with creed and Scripture, than our heresy-hunters are aware of; and, if they pushed their inquisitorial work very far in this direction, they would be pretty sure to vacate half the pulpits in the land.

THE BANQUET TO DR. HOLMES.

All who had the good fortune to be present at the complimentary dinner to Dr. Oliver Wendell Holmes, given by the Medical Faculty of New York at Delmonico's, April 12th, will long remember it as a rare occasion. It was a most appropriate tribute of honor to the distinguished guest, and the taste and elegance displayed in the banquet and the excellence of the judiciously chosen speakers did abundant credit to the managers of the affair. But their task was not difficult, for hardly ever before were such favorable elements combined to give success to such an occasion. In the first place, if the committee had gone around the world with lanterns, over all the lines of latitude and longitude, they could not have found another so eligible a man to exploit in the festive and honorary way as Dr. Holmes. Known, admired, and loved wherever the English language is spoken, illustrious as a poet, humorist, novelist, essayist, conversationalist, and lecturer, and, finally, so specially distinguished as an anatomist and physician as to command the high regard of the medical profession in the metropolis of the country, nothing was wanting to give inevitable success to any complimentary expression of unaffected admiration and profound respect. Delmonico is, of course, a constant quantity, and can be counted on for the perfection of a feast, but the intellectual furnishings in this case were spontaneous, varied, and also of the highest quality. When prose was exhausted, poetry came to the rescue, eloquence flowed as freely as the wine, divinity refused to be outdone by medicine in praise of the guest, the press claimed him as a typical journalist always ready for sagacious comment upon memorable events, and literature and science pressed their rival claims for the inscription of the name of Holmes upon their banners. The doctor took it all with the most gracious good-nature, knowing as well as anybody that there was a great deal more truth than flattery in the cordial utterances of which he was the target, and he gave the supremest proof of imperturbable good-humor by submitting to the insatiate exactions of a crowd of autograph-hunters who cornered him for their diabolical purposes after twelve o'clock.

LITERARY NOTICES.

Dynamic Sociology, or Applied Social Science, as based upon Statical Sociology and the less Complex Sciences. By Lester F. Ward, A. M. In two volumes. New York: D. Appleton & Co. Pp. 726 and 698. Price, $5.

In the rush of publications from a teeming press there now and then comes a work of such grave and exceptional import as to demand a special and careful consideration, and among these are to be included the two comprehensive volumes now before us. Under the technical and somewhat unattractive title of "Dynamical Sociology," Mr. Ward has made an original and able contribution to the large and very important subject of social science. Although he is, of course, indebted to many sources for his materials, yet the handling of the topics is his own. His work is not a compilation or *résumé* of previous promulgations, but an elaboration of his own independent views; and he has constructed a system which, from its breadth, its scientific basis, and its elaborate method lays claim to the character of a philosophy.

It must be confessed that the presumptions in these times are strongly against the novel and ambitious reconstructions of thought, which so frequently challenge public attention, and, if the author were asked in this case for his credentials, he would probably say that they must be found in the book. Yet Mr. Ward is well known by his scientific, economical, and social contributions to the magazines, as well as by other publications of recognized merit, and if he has not before issued any considerable book, it is probably because he has been absorbed for the last ten years in the preparation of the extensive treatise now published.

Mr. Ward's title, as we have intimated, is unfortunate. Sociology is a forbidding word—snarled at by petty purists as illegitimate—and not yet settled and defined in familiar speech; while the kind of sociology designated as "dynamical" only deepens the obscurity, and makes it necessary, at the outset of any intelligible notice of the work, to explain what is meant to be indicated by these terms. This will, moreover, furnish the key to the method of the book.

The author assumes sociology to be a science already so well established as to take proper rank in the family of sciences. It deals with the laws of social phenomena, as botany deals with the vegetable kingdom, and zoölogy with the animal world. But science is of two kinds, pure and applied, the former consisting of an exposition of facts and principles, and the latter of their practical applications for purposes of utility. Pure sociology, therefore, confines itself to the classification of the facts and the elucidation of the principles of social phenomena. It deals with society by the natural history method, describing, analyzing, comparing, and generalizing the comprehensive data of the subject. Its aim is simply the establishment of a body of truth, without the formal consideration of its uses. This is sociology as generally and properly understood.

But Mr. Ward thinks that, when the practical applications of this science are to be considered, new terms are needed to mark an important distinction, and so he uses the word *statical* to characterize its common scientific form. But this established sociology, or "Statical Sociology," which consists of the classified facts and generalized principles of the science, he holds to be of a negative or passive kind, and he says that this has hitherto proved sterile or unproductive of benefit to the community. Like the other sciences, it needs application to make it useful and valuable. But this application involves active human agency, the control of social effects, and, as man's effort and directive power is here the main idea, he expresses this element of force by the term *dynamic*, and calls this branch of the subject "Dynamic Sociology." On this view, statical sociology deals with the great processes of nature, with genesis and natural evolution; while dynamic sociology treats of psychic human agency, and artificial results in the social sphere.

Mr. Ward maintains that the time has come when sociology must pass formally from the theoretic to the applied stage. While admitting the impracticability of most of the measures that have aimed at social amelioration, he nevertheless considers that we can no longer avoid the endeavor to derive certain fundamental principles of social action that shall bring the phenomena of society under the same intelligent control that science has long made possible in the division of physical phenomena, and guide the active interference of man in the direction of social affairs and to the accomplishment of social ends. This he assumes to be the art stage in the development of the subject in which purposed artificial agencies supplement and carry forward the natural processes of development for the attainment of the highest fruits of human progress.

Mr. Ward devotes his first volume mainly to "Statical Sociology." It opens with a long introductory chapter, presenting a general view of the entire scheme. This is followed by two historical chapters, reviewing the two great modern systems of Auguste Comte and Herbert Spencer, in a manner sufficiently full for his general purpose. Then follow four chapters dealing with the most fundamental principles of cosmical development, or evolution in the domain of purely natural phenomena. These are entitled respectively "Cosmogeny," "Biogeny," "Psychogeny," and "Anthropogeny," dealing with the genesis of worlds, of life, of mind, and of man, and naturally leading up to the higher department of "Sociogeny," or the genesis and development of human society. Following the current terminology, we have here to do with pure sociology only, or its treatment from the point of view of the laws of nature. As a comprehensive exposition of the doctrine of evolution, this volume has great merit.

Sociological study thus far, Mr. Ward maintains, has chiefly given attention to the genetic or unconscious progress of society. The causes that have produced this passive or unconscious social progress are subjected to a searching analysis, and are found in the *social forces*. These consist fundamentally in desires, but they are desires which inhere permanently in the nature of man as a living organism. They are divided into two great groups, the original, or essential, and the derivative, or non-essential, social forces. The essential forces are those desires which belong to man as an animal, and are necessary to the maintenance of the primary functions of nutrition and reproduction. The non-essential forces are those desires which have been developed in the course of evolution, and they are divided into the æsthetic, the emotional, or moral, and the intellectual social forces. The primary forces, which have led to social transformations, are, therefore, blind forces, which result to the performance of acts with no reference to their ultimate effects.

Mr. Ward's argument for dynamical sociology, to which his second volume is devoted, is not easily presented in a paragraph, but it is substantially as follows: The ultimate end of human action is well-being or *happiness*, but this can not be attained through direct effort; it requires means. There are five proximate ends standing in as many degrees of remoteness from the ultimate end, the attainment of any of which is equivalent to the attainment of all the less remote ones, and the ease in securing which is directly proportional to their remoteness. These proximate ends, therefore, constitute so many means to the attainment of the ultimate end of well-being.

The first of these proximate ends is human progress itself, which, in order to be true progress, must secure the ultimate end. But progress is not in any proper sense attainable by direct effort; it must itself be sought through means. The means of progress, which therefore become the second proximate end, must consist in the proper kind of *action*, but such action is only less difficult of direct attainment than is progress itself. Here, again, the necessary means must be adopted to secure the end.

The higher forms of action, such as seriously affect the condition of society, are chiefly the result of the ideas or opinions entertained. In a general sense, then, *opinion* may be regarded as the means to action, and hence as the third proximate end. But direct attempts to influence opinion are also practically futile; means must be employed here, as before.

Ideas and opinions rest upon the data in possession of the mind. Such data, to conduce to the several proximate ends, and through these to the ultimate end of well-being, or happiness, must be in harmony with reality. In other words, the data of opinion must consist in *knowledge*. Knowledge, therefore, is the fourth proximate end, the attainment of which will carry with it that of all the less remote ones, and also that of the ultimate end. Now, knowledge may be attained by the direct effort of the individual; but the mind is most receptive of it during the plastic period of youth, before an appreciation of its value can have been acquired sufficient to insure the effort to obtain it. To leave it to enforce itself, therefore, is virtually to fail of its attainment, so that this also is to be secured only through means.

The means to knowledge is instruction or *education*. This is defined as "the universal distribution of the most important extant knowledge." As an end, education can be easily secured by direct effort, even of society in its collective capacity. It differs from all the other ends in requiring no further means for its accomplishment than the mere mechanical appliances. Education, therefore, constitutes the most remote proximate end, and the *initial means* to the attainment of all the less remote ends, and also of the ultimate end of the general welfare. All these ends may, therefore, be wholly neglected and left to take care of themselves, and the entire energy of society may be concentrated upon this most remote end, or initial means, to the highest social progress.

The second volume of Mr. Ward's work opens with a chapter treating chiefly of man's relation to the universe, which he insists must be more clearly conceived before any further progress can be made in philosophy, and it ends with a statement of the definitions and theorems of dynamic sociology. The remaining six chapters are devoted to the detailed consideration of the six theorems, one being given to each of the great ends, in the order in which we have noticed them. The work, therefore, closes with a radical discussion of the claims of education as above defined, as the supreme essential condition to further and higher social progress.

No idea can be given in such a brief notice as this of the number of important subjects of great public interest at the present time that are traversed by Mr. Ward in these solid volumes. The work is more constructive than critical, but it deals throughout with live topics and urgent public problems. The author takes radical issue with his philosophic predecessors, and arrives at new results for which he claims the sanction of science and reason. As the reader will perhaps have inferred, the drift of his reasoning is toward a great extension of coercive agency and government control in the work of social progress. His work is, in fact, a vigorous and systematic assault upon the doctrine of *laissez faire*, and the policy of leaving things to spontaneous influences and the self-regulation of private enterprise. It is, perhaps, the strongest defense yet made of the enlargement of state functions for the direction of social affairs. The task was an ambitious one, but the manner of its execution proves that it was not presumptuous.

The merits of Mr. Ward's work are unquestionably such as to entitle it to the serious attention of students; but, aside from its intrinsic claims, its logic is so strongly in the direction of predominant American tendencies, that it is sure to be welcomed by many as a representative exposition of American policy and thought. It appeals strongly to different classes of thinkers. Boldly coping with the ripened systems of the Old World, it will commend itself to many who are ambitious about the development of philosophy on this side of the Atlantic. The work is, moreover, of an eminently practical sort, and deals with the relations of political and social science in their bearing upon the interests of the community in such a way as to entitle it to the consideration of statesmen and political economists. Besides, as it offers a new synthesis of facts, and aims to co-ordinate into a uniform scheme the accepted truths of all the sciences, it can not fail to awaken the interest of thinking scientific men in all departments. And, as the philosophy of religion is broadly and independently treated, the work is certain to have an interest for all schools of religio-philosophic speculation and inquiry. As Mr. Ward's work is thoroughly up to the times both in substance and spirit, the reader will of course be prepared for a good deal of freedom and boldness in discussion; but the author is no trifler, though, in the courageous expression of his convictions, he goes no further than is justified by the practice of this questioning age.

We may add that the work is written in a style that will commend it to popular readers. Mr. Ward makes himself perfectly understood, and without effort on the part of those who follow him. He is at times diffuse, and we think the work would have borne considerable condensation, but, believing that the views he desires to promulgate are important, the author seems to have been only solicitous for that fullness of statement that shall give completeness to his meaning in the reader's mind. The references to collateral discussion are numerous throughout the text, so as to facilitate the following out of any special argument, and the index to the work is careful and exhaustive. Mr. Ward has been arduously occupied upon his treatise for a long time, and may be congratulated upon the perfection of its form as a product of the book-making art.

It has been our purpose in this notice simply to give the best account we could in so brief a space of the general characteristics of the "Dynamic Sociology." Our readers hardly need to be reminded of our decisive dissent from the doctrines of the school of which Mr. Ward will now easily take the place of the ablest leader, but we have refrained from criticism, that our statement might be as far as possible fair and unbiased. There is, at any rate, a great deal in this work that is instructive, and to be cordially commended, and there are parts of it that we could wish to see more widely circulated than they can be in these formidable volumes. Though disagreeing with much that it contains, the book is nevertheless to be welcomed as a timely contribution to contemporaneous inquiry, and it will unquestionably aid in giving a fresh impulse and a fruitful direction to the discussion of large and momentous subjects.

INTERNATIONAL SCIENTIFIC SERIES. No. XLV.

Man before Metals. By N. Joly, Professor at the Science Faculty of Toulouse. With 148 Illustrations. New York: D. Appleton & Co. Pp. 365. Price, $1.75.

The subject of the early history of mankind, in the light of the modern doctrine of the antiquity of man, is not only of growing interest, but in its researches and its expositions it is enlisting much of the leading talent of the age. It is established that we have to go back of all written history for that primitive basis of history which is written only in the book of nature. Here science comes to the aid of the philosophical historian, and reveals those conditions of man and society which are indispensable to the understanding of the subsequent course of humanity. Among the latest and ablest contributions to this subject is that by the eminent French authority, Professor Joly, whose contribution to the International Series is now rendered into English in a very popular form under the title of "Man before Metals." His book is an excellent compend of our present knowledge on the antiquity and early history of man, and the author's French clearness of statement has been well preserved in the translation.

In the first part of the volume, devoted to "The Antiquity of the Human Race," Professor Joly describes the discoveries that have been made in the bone-caves, the kitchen-middens of Denmark, the Sardinian Nuraghi, and on the sites of the Swiss lake-dwellings. A short chapter is devoted to "Prehistoric Man in America," but the limits of the volume forbid any detailed account of discoveries outside of Western Europe. The author disparages certain attempts to estimate the number of years that man has lived on earth, and the duration of the stone, bronze, and iron ages, and maintains that all peoples have not passed through these three ages at the same time. Hence such divisions can have only a relative, not an absolute, chronological value. That human bones are found in strata where they could not have been buried in later time, and intermingled with bones of the cave-bear, the mammoth, the reindeer, and many other long-extinct species; that the bones of these beasts often bear wounds—sometimes partly healed—which were plainly made by the weapons found in the same localities; with other evidence still more remarkable—prove that man was present in Europe during the Quaternary age. Relics have been found that have convinced some archæologists of the presence of man during the Tertiary period, and this opinion our author shares, though he does not deem the assumption proved.

Part II, "Primitive Civilization," recounts what has been learned from the relics of primitive man as regards his domestic life, methods of industry, his progress in domesticating animals, in drawing and carving, his religious ideas, and customs of human sacrifice and cannibalism. The author concludes, from the data so far obtained, that primitive European man dwelt for a considerable period in caves. The flesh of the mammoth, the great cave-bear, the horse, the aurochs, and other animals, generally eaten raw, together with wild fruits and roots, formed his staple diet. The use of fire was known, and pottery had been invented. He clothed himself in skins, which he sewed by means of bone needles. Cannibalism was practiced to some extent, and the horrors of war were already known. But, in spite of his savage customs, "he was *man* in all senses of the word—anatomically, intellectually, and morally."

On the Desert, with a Brief Review of Recent Events in Egypt. By Henry M. Field, D. D. New York: Charles Scribner's Sons. Pp. 330. Price, $2.00.

We must confess to having read Dr. Field's book with great pleasure, and found it refreshing, entertaining, and instructive. We say "confess" in honest acknowledgment of an interest hardly expected in a new book on the wanderings of the old Jews. No doubt, we were prejudiced, as Hebrew matters had been somewhat overdone in our early education. Between the horrible droning sermons, mostly about the Israelites, which made the day of rest a weariness and a burden, and the Sunday-school exercises, which were worse because sleep was impossible, and the pious books about the patriarchs and prophets, which had to be read all during the week, we got an early surfeit of things Hebraic, and when there came at length the happy liberty of reading what we liked, the children of Israel got a wide berth, and we naturally failed to keep up with the progress of modern investigation into the profane aspects of Jewish history. But early associations are omnipotent, and we have accordingly gone through Dr. Field's book describing the present aspects of ancient sacred places with an unusual degree of satisfaction.

Dr. Field's volume, we observe, has been criticised for its want of novelty. It is said that he has gone over ground that has been traversed many times before, until its interest is exhausted, and that he has not been able to add anything new or important to what previous travelers had furnished. Very likely those who have kept up with Palestine explorations and antiquarian researches into the old haunts and relics of the Jewish people would find no important revelations in this volume. But it was not intended to enlighten those who have spent their lives in the study of Jewish history. The author offers his book merely as an introduction to the learned works of those who have devoted themselves to the investigation of the subject.

He says: "The Peninsula of Sinai has been a favorite ground of Biblical explorers. In their zeal to visit scenes made dear by connection with sacred history, they have sought to follow the track of the children of Israel from the time of their departure out of Egypt; to trace their marches on the desert; to fix the place of their encampments, not only around the base of Sinai, but even when wandering and almost lost in the great and terrible wilderness. The fruit of these researches is a library of exploration, which forms a most valuable addition to our Biblical literature, not only for the knowledge it gives of sacred geography, but of the whole religious, social, and political economy of the Hebrews. While these great works, the monuments of so much learning, occupy the attention of scholars, other readers may be interested in turning over a portfolio of sketches, which claims only to present a few pictures of the desert."

From this point of view we have found the work extremely interesting. It is written in an easy and familiar style, and abounds in pleasant descriptions and common-sense reflections relating to the scenery of the country, the associations of prominent places, and the character and habits of the people that came under the author's observation. The first two chapters, devoted to Egypt and its relations to England, give an excellent summary of what is known as the "Egyptian question," and form an instructive preliminary to the subsequent chapters on the wanderings of a people so intimately associated as were the old Hebrews with the ancient Egyptians.

It was the object of our traveler to go over the ground traversed by the Hebrew people after their flight from Egypt. He accordingly crossed the desert by camel navigation, following their track, and lingering to observe the various locations that have derived their interest from the sacred history. Starting from Suez, the first point of interest reached was the wells of Moses at a mile or two on, and from this station the party pursued the route to Mount Sinai, a distance of one hundred and fifty-three miles, at the rate of twenty to twenty-five miles a day, the usual "camel's journey." After spending some time among the interesting scenes of Mount Sinai, they started through the mountains and struck into the great wilderness in which the children of Israel wandered for thirty-seven years before reaching the land of promise. The narrative then proceeds with its detail of incidents of tent-life, camping, and marching, and the description of desert scenes and memorable localities until the terrible wilderness is crossed, and the travelers emerge into the crude civilization of Palestine in the neighborhood of Gaza. From this point they proceeded through the hill country to Bethlehem, "the place where Christ was born"—a town, at present, of some five thousand inhabitants—and the chapter devoted to it is perhaps the most interesting in the book.

Of course, Dr. Field, as a good, sound, orthodox man, will not suffer his reader to suppose that he has taken this excursion from mere idle curiosity, but because of his profound religious interest in the history with which his observations are associated. The thread of narration is, therefore, once broken by an episode in which he goes into a discussion and a defense of the Hebrew polity which has been the subject of much criticism in these skeptical times. It is not so much his object to maintain the inspiration of Moses as to vindicate his wisdom and humanity as a lawgiver. His chapter on "Theocracy and Democracy," in relation to the Hebrew system of government, is readable and suggestive, but we suspect that the philosophy of the subject will not be cleared up until it is studied in the light of the great law of social evolution.

Home Gymnastics; with a Short Method of acquiring the Art of Swimming. By T. J. Hartelius, M. D. Translated by C. Löfving. J. B. Lippincott & Co., Phila. Pp. 94. Price, 60 cents.

Of course, the importance of exercise to health is by no means a modern physiological discovery, but we undoubtedly owe to Ling, of Sweden, the most ingenious system of gymnastics, calculated to produce a harmonious development of the human organism, and to insure the preservation of health as well as the cure of diseases. It is said that Ling never used a movement of which he could not scientifically demonstrate the physiological effects, and there can be little doubt of the important influence it has exerted during the half-century that has elapsed since the promulgation of the "movement-cure."

The editor of this volume remarks that "it is dawning more and more upon the minds of physiologists and practitioners that 'motion is the principal agent in the whole process of life,' and that systematic muscular exercise is one of the best means for influencing the vital actions of the body." And, such being unquestionably the case, our most practical concernment is with the best means of gaining the benefit of these systematic exercises. Those who have well-equipped gymnasiums within reach may be congratulated that the problem is solved for them, but the great mass of people are without such opportunities. The little work of Dr. Hartelius, which has been so judiciously translated, is exactly what is wanted for universal home use. Systematic exercises are described and illustrated, which are suited to strengthen and develop all parts of the muscular system, and this without the use of any other apparatus than a bench or seat, and even this is by no means indispensable. All that is required for exercise is the body itself, and as most people possess this outfit they need not be put to the slightest expense to secure a comprehensive system of gymnastic exercises, and which, moreover, shall be just as efficient as they choose to make it. Following the descriptions of movements are lists adapted for specific purposes, and for infants and old persons, as well as for those in full vigor.

THE ALTERNATIVE, A STUDY IN PSYCHOLOGY. New York: Macmillan & Co. Pp. 387. Price, $2.75.

THIS anonymous work is a vigorously written polemic on metaphysics in its more modern aspects. It is written with a conservative *animus*, and the author is of opinion that he has helped forward psychological inquiry in several important particulars. Mr. Henry Sidgwick, certainly a very competent authority, says, in an advertisement to the volume: "I have had an unexpected interim of enforced cessation from my work, which I have employed in reading about half the proof-sheets you sent me. Without reading any more—which for the present I have not time to do—I feel no doubt that the book deserves the attention of all students of philosophy from the amount of vigorous, precise, and independent thinking that it contains—thinking which appears to me generally consistent, so far as it has been completely developed, though, at some important points, the work of definition and analysis does not seem to me to have been carried far enough. I also find the terse, forcible individuality of the style attractive on the whole, though I can not but wish that the author had somewhat restrained his impulse to innovate in technical terminology."

IDYLS OF NORWAY, AND OTHER POEMS. By HJALMAR HJORTH BOYESEN. New York: Charles Scribner's Sons. Pp. 185. Price, $1.25.

THIS is a collection of brief poems, some forty in number, mostly on light and fanciful subjects suited to sentimental treatment. They are of excellent literary merit, and show a skillful mastery of English versification that is certainly remarkable in an author writing in a foreign tongue. The pieces in this volume are considerably varied, both in form and in the subject chosen; we have been most struck, however, with those on "The Sea," "The Air," and on "Evolution," the latter of which we have taken the liberty of transferring to our pages. The poetic treatment of the enlarged views of nature, for which we are indebted to science, is an important part of the "progress of thought."

ABORIGINAL AMERICAN LITERATURE.

THE second volume of Dr. D. G. Brinton's "Library of Aboriginal American Literature," is announced to appear in June. It is the "Iroquois Book of Rites," comprising the original text and a literal translation, with introduction, notes, and glossary, and is edited by Horatio Hale, Esq. This is a native composition, partly in the Mohawk and partly in the Onondaga language, and includes the proceedings observed in the council when a deceased chief is lamented and his successor is installed. The forms, after having been preserved and handed down in memory for several generations, were written down, by desire of the chiefs, when the language was first reduced to writing.

SCIENCE IN SHORT CHAPTERS. By W. MATTIEU WILLIAMS, F. C. S. New York: Funk & Wagnalls. Pp. 308.

THIS volume contains a great number of brief essays, popularly written, on a wide variety of scientific subjects, and the name of the author is a sufficient guarantee of the general soundness of the information and criticism presented in the book.

The Diadem of School-Songs. By William Tillinghast. Syracuse, New York: C. W. Bardeen. Pp. 160. Price, 50 cents.

The "Diadem" is intended to facilitate instruction in sight-singing by ordinary teachers, even though they may not themselves be singers. Besides a new system of instruction arranged for this purpose, and a manual of directions for the use of teachers, it contains songs and music of varied character for all grades of schools.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Proposed Ordinance, and Rules and Regulations on Plumbing and House Drainage for Philadelphia. By the Committee of Twenty-one. Philadelphia: P. Blakiston, Son & Co. Pp. 14. 10 cents.

Report of the Director of the Illinois State Laboratory of Natural History. 1881–'82. By S. A. Forbes. Normal, Ill. Pp. 12.

The Sphingidæ of North America. By A. R. Grote, A. M. Washington, D. C. Pp. 5.

Books for the Young. Compiled by C. M. Hewins. New York: F. Leypoldt. Pp. 94. 25 cents.

University of Pennsylvania, Catalogue and Announcement, 1882–'83. Philadelphia. Pp. 116.

Entomological Papers from the "Transactions of the Iowa State Horticultural Society," 1882. Des Moines: F. M. Mills. Pp. 42.

"The American Fruit-Drier, or Pneumatic Evaporator." Waynesboro, Pa.: American Manufacturing Company. Pp. 48.

The Cornell University Register, 1882–'83. Ithaca, N. Y. Pp. 123.

The Physiology of Protoplasmic Motion. By Th. W. Engelmann, M. D. Translated by Charles S. Dolley, M. D. Rochester, N. Y.: Davis & Leyden. Pp. 40. 50 cents.

Proceedings of the Davenport (Iowa) Academy of Natural Sciences. Vol. III, Part III. Pp. 311, with Four Plates.

Lectures delivered to the Employés of the B. & O. R. R. Co. By Professor H. Newell Martin and Drs. H. Sewall, W. T. Sedgwick, and W. K. Brooks. Baltimore: B. & O. R. R. Co. Pp. 98.

The Q. P. Index Annual for 1882. Bangor, Me. Pp. 51.

The Bacteria. By T. J. Burrill, Ph. D. Springfield, Ill.: H. W. Rokker. Pp. 65. 50 cents.

Report of the United States Bureau of Statistics on Imports, Exports, Immigration, and Navigation, September 30 to December 31, 1882. Washington: Government Printing-Office. Pp. 359.

The Great Ice Age in Pennsylvania. By Professor H. Carvill Lewis. Pp. 21, with Map.

Scripture Opened. A Topical and Analytical Commentary. Acts. By Rev. J. M. Coon, Beaver Dam, Wis.

The Maintenance of Health. By J. Milner Fothergill, M. D., M. R. C. P. New York: G. P. Putnam's Sons. Pp. 366. Paper, 60 cents.

"Appalachia." April, 1883. Boston: W. B. Clarke & Carruth. Pp. 202. 50 cents.

Register of the Appalachian Mountain Club for 1883. Boston: W. B. Clarke & Carruth. Pp. 36.

The Higher Professional Life. By J. M. Da Costa, M. D. Philadelphia: J. B. Lippincott & Co. Pp. 18.

Reports of Experiments on Insects injuriously affecting the Orange-Tree and the Cotton-Plant. United States Entomological Bureau. Washington: Government Printing-Office. Pp. 62.

Reports of Observations on the Rocky Mountain Locust and the Chinch-Bug. United States Entomological Bureau. Washington: Government Printing-Office. Pp. 36.

United States Monthly Weather Review for February, 1883. Washington: Office of the Chief Signal-Officer. Pp. 52, with Maps.

Parish Institutions of Maryland. By Edward Ingle, A. B. Baltimore: Johns Hopkins University. Pp. 48. 40 cents.

Report of the Board of Commissioners of the Tenth Cincinnati Industrial Exposition. 1882. Cincinnati: James Barclay. Pp. 320.

Illustrated Art Notes of Fifty-eighth Spring Exhibition, National Academy of Design. By Charles M. Kurtz. New York: Cassell, Petter, Galpin & Co. Pp. 84. 25 cents.

A Roman Catholic Canard. Boston: "Investigator" Office. Pp. 16.

Two Great Works to be done on our Sidereal System. By Jacob Ennis. Washington, D. C.: Rudd & Detweiler. Pp. 12.

On the Action of Certain Vegetable Acids on Lead and Tin. By Francis P. Hall. Boston, Mass. Pp. 13.

Biennial Report of the Superintendent of Public Instruction of Florida. By E. K. Foster. Tallahassee, Fla.: Charles E. Dyke. Pp. 24.

Alcoholic Inebriety. By Joseph Parrish, M. D. Philadelphia: P. Blakiston. 1883. Pp. 185. $1.25.

Home Gymnastics. By Professor T. J. Hartelius, M. D. Philadelphia: J. B. Lippincott & Co. 1883. Pp. 94.

The Possibility of not Dying. By Hyland C. Kirk. New York: G. P. Putnam's Sons. Pp. 112. 75 cents.

French Forest Ordinance of 1669. With Historical Sketch of Previous Treatment of Forests in France. Compiled and translated by John C. Brown, LL.D. Edinburgh: Oliver & Boyd. Pp. 180.

The American Citizen's Manual. Part II. By Worthington C. Ford. New York: G. P. Putnam's Sons. Pp. 184. $1.

Marianella. By B. Perez Galdós. From the Spanish by Clara Bell. New York: William S. Gottsberger. Pp. 264.

Libraries and Schools. Papers selected by Samuel S. Green. New York: F. Leypoldt. Pp. 186. 50 cents.

Libraries and Readers. By William E. Foster. New York: F. Leypoldt. Pp. 136. 50 cents.

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

On Work and Wages. By Sir Thomas Brassey, K. C. B., M. P. New York: G. P. Putnam's Sons. Pp. 296. $1.

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

Oliver Wendell Holmes, Poet, Littérateur, Scientist. By William Sloane Kennedy. Boston: S. E. Cassino & Co. Pp. 356.

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

The Advanced Question-Book. By Albert P.

Southwick. Syracuse, N. Y.: C. W. Bardeen. Pp. 366. $1.50.

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

Man before Metals. By N. Joly. New York: D. Appleton & Co. Pp. 365.

Manual of Assaying Gold, Silver, Copper, and Lead Ores. By Walter Lee Brown, B. Sc. Chicago: Jansen, McClurg & Co. Pp. 318. $1.75.

Authors and Publishers. A Manual of Suggestions for Beginners in Literature. New York: G. P. Putnam's Sons. Pp. 96. $1.

Eureka—The Mysteries of the World Mysteriously Revealed. By Asa T. Green. Cincinnati: A. G. Collins. Pp. 141.

History of Medical Economy during the Middle Ages. By George F. Fort. New York: J. W. Bouton. Pp. 488.

Life of Sir William E. Logan, Kt., First Director of the Geological Survey of Canada. By Bernard J. Harrington. Montreal: Dawson Brothers. Pp. 432.

POPULAR MISCELLANY.

How to act in a Tornado.—Sergeant John P. Finley, Signal-Service officer at Kansas City, Missouri, has published, in a pamphlet on tornadoes, some useful directions concerning the course to be taken to escape the dangers of those terrible forces. The inhabitant of a tornado-frequented district must be watchful in the season of visitations, for he can never know when the destruction will come upon him. On the first sign of the approaching vortex, he must run—always to the north, unless by going in that direction he will have to cross the entire path of the storm. If he is nearer to the southern edge than to the center of the probable path, he may go south, bearing slightly east; but in no event should he ever run directly to the east or northeast. It is impossible to save any building that may lie in the path of the tornado, or any property that can not be got out of its way. No material, no method of construction can be competent to resist the raging destruction. Nothing rising above the ground can escape it. The most practicable measure of precaution is to construct a "dug-out" at some suitable point, within easy distance from the house, to serve as a place of refuge or shelter. The retreat should be entirely under-ground, with a roof at least three feet thick, not rising above the surface of the earth, and entered from the northern or eastern side. A "cellar-cave" may be constructed from the cellar, if the house has one, to serve as a substitute for the "dug-out." It should be excavated from the west wall of the cellar, toward the west, and should be made as complete and secure as the "dug-out." If, however, the storm can not be escaped, if no refuge is at hand, or there is not time to get to it, the safest thing to do is to place one's self against the west wall of the cellar, face forward, or against the south wall, as near the southwest corner as possible. The northeast quarter is in any case a fatal position, and should always be avoided. If one is actually overtaken by the tornado, his only resource is to cast himself face downward upon the ground, with his head to the east and his arms thrown over his head to protect it. If a stump or large stone, or anything heavy that the wind will not blow over, is near, he may get a trifle of protection by throwing himself to the eastward of it. If in a house with no cellar, he should get into the west room, on the ground-floor if possible, and away from all stoves and heavy furniture. The people of towns might find it to their advantage to provide for having a watch, to be on duty on all days when the air bears the premonitory symptoms of a violent wind-storm, to give a signal to the whole population on the appearance of the first real threatening signs. The signs of the formation and approach of a tornado-cloud are distinct and sufficiently suggestive to afford opportunity for timely and concerted action. Sergeant Finley is continuing his investigations of the phenomena of tornadoes, and he has prepared three full schedules of minute inquiries calling for the facts attendant upon the appearance of the storms, which he sends to persons who were within the path of one, who were on the outer edge of the path, and who were from ten to one hundred miles from it.

Science and Faith.—"Science and Faith" was the subject of an address delivered some time ago by Professor A. J. DuBois, of the Sheffield Scientific School, before the Scientific Society of Bridgeport, Connecticut. The burden of the address is an attempt to show that the basis of all scientific knowledge is faith; that what we consider our most certain knowledge does not and can not admit of rigid demonstration, but rests at bottom upon assumptions whose truth must be taken simply upon trust. All scientific proof is really based upon the single hypothesis of the uniformity of nature—a doctrine which can never be demonstratively established, but of which the highest and strongest proof is, and always must be, merely cumulative. The evidence for this hypothesis rests upon our experience, and that is of a limited character. Thus, the foundation of our knowledge is an assumption, which, though highly probable, can not be proved. "And yet we believe: our conviction is so perfect that, even if exact and rigid demonstration were possible, it would add not one particle to the positiveness of our conviction. The fact remains, then, that we believe that which we can not prove. The scientist, no less than the theologian, rests his conclusions ultimately upon faith. When reason halts, faith steps in and leads us onward, and upon the basis of faith our most certain conclusions are founded." Reason, indeed, is our guide; but faith—that faith which, resting upon experience, nevertheless transcends experience—must be the rod and staff on which we lean. The greatest debt we owe to Science, Professor DuBois concludes, "apart from all she has done and is doing for our bodily comfort and our mental development, is for the lesson of faith she is thus ever teaching us — the lesson that Reason and Faith must ever go hand in hand . . . that man can never feel sure of attaining absolute knowledge—that pure truth is not for him; that just so surely as he walks by reason and by reason only, just so surely he must reach a point where reason halts and waits on faith."

Baron Stjerstedt's Antique Coins. — Baron A. W. Stjerstedt, who died in September, 1880, was one of the most distinguished numismatists in Sweden, and in 1857 received the grand prize of the Royal Academy of Archæology of that country for his work on the copper coinage of Sweden and its foreign possessions. He was the author of other numismatic works, and formed extensive collections of Swedish and of antique coins. The latter collection is one of unusual interest and value, not less for its completeness than for the length of time and the extent of territory it represents. Its chronological range is from about 800 B. C. to the reigns of Theodore II of Constantinople, and Manuel Comnenus of Trebizond, in the thirteenth century of the Christian era. Its geographical range comprises nearly all of the world with which the Greeks and Romans were in actual contact. Its historical continuity, although, perhaps, not unbroken, is marred by few extensive or important gaps. The department of Grecian medals includes the municipal, popular, or royal coins of cities, provinces, and states in ancient Lusitania (or Portugal), Spain, Gaul, Italy, Sarmatia, Mœsia, Thrace, Macedonia, Greece, the states of Asia Minor, Syria, Phœnicia, the Parthian kings, Ptolemaic and Roman Egypt, Numidia and Mauritania, nearly a thousand examples in all. In the Roman department are found four pieces described as "autonomous coins of Rome," consular medals, and imperial medals from Julius Cæsar to Julius Nepos, A. D. 475; while in the Byzantine department are placed the coins of the Eastern emperors, from Arcadius to Manuel—making, with a few Gothic and Vandal coins and odd pieces, 2,467 coins of Rome and its Eastern Empire. Ordinary collections are of value as curiosities or for the illustrative specimens they afford. So comprehensive a collection as that of Baron Stjerstedt may be made useful for instruction in numerous ways. It holds the thread of history with a nearly continuous series of object-lessons, and shows the relations of even the most remote points of Europe in very early times. It illustrates the growth and prevalence of myths, the vicissitudes of dynasties, and changes of religion. Some old Roman coins show Romulus and Remus suckled by the wolf. Emblems of the divine legends of the Greeks and Romans abound in hosts of pieces. Some bear contemporary portraits of men with whose names history is full; a group for Judea shows pieces of silver of the kind with which Judas was paid for his treachery; in the series for imperial Rome are shown the growth of Christianity upon paganism, the attempt to supplant it again by pagan rites, and the final triumph of the Christian emblems. In another view, the coins, for the most part still sharp and bright, illustrate the development and vicissitudes of art, from the rude efforts of archaic and provincial stampers to the finely finished medals of which those bearing the handsome features of Alexander the Great and those of the first Roman emperors may be taken as specimens. The base metal of which the coins of whole epochs were composed attests the antiquity of the dishonesty of "fiat money." The collection, which is offered for sale in this country, will be of great value to the institution that is fortunate enough to secure it.

Vegetation of the Catskill Mountain-Tops.—Professor Charles H. Peck, of the Adirondack Survey, has recorded the fact that many swamp-loving plants grow on the higher mountains of the Adirondacks, where they find the conditions of moisture suited to their growth in the frequent rains, the general prevalence of clouds, and the low temperature, all operating as obstacles to evaporation. He has found on the open summit of Mount Marcy, 5,344 feet above the sea, seven species of swamp-plants, growing five hundred feet above the tree-line, with no protection from the sun except what the vapors afford. Mr. E. P. Bicknell remarks, in his "Monograph on the Summer Birds of the Catskill Mountains" ("Transactions of the Linnæan Society of New York"), that the same fact is observable in that range, and is most strikingly illustrated by the white hellebore, which was noticed in low, damp woods in the valleys and along the streams, and growing in some profusion near the summit of Slide Mountain. "Close around the summit, too, were found, growing in abundance upon the carpeting of wet moss, plants which, at a less altitude, were rare or altogether absent, owing obviously to the scarcity of suitable swampy land. Thus, *Coptis trifolia*, which had not been noticed lower, was abundant; *Viburnum cassinoides*, elsewhere met with only in a small marsh at an elevation of about 1,900 feet, here reappeared, as well as *Viola blanda* (Willd), *Carex intumescens* (Rudge), and other plants less distinctly confined to wet and marshy situations." Mr. Bicknell also observes that in passing from the valleys into the mountains it was interesting to observe of plants of general distribution how much less advanced was their seasonal condition as the elevation increased. The extremes of this contrast, as shown by the vegetation at the summit of Slide Mountain and that of the valleys below, were most striking. Some species, which in the valleys had ceased flowering and were bearing green fruit, were still in full bloom at the mountain-tops; while others, in like condition in the valleys and on lower slopes, on the mountains had not advanced beyond their earliest buds.

Animal Revenge.—The active existence of a feeling like that of revenge and the possession of powers of memory of considerable definiteness and endurance in animals are illustrated in some anecdotes published in a recent number of "Chambers's Journal." Vixen and Viper were two dogs sent to hunt an otter. Only Vixen was able to attack the animal, and she was killed by him. Viper, who mourned for her intensely, went out in the night to hunt the otter; and the two were found on the next day clinched in death, with all the evidences of a desperate struggle around them. A Newfoundland dog was enraged by a traveler who, passing on horseback through the village, struck at him with his whip. A year afterward the traveler was passing through the same village, when the dog recognized him, and bit him through the leg. A friend of the owner of a dog, Tiger, set a stout bull-dog against him, and Tiger got the worst of the fight. He remembered the event, and watched faithfully at the neighbor's door for his opportunity. It came; the dog seized the man, and avenged his wrong. Afterward he tried to make friends with him, and to restore the relations as they had been before the offense was given. A servant-maid was accustomed to throw water upon a dog chained up during the hot weather, and for the best of motives—to cool him off. The dog, however, took the proceeding as an insult, and the first time he found himself loose sprang upon the girl and killed her. It was the duty of two dogs to take their turns at a turnspit. One of them shirked his task, slunk away, and hid. The other, when called upon to take his companion's turn as well as his own, led the people to where the truant was hid and killed him on the spot. A Newfoundland dog in Cork was annoyed by a cur. He took the animal, threw it over the dock, then plunged in himself and saved its life. Another Newfoundland dog was sent back by its master with a key which was needed at the house. It was attacked on its way by a butcher's dog, but went on about its business, paying no attention to the interruption. The key delivered, it stopped, on its way back to its master, before the butcher's shop, till the dog came out, then attacked it and killed it The story has become an old one of the elephant that cracked a cocoa-nut on the head of a man who had cracked one on its skull, and killed him. Of another elephant—and he was called "the fool,"—it is said that a quartermaster threw a tent-pin at him. A few days later, the animal came upon the quartermaster, lifted him up in his trunk, and put him in a large tree, to get down as best he could. Another elephant was treated to some nuts by a visitor who ended by giving him some so hot that they burned him. In his agony, he drank six pails of water, then threw the pail at the visitor. The two met a year afterward, when the joker offered his nuts again. The elephant ate with relish till the hot nuts appeared, then took the joker by the coat-tails and held him up till the cloth gave way and the man fell to the ground. The elephant proceeded to eat the nuts in the coat-pockets, then tore up the coat-tails and threw the pieces after the owner. The last story is of a monkey, which, being caught stealing a friar's grapes, had to wear a weight on its tail. Afterward, while the friar was performing mass at the church, the monkey climbed to the roof of his cell, and with the weight on its tail broke all the tiles.

Egyptian Funeral-Wreaths restored.—Dr. Schweinfurth writes that he has examined the wreaths which were deposited within the coffin of Aahmes I, King of Egypt, of the eighteenth dynasty, whose mummy is now in the museum at Boolak, and has found them to be composed of the flowers of the *Acacia Nilotica*, the *Nymphæa cerulea* (isolated petals), the *Alcea ficifolia*, and a *Delphinium*, or larkspur, which he supposes to be *orientale*. The wreaths of the other kings, whose mummies were associated with that of Aahmes, contained flowers of *Carthamus tinctoria* and leaves of the *Mimusops kummel*. Leaves of the watermelon were found in one of the coffins. A number of the flowers and leaves have been restored to their shape by moistening them, dipping them in alcohol, and spreading and drying them; and by this means has been obtained an herbarium of thirty-five-hundred-years-old specimens. The color of the chlorophyl, violet in the larkspur, green in the watermelon-leaf, is preserved to a remarkable degree. The Egyptian willow, of the twigs of which the framework of the wreath was composed, the *Acacia Nilotica*, and the *Nymphæa cerulea*, still grow wild in Egypt as well as in tropical Africa. The *Mimusops kummel* has been observed in modern times only in Abyssinia, while the larkspur (*Delphinium orientale*) is diffused all over the East, but is cultivated in Northern Africa as an ornamental plant. The *Carthamus* is still cultivated as a dye-plant in the East and in Egypt. Besides the wonderful preservation of delicate flowers and their colors, this "find" affords new examples of species, both wild and cultivated, which have suffered no variation during a long series of ages. Aahmes I, on whose mummy most of these flowers were found, reigned about 1800 B. C.

Insect Organs of Smell.—Gustav Hauser, of Erlangen, has made the organs of smell of insects the subject of his studies. That they are related to the antennæ is shown quite clearly by several experiments. Glass rods dipped in oil of turpentine or acetic acid, when brought near to insects, caused them to move their antennæ and turn quickly around; but, when the antennæ were cut off, the same insects showed no signs of sensation, although the substances were brought close up to them. Flies with their antennæ cut off paid no attention to putrid meat, although they had previously been strongly attracted by it. Varnishing the antennæ with paraffine was followed by a similar insensibility. Herr Hauser's conclusion is that the organs of smell of most insects consist, first, of a stout nerve proceeding from the brain-ganglion, and running along the antennæ; second, of a perceptive terminal apparatus, represented by staff-cells proceeding from the hypodermis, with which those nerves are connected; and, third, of a supplementary apparatus, composed of cavities or cones filled with a serous fluid, which may be regarded as out-foldings of the epidermis. The organs appear to be most highly developed, as would naturally be supposed, in those insects which appear to use the sense of smell in seeking for food. The greatest number of smelling cavities and cones are found among wasps and bees, the honey-bee having fourteen or fifteen thousand cavities and about two hundred cones in each antenna, the leaf-wasp a smaller number. The flesh-and-dirt flies have from sixty to a hundred and fifty organs of smell, while the flies that live on plants have only five or six cavities to each feeler.

Photographing the Corona.—Professor Huggins announces that he has succeeded in photographing the solar corona without the assistance of an eclipse. It having been shown by Professor Schuster's observations of the last eclipse that the coronal light as a whole is very strong in the region of the spectrum extending from about G to H, he conceived that by making exclusive use of this part of the spectrum, while enjoying the best possible conditions of exposure and concentration, it might be possible to take a photograph of the kind sought. He found a commercial violet (pot) glass which effected the separation required, and using this—and a potassic permanganate solution in his later experiments—with a reflecting telescope, and gelatine plates, he obtained twenty successful photographs between June and the 28th of September of last year. Captain Abney, whose experiments during the last eclipse have made him a competent judge, declares the photographs as trustworthy as any that were taken then. Professor Huggins believes that there is little doubt that under the most favorable conditions the corona may by his method be successfully photographed from day to day with a definiteness which would allow of the study of the changes which are doubtless always going on in it. By an adjustment of the times of exposure, the inner or the outer corona could be obtained as might be desired.

Cram Examinations.—"Hot-house Education" is the title of a pamphlet recently published in England, on the absurdity of the examinations in vogue there, which are systematically prepared for by cramming. Dr. Crichton Browne is authority for the statement that, by submitting boys of twelve or thirteen to the examinations, "we may be able to select those of the quickest wits, and those most susceptible of cram; but we should certainly not bring to the front those of the greatest grasp of intellect and force of character," and that to institute such examinations at such an age seems to be offering a premium on precocity. In the examinations of older candidates, tests are often exacted of a kind which an examiner who has been quoted by Mr. Froude described as setting a paper "for which Macaulay might possibly get full marks." A case is cited by Mr. Digby, the author of the pamphlet we have referred to, of an examiner who had to appeal to the Geographical Society for the answer to a problem which he had set to candidates, but could not for the time being solve himself. Another instance is that of an examiner for the army who gave out as a subject of composition, "A Visit by Sir Roger de Coverley and the 'Spectator' to Lord's Cricket-Ground." Such cases might, perhaps, be met by fixing the rule that those who make the examinations should be required to pass them.

The Right to Rest.—The London "Spectator" calls for the establishment of a new rule of etiquette, that a man who announces that he is seeking rest shall be let alone. In the hurry and strain of modern intellectual life, a necessity has arisen for periodic rest. "Overwork" is now recognized by physicians as a specific cause of disease, and a few of them are making the effects of over-cerebration, under a hundred names, a distinct specialty. The incomes of several first-class doctors in London are derived almost entirely from men whose brains are overworn, and whose nerves are so "over-strung," or "understrung," or "gone to pieces," or are "so excited," that they can neither sleep, nor work, nor remain quiet. These specialists have become abnormally discerning, and "can tell almost at a glance where anxiety has been the cause of disease, and where, as sometimes, though seldom, happens, it must be sought in actual overwork; where alcohol or drugs have assisted the decay of nervous force, and where asceticism, tried as a remedy, has seriously injured the resisting power, diminishing the fuel, till every day threatens to empty the store. They differ considerably, we are told, in their practice, some having a lingering faith in the milder narcotics, which others have lost; and some in sleep by itself, which others think is only perfectly recuperative when it comes unsought, . . . but they all agree in recommending perfect 'rest.' Their patients, who have instinct to guide them, and some memories of quick recovery during accidental or incidental lulls in life, always agree with them, but always start the question, how the rest is to be obtained." The distinguished patient can not find it anywhere in the land, for he is pursued wherever he goes by telegrams and letters, and callers, and newspaper gossip; and the only remedy, which some have heroically tried, is to go out to sea, where one can not be followed up; but this is often decidedly inconvenient. So, let the profession, and society, and the newspapers establish the rule that, when a distinguished man seeks rest for a period, he shall not be interrupted in it.

Room enough in the World yet.—Mr. R. Giffen, an English statist, has taken up the Malthusian cry that the world is filling up too fast, and has uttered his apprehension that all inhabitable countries will soon have all the population they can hold—and then what will mankind do? The "Spectator" answers him with arguments very like those which M. Fouillée has used with so much skill and effect in his articles on "Scientific Philanthropy." The laws of increase of population do not work as the Malthusians fear they will, but have ways of their own that it is hard to calculate upon. There is still, and will be for a long time, room enough in the world for all candidates for the privilege of living upon it. The United States still receives and finds homes for all who come—unless they come from China—and has a little room left. The State of New York, with five millions of population, has capacity, according to the standard that prevails in Suffolk, England, for thirty millions. The Dominion of Canada might hold fifty millions in comfort, without neighbors ever visiting each other on foot; and British Columbia has room "for twenty millions of happy people." Then, when North America is filled up, South America offers vast expanses that are not only not occupied, but are in reality not explored, of which Brazil has room for all Europe. Australia could support forty millions in its habitable belt; and Africa—who yet can begin to guess at its capacity? In the mean time, the population of Ireland is diminishing, and the failure of the French to increase excites more apprehension than any fact which is brought to the notice of their economists.

Americanitis.—Sir Charles W. Dilke, in his "Greater Britain," thought he noticed a tendency in the Caucasian native American to acquire the red Indian type of physiognomy. Mr. W. Mattieu Williams echoes this opinion, and has cited several pieces of evidence to show that a change in the direction mentioned is going on, and that it is a process of desiccation produced by the dryness of our climate. Mr. R. A. Proctor asserts that during his three visits to America he lost about thirty pounds in weight, which he recovered on returning home. Mr. Williams's own son, after residing for some time in this country, became thin, lank-jawed, and sallow, "displaying all the characteristic symptoms of what I can not refrain from calling *acute Americanitis*," but began to recover immediately after returning home. On one occasion, at the house of the late George Combe, at Edinburgh, some family portraits were brought out, including those of members who had remained at home, and photographs of members who had emigrated to America a generation before, and with them a portrait of Black Hawk. "We placed the chief on one side, the Edinburgh portraits on the other, and those of the descendants of the American emigrants between, and all agreed that the deviations from the original family type were in a direction toward that of the red Indian. Mr. Combe maintains that this is generally the case, and I agree with him in regarding the typical 'native American'—that is, the descendant of early English settlers—as displaying physically (I do not say intellectually and morally) a notable degree of reversion—or rather deviation—toward the aboriginal type displayed in the best examples of red Indians—i. e., the old fighting chiefs."

Publication of Astronomical News.—The supervision of the announcement of astronomical discoveries, which has hitherto rested with the Smithsonian Institution, has been transferred by it to the Harvard University Observatory. The first scheme for publishing news of this class in the United States was started by Professor Peters, who arranged with European astronomers for an exchange of reports with the Smithsonian Institution. The orbits of comets were published only in the German "Astronomische Nachrichten" till 1878, when their publication was begun by the Boston Scientific Society, through Mr. S. C. Chandler, in its "Science Observer." Mr. Chandler devised a new and improved code of signals for the transmission of announcements by the Atlantic cable, and engaged the co-operation of the Harvard Observatory in computing the cometary orbits. His publications in the "Science Observer" attracted attention in Europe, so that when the "Centralstelle für Astronomische Telegramme" was formed at Kiel, Prussia, in 1882, Mr. Chandler and his colleagues were made its agents for the distribution of astronomical intelligence in this country. Wishing to provide for their trust a more solid responsibility than their personalities could give it, they offered it to the Harvard Observatory, which accepted it. This act has now been ratified by the Smithsonian Institution.

Influence of Vapor on Radiation.—Professor Tyndall has published an account of some interesting experiments he has made on the variations in the radiation of heat from the earth's surface. On an elevated plateau he hung a thermometer four feet from the ground, and placed another on cotton-wool at the surface. The difference in the registry of the two instruments, that of the surface thermometer being always lowest, varied from four degrees to seventeen degrees, even when no difference was apparent in the clearness of the atmosphere. A careful review of the hygrometric conditions under which the different observations were made established the fact that the variations were dependent upon the existence or withdrawal of the check to radiation which is imposed by the presence of aqueous vapor. As a general conclusion, it may be said that, "with atmospheric conditions sensibly alike, the waste of heat from the earth varies from day to day; a result due to the action of a body which escapes the sense of vision." Similar conclusions, or the basis for forming them, are derived from the observations of Professor Soret, of Geneva, and General Strachey.

NOTES.

The Annisquam Laboratory of the Boston Society of Natural History, which has been in operation for two summers, will be open for the reception of students during the coming summer from July 1st to September 1st. It is situated on an inlet of Ipswich Bay, on the north side of Cape Ann, about three miles and a half by coach from the Eastern Railroad station at Gloucester. It is intended for persons who have already made some progress in the study; and no lectures or stated courses of instruction will be given, but suitable direction and advice. Collecting implements and row-boats are provided, and a yacht will be at hand for dredging parties. Applications may be made to Alpheus Hyatt, curator, Boston.

Professor Edmond Perrier has identified a new crinoid, the *Blastocrinus*, among the animals brought up by the Travailleur from the deep seas off the coast of Morocco. This raises the number of known living species of these most ancient animals of the sea to thirteen. The *Blastocrinus* is marked by a stem of large size supporting a calyx which is composed of five pieces, to which are fixed articulate and very mobile arms. The stem is also composed of a succession of circular articulations, placed one upon another. The radical system of this animal is very interesting. Instead of being concentrated into a single stem, it branches out into a kind of tuft, and the animal seems to have the faculty of putting out a sort of runners, like those of the strawberry.

Professor Frederic Augustus Abel, the eminent English chemist, is to receive from the Queen the honor of knighthood for his services in the War Department in relation to the chemistry of explosives, etc. Professor Lyon Playfair, F. R. S., has also received from her Majesty the honor of Knight Commandership of the Bath.

M. Ed. Landrin has deduced from certain experiments that the "setting" properties of hydraulic cements are due to the presence of an allotropic variety of silica which he calls hydraulic silica. He has prepared this form of silica, and has found that it has the property of forming with lime mixtures that harden under water. At the same time, while primarily it is insoluble in hydrochloric acid, it becomes when mixed with lime susceptible to its influence. He has further discovered that aluminates of lime are at least as soluble in water as gypsum, and are liable to spoil any cement in which they may be present.

Herr Josef Knörlein, the entomologist, died at Linz, February 12th, in the seventy-eighth year of his age.

A company has been formed and chartered to construct and work an electric railway running from Charing Cross to Waterloo, in London. The line will pass under the Thames through iron caissons. The power will be transmitted from a stationary engine to the carriages, and these will run separately, starting as filled, and occupying about three and a half minutes in the trip. A contract has been made with the Siemens Company to supply machinery and rolling-stock, and the construction of the road has been let, to be finished in eighteen months from the beginning.

The death is announced, at Basle, of Dr. Ziegler, the distinguished cartographer. He studied under Carl Ritter, and afterward established in his native town of Winterthur the cartographic establishment now conducted by Messrs. Wurster and Randegger. His most important maps are his great map of Switzerland, maps of Glarus, of St. Gall, and of the Engadine, and a hypsometric map of the world. A geological atlas and an explanatory description of the geological map of Switzerland by him are now in press.

It is estimated that the ivory which was imported into Great Britain during the nine years from 1872 to 1881 (5,286 tons) represented 296,016 pairs of tusks, and consequently a corresponding number of elephants that have been slaughtered. At this rate of destruction the elephant must in no very long time become extinct. Notice is taken in one of the reports of Mr. Webster, our consul at Sheffield, to the Government of the United States, of the small size of a large proportion of the tusks brought to the market, as indicating a wasteful destruction of young elephants. It is time, if this valuable game is to be preserved, to look for some means of checking the reckless hunting of it which is going on.

Herr Johann Spatzier, a botanist of Silesia, has recently died, at the age of seventy-seven years.

Professor P. C. Zeller, the distinguished Prussian entomologist, died suddenly, of heart-disease, on the 27th of March, in the seventy-sixth year of his age. He was the author of a valuable work on *Lepidoptera*, and had made important studies of American forms.

More than twelve months ago, a "perpetual" clock was started at Brussels. An up-draught is obtained in a tube or shaft by exposing it to the sun; this draught turns a fan, which winds up the weight of the clock until it reaches the top, when it actuates a brake that stops the fan, but leaves it free to start again when the weight has gone down a little. This clock was keeping good time in June, after running continuously for nine months.

M. Pasteur's recommendation of vaccination as a safe preventive of anthrax in sheep is contradicted by the professors in the veterinary school at Turin, who aver that, in their own experiments, they have found the vaccinated animals to be as liable as any others to be fatally attacked by the disease on inoculation. M. Pasteur has taken notice of their criticisms, and expresses the opinion that the animals they experimented with did not contract and die of anthrax, but of septicæmia, which is infallibly developed twenty-four hours after death in all animals dying of anthrax. He has offered to subject his views to a practical test, by going to Turin and experimenting with the professors, to show that vaccination, while it may not protect against septicæmia, is proof against real anthrax.

Dr. Bertillon, an eminent French statistician, died on the 3d of March last, having reached the age of sixty-one years. He is credited with having made new applications of the study of statistics, and with having been the founder of demographic science. He was also a naturalist and a close observer of animal structure and life; he paid considerable attention to botany; and has left some valuable labors in mycology. Dr. Bertillon's works in science were performed during the greater part of his life without reward. The chair of Demography in the School of Anthropology, offered him in 1876, was the first public position he held. In 1880 he was appointed by the Prefect of the Seine to the head of the Bureau of Municipal Statistics of Paris, which was founded at that time.

M. Tacchini has succeeded in observing the solar prominences upon the very disk of the sun. By enlarging the opening of his spectroscope, he has been able a few times to recognize on the edges of the spots these grand eruptions of hydrogen and the unknown substance helium.

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THE RAILROAD PROBLEM IN THE UNITED STATES.

By GEORGE ILES.

GEORGE STEPHENSON, in October, 1829, made his memorable journey in the Rocket over the Rainhill trial course; the next year the Liverpool and Manchester Railway was opened, and soon every civilized nation adopted the new method of locomotion. In the United States a variety of circumstances have concurred to make the railways the most extensive, the most economical in working, and the most influential in the world. The immense area of the country, the small value of most of the land required for the roads, the easy grades marked out by the great water-courses of the continent, and the broad prairie-sweeps, conjoined with the ease and cheapness of obtaining charters, make American railroads but one third as costly in construction as those of Great Britain and the European Continent, and much less expensive in operation. On this side of the Atlantic railways are built with embankments, culverts, bridges, and tunnels, much less elaborate and substantial than those of England and France. The requirement here is not the best but usually the cheapest thing that will serve. This is one of the reasons among others why American freight charges are the lowest in the world. In 1881 the average cost of moving a ton of freight a mile was 1·66 cent in France, 1·5 cent in Belgium, and but 0·9 cent in the United States. The railways of the Union are now 114,000 miles in extent, and construction proceeds at the rate of thirty miles a day. The aggregate capital of the lines is $6,500,000,000, one eighth the valuation of all kinds of property in the country, according to the best estimates.

Less than fifty years ago, within the clear recollection of men now living who were then actively engaged in business, the great problem was, how soon the country could be provided with railroads. Farsighted men of capital and public spirit saw something of what railroads were to be, and soon the iron way began to connect the great cities of the Atlantic together, and then these with the interior of the New England and Middle States, until at last the continent has been belted, and the distant mining-camps of the Rocky Mountains, and the broad stretches of the Californian and Texan plains, are directly connected with every city and town in the country. A single life covers the entire period which separates the time when stage-coaching and wagoning were the methods of transportation, from to-day, when railroads loom up in capital and centralized control as the most important element of American commerce.

The benefits derived from the railroads have been so great as to have virtually created the population and wealth of some of the wide Western States and Territories. Railroads have opened up homes for millions sent across the sea from overcrowded Europe, have cheapened food, clothing, and shelter, have practically broken down State and sectional lines, and by interfusion of capital and population have done more to weld the Union together than any other influence. The locomotive has proved a giant indeed, capable of bearing heavy burdens, and accomplishing splendid results; yet of late railroad corporations have shown a disposition to abuse their strength for public oppression, and the railroad problem is, how this tendency may be best overcome.

While on all hands the indebtedness of the community to railroad enterprise is gladly acknowledged, and while the average return on railroad investments throughout the country is but three per cent, and the charges generally are lower than elsewhere in the world, yet the complaints made against some of the leading lines are so serious as to have given rise to one of the angriest discussions of the time.

The chief complaints, of course, have been made against the lucrative roads, those which run through thickly-settled regions, like the New York Central; and against lines which, like the Central Pacific, are monopolies pure and simple. The complaints are of exorbitant charges, of discrimination in favor of individuals, firms, and localities; that the railroad companies lend themselves to the aggrandizement of monopolies such as the Standard Oil Company, and of minor subsidiary organizations, car, bridge, express, stock-yard, and elevating companies which absorb parasitically profits which should belong to the railway shareholders, and which, if rightfully appropriated, would tend to relieve the burdens borne by the general public. The complainants furthermore aver that the railroad companies make use of their influence, as employers of large bodies of voters, to corrupt Legislatures and courts that they may remain unpunished in committing acts of fraud and rapacity, and defeat attempts by the State to exert the control which the highest authorities declare to be within its rightful powers.

To take up these complaints somewhat in detail—and beginning with that of exorbitant charges—there was provision made in most of the early railroad charters—those of New York State, for instance—whereby the profits divisible annually were limited to ten per cent; but this provision, intended to secure shippers against unduly high rates, has been evaded by the process known as stock-watering. To illustrate: The contract for the consolidation of the lines forming the New York Central Railroad was made in 1853, and the ten amounts of capital then fused formed a total of $23,000,000, on which premiums were granted aggregating $8,900,000. In 1868 and 1869 the New York Central and Hudson River Railroad Companies were consolidated as a single company, which named its capital at nearly $45,000,000 more than the capitals of the two lines before union. Of course, more than ten per cent would have to be earned on the inflated figures before the State law would apply, and by that time doubtless a new company would appear to buy the road at a handsome advance on its nominal capital. The critics of stock-watering or of the capitalizing of surplus earnings say that it is in substance exacting money from the people, creating an indebtedness representing the same, and making this the basis for forever asking the public to pay interest upon their money so exacted. These critics would limit the profits of the lucrative roads, but, unjustly it would seem, would leave the struggling lines to their fate.

The railroad companies are told, "You may earn as little as you can, but, if by good fortune and good management you earn more than ten per cent, the State will seize the surplus." Practically, however, the law can not be enforced, as the common rights of sale and purchase can be exercised to evade it.

In response to the complaints against the New York roads, the Assembly in February, 1879, appointed a special committee, with Mr. A. B. Hepburn as chairman, to investigate alleged abuses, propose remedies, and report. The testimony before this committee fully established the truth of the alleged abuses in discrimination. Mr. Goodman, Assistant General Freight Agent of the New York Central Railroad Company, testified that special rates were given to all points almost invariably when asked. About ninety per cent of the business between New York and Syracuse was done at reductions from tariff terms, and about one half the business between New York and other points was done at special rates. Other witnesses proved that flour had been carried from Milwaukee to New York while the tariff rate was thirty-six cents, at the specially reduced price of twenty cents, the maintained rate at the time from Rochester being thirty cents. Rochester is 350 miles from New York, and Milwaukee 1,030 miles. So marked and inconsistent a difference did there exist between local and through freight charges, that Mr. W. W. Mack, of Rochester, could ship edge-tools to New York and thence to Cincinnati *via* Rochester, and save fourteen cents per hundred; to St. Louis by the same route, eighteen cents per hundred—in each case the goods being carried seven hundred miles more than a direct haul! Surely one would say that rates devised so loosely as to render Mr. Mack's plan worth adopting discredit the officials responsible for them. Among the remarkable cases of discrimination proved were the following: Babbitt & Co., soap-manufacturers in New York, ascertained that Crouse & Co., of Syracuse, had a special rate of eight cents per box over the New York Central road; Babbitt & Co. asked for a similar reduction, which was refused, the rate charged them being twelve cents to Syracuse, and this while their shipments over the New York Central and Hudson River Railroads aggregated 1,346 tons in the year preceding the session of the committee. In the winter of 1877 Jesse Hoyt & Co. and David Dows & Co., of New York, two large grain firms, controlled the market by having obtained freights from the West two and a half to five cents per hundred less than any of their competitors. Their facilities for freight exceeded their purchasing power, so they actually sublet their privileges to other houses in the trade.

Towering far above all the wrongs under the head of discriminations ever perpetrated by railroads must be placed those committed in favor of the Standard Oil Company. This monopoly, the strongest of the kind in the world, controls the production of petroleum in the United States, the second largest export of the country; its relations with the railroads are such that it obtains freighting at an immense reduction from the terms charged to other customers of the roads. In August, 1879, the Erie and New York Central roads charged the Standard Company about ten cents for hauling a barrel of three hundred and ninety pounds somewhat more than four hundred miles, empty cars having to be hauled back over the lines. Contrast this with the charge of forty-five cents for bringing a can of ten gallons of milk weighing ninety pounds but sixty miles! The proportions are as 1 to 130. From January to October, 1879, the total shipments from the oil-regions were 12,900,240 barrels. All shipments to the seaboard might have borne one dollar more per barrel than they did, yet all these millions of dollars were lost to the roads by a policy for which their officers are accountable. The Central Pacific Railroad Company is another against which discriminations of an unwarrantable character have been proved. While one shipper was charged 65 cents from Ogden to Toano, another shipper was charged $3.35 for the same service. Vegetables were carried for different firms at rates as various as 55 cents and $1.36. Through rates from New York to San Francisco were to some shippers one half those charged to others. The complainants take good ground when they declare that discriminations in favor of particular localities and firms create deficiencies which shippers generally are taxed to equalize; and, as mercantile competition becomes yearly more severe, the unjust discriminations of railroads unfairly discount the legitimate returns of business enterprise, and hasten the undesirable tendency so plainly observable on all sides, whereby the great houses are constantly absorbing the trade of the lesser ones, and the business of the country seems passing into fewer and fewer hands.

As to the growth of subordinate railroad organizations, the quotations of the stock-exchanges and the testimony of those interested in investments not listed on the stock-exchanges prove the great lucrativeness of express, fast-freight line, palace-car, elevating, and stock-yard companies. It is a question whether these businesses can be successfully carried on by railroad companies, but, if not, the corporations which give them birth should, if honestly managed, see to it that they retain such interest as to participate in the large profits earned. The chief danger attending these subsidiary organizations is, that the railroad officials who take stock in them are interested in granting them special privileges and good bargains. It is notorious that officers of unprofitable or bankrupt roads have grown rich by interests of the kind mentioned.

The political power which the railroads can exert has repeatedly attracted public attention. In New York State there are thirty thousand railway employés, and the number of people indirectly interested in the roads, and influenced by them, is perhaps equally large. At the capital this voting element has opposed railway legislation, and triumphantly. Parallel cases have occurred in other States, notably in California and Illinois. As an example of what a railroad can do in the way of controlling political action, let this quotation be given from Jay Gould's testimony before the State Committee appointed in 1873 to investigate the management of the Erie Railway: "I do not know how much I paid toward helping friendly men. We had four States to look after, and we had to suit our politics to circumstances. In a Democratic district I was a Democrat, in a Republican district I was a Republican, and in doubtful districts I was doubtful; but in every district, and at all times, I have always been an Erie man." Other testimony proved that millions of dollars had been expended from the treasury of the Erie road in nominating, electing, and corrupting Senators and members of Assembly. A new danger certainly threatens public liberties in the light of these and many kindred revelations, a danger which, perhaps, only counter-organization by the people can successfully face. It was a notable day in American history when the attorney of the Pennsylvania Railroad threatened the Supreme Court of the State with the displeasure of his clients if a verdict unfavorable to them were granted. When President Vanderbilt, of the New York Central, was told about the State Commissioners who were to supervise railroad affairs, he said that either the railroads would have to own the commissioners or the commissioners the railroads. His later utterances with respect to public criticism are tolerably familiar, and need not be here repeated.

The complaints against railroad management, as far as they appear to be just, show that the railroad problem may be divided into two parts: First, how shareholders in railroads can meet the difficulties of joint-stock ownership, and control their property, so that it can be made by all legitimate methods as profitable as possible. This means the election of directors not as now, as a whole board by a single majority vote, but by a plan of minority representation, which will give a voice in the directorate to every interest entitled to it. It means including in the business such branches of traffic as are now delegated to subsidiary companies, where this can be done advantageously; and the employing of officers of such high character and ability that they shall be disposed to co-operate with one another to avoid illegitimate and ruinous competition—officers able to establish tariffs based on sound and consistent principles, and tariffs with which no subordinate officer shall have power to tamper.

The second part of the railroad problem is how the general public, while desirous of paying just remuneration to the roads, may protect themselves against extortion and unjust and arbitrary discriminations. This part of the subject raises the question of the constitutionality and feasibility of State control, and brings up for discussion the various influences which are spontaneously exerted within the railroad business itself for its fair and equitable management. In the brief sketch here presented of the chief complaints made against the railroads, it has been evident that some of the most serious of these complaints arise from the inherent difficulties of joint-stock ownership. A board of directors, provided with many proxies, can do pretty much as they please, and the history of American roads shows that at times they please to enrich themselves at the expense of those whom they represent.

The shareholders in a large company are often a shifting, chaotic, and helpless body, fortunate, indeed, when the directorate are sufficiently honest and interested to administer affairs as they should. It seems strange, too, that the management of railroads should so widely permit an evil which causes so much just censure, namely, the cutting of rates, by a staff of agents scattered throughout the whole country. When control by the owners of railroad property remains as imperfect as it is in important particulars, it certainly seems an idle task to attempt the State control of the largest and most complicated business in existence.

The discussion of the railroad problem has given the public some insight into the difficulties which beset this business. There are now in the United States some twelve hundred railroad companies, more or less actively competing with one another. Between two great cities like New York and Chicago, and between a great center of distribution like St. Louis and the Atlantic seaboard, there are many competing routes, and the contest for business among these routes is very keen, and at times so violent as to set all considerations of profit at defiance. The routes connecting the great West with the Atlantic ports vary in directness, in gradients, and in the thickness of the population in the districts through which they run; it follows that their inequality of desirableness as freight lines must be balanced by differences in rates. To establish and maintain these differences in rates, it has been the practice for the roads to enter into agreements with one another, and, in making these agreements on fair and satisfactory terms, and in enforcing the agreements when made, have been encountered the most perplexing tasks of railway management. In arguing for a basis of rates, two widely different stand-points are occupied by the trunk-lines running eastward from Chicago. The great interests centering in New York declare that the cost of service should be the prevailing consideration in proportioning rates among competing lines.

It is adduced that the easy gradients of the New York Central and the immense traffic which belongs to the cities and towns through which it runs enable it to be operated at less cost per ton per mile than any other road in the country: the geographical and census arguments should, therefore, be permitted to give New York a preference over competing cities in the framing of joint tariffs. Philadelphia and Baltimore take different ground: they point out that they are respectively one hundred and thirty-two and one hundred and fifty-two miles nearer Chicago than is New York *via* the New York Central, and therefore they desire freight rates to be fixed on the basis of mileage. Contests, which have consumed many millions of dollars, leave the question open as to which of these two principles shall govern the charges of the trunk-lines on through business. Another reason for the difficulty attending the making and keeping of agreements between railroads is the fact that the temptation to bad faith is extreme. If one road can defraud another of some freight by an illegitimate reduction of rate, the cash so earned is almost wholly profit, for the fixed expenses of the road are scarcely affected whether that freight be carried by it or not. The bad faith of a single road can lead to the breach of an agreement entered into by several great roads; and often it is the weak or bankrupt line whose dishonorable dealing leads to a war of rates being declared which may cost a million dollars before it ends. And a curious point comes up just here: so dear to the heart of the average shipper are these wars of rates, that clear-headed men who know his inner springs aver that the shipper does not desire permanent peace among the railroads, and does not wish to see them earn their incomes with the steady regularity enjoyed by the investor, say, in Government bonds. Peace to the shipper would be as distasteful as the absence of fluctuations to the speculator in stocks or grain, for railroad men and those who find fault with them seem to be made of the same clay.

Railroads have enemies within as well as without. Intense competition has given birth to a class of soliciting freight agents, to whom reference has already been made; these men are empowered to grant reduced rates at discretion; their bargains are binding on all the lines forming the routes for which they solicit business, and their acts are in their nature so difficult of detection, and so inimical to the integrity of agreements, that a sound business policy would dictate that their powers should only be wielded by officers of the roads sufficiently high in position and character to guarantee good faith in carrying out the joint contracts made by the presidents of the lines.

It is a strange fact in railroad history that the contracts between roads for the maintenance of rates have never, up to the present time, invoked legal sanction and enforcement; they have been made and broken purely at will. Good authorities, among whom may be named the Railroad Commissioners of Massachusetts, state that the existing laws of the country afford all the provisions needed for the purpose; while, again, the chief railroad expert in the country, Mr. Fink, holds that special legislation is necessary. So important does Mr. Fink hold this matter to be, that he states that when the necessary enactments have been passed, and when railroad managers have the good sense to co-operate and avail themselves of legal authority, he will regard the railroad problem solved as far as solution is possible.

In March, 1882, a commission at Washington, appointed to consider the railway question, brought together Mr. Fink and General Reagan, of Texas, the member of Congress who proposed a bill for the direct regulation of the railroads by the Federal Government. General Reagan's bill is chiefly aimed at what he and many others conceive to be a grave injustice, namely, the discrimination which makes through freight pay a much less rate than local freight, and which grants one shipper more favorable terms than another for the same service. The bill would make the rate per mile uniform over all roads, and would make through rates the sum of the local rates charged over the component parts of a line. The testimony of Mr. Fink before the commission, and particularly in reply to General Reagan, is one of the most instructive pieces of railway literature so far given to the public. Mr. Fink deemed the railroad problem too difficult to be handled by a directly appointed commission: all that he could recommend was a commission to investigate complaints. He pointed out the great services railroads had done the country, and declared the evils attending the management of the business to be largely unavoidable amid affairs so vast and involved. As an example of the benefits railroads had conferred upon the public, he stated that in the fall of 1880 the rate from Chicago to the East was but six tenths of one cent per ton per mile, or equal to carrying seventeen barrels of flour one mile for one cent! The intense competition between roads has been one of the main causes of the remarkable economy of their management, and their eagerness to adopt every improvement as soon as produced, chief among which improvements must rank the steel rail. Quoting from Mr. Edward Atkinson, Mr. Fink said that an artisan in the Eastern States pays the transportation from Chicago on a year's food by a single day's labor, and so great have been the reductions during recent years, in railway charges, that, had the rates of 1873 been maintained until 1879, the roads would have had in the interval $922,000,000 more revenue than they actually collected. In 1880 more than three times as much freight was carried by the roads as in 1868, and at sixty per cent less rate ; and, although shippers may grudge certain companies the appreciation of their property which has taken place—an advance in value decidedly less than that which has overtaken real-estate holdings generally—no agitation has yet been promoted to pay dividends or make up deficiencies on unprofitable lines, although such lines have been indirectly great sources of prosperity to their districts and the country at large. Mr. Fink recognizes the injustice of charging different prices to different firms for the same service, but has no faith in any attempted legal preventives of the practice. Rebates may be granted a year or two after a transaction, or may take the form of gifts, or in other ways detection may be evaded. His explanation of the disparity so often complained of, between local and through rates, is very interesting. A line is built chiefly to accommodate and develop the region through which it passes ; that region, without it, might remain backwoods or unbroken prairie ; and, therefore, as the services of the road are of most value to its own district, that district should in justice principally contribute to its support. Now, when a road has a fair local business at regular tariff rates, and can add to its business without proportionate increase of expense by taking through freight originating in a city like Chicago, where many competing roads center, then it is allowable to grant marked reductions in terms to attract a share of through business. It is plainly unfair, under the circumstances, to take the stand of certain complainants and ask that local rates be based upon through rates. Mr. Stanford, President of the Central Pacific Railroad, explains some of the discriminations of his line on the same principle. A car-load is taken from New York to San Francisco for $300, but if dropped at Elcho, 619 miles east of San Francisco, the charge is $800, the sum of the through rate from New York to San Francisco, plus the charge from San Francisco to Elcho. Mr. Stanford points out that his road has to meet severe water competition at San Francisco, and that therefore the local rates charged towns created by the line can have no relation to competitive terms, and must wholly rest on considerations of the revenue to be earned on the capital employed, after the expenses of management are paid. Facts worthy of being weighed in this connection are that cars carrying local freights are, on an average, not more than a quarter filled, and that they are subject to long delays at way-stations, causes justifying low rates on full cars in active motion on long, unbroken journeys.

Another form of allowable discrimination Mr. Fink holds to arise where a new industry awaits development, and offers all it can afford to pay—a rate somewhat under the tariff. He gives as an example a case where staves from a Western point were to be sent to England, to compete there with staves from Norway: he holds it to have been good railway policy to create freight by carrying it at a reduced figure, if it gave promise of increased business in the future, with a prospect of building up a new industry for the country.

The Anti-Monopoly League of New York, an association formed to expose railroad abuses, and to endeavor to have them corrected by political agitation and legislative enactment, has widely circulated as the policy of the Erie and New York Central Railroads a statement signed by their presidents, wherein they declare it their principle to charge all an article will bear, and at the same time stimulate its production (they probably meant, not interfere with its production). On the Central Pacific Railroad the value of a shipment of ore or merchandise affects the cost of its carriage, and at first view the fact certainly has an arbitrary look. The explanation of the somewhat carelessly stated principle is this: Ores of various values are offered to the Central Pacific road, let us say; the least valuable can not afford to pay tariff rates, although it can pay the cost of transportation and a small percentage of return to the capital of the line. The manager decides that a little profit is better than none, and accepts the ore of small value at a reduced rate. The same principle of classification makes dry-goods pay a higher rate than coals, just as letters cost more for postage than books and parcels; its adoption develops the utmost quantity of railroad business, cheapening the average charge, and adjusting the burden of expense to the various capabilities of the different elements of traffic. Railroad managers, on the same general principle, find it pays to develop suburban passenger and excursion business on terms much below the charges for single tickets.

Against the proposal of General Reagan and others to make a uniform rate for every mile of railroad in the country, it is very properly urged that tariffs must vary from many considerations: the indirectness of one road competing with a shorter one obliging it to charge a lower rate per mile, or do no business; the determination of freight in a single direction, as of lumber from the Wisconsin forests, which requires the hauling of empty cars northwestward; the comparatively small business of some lines such as those common in the West, which serve as mere gatherers-up for the trunk-lines and feeders of them; the cost of fuel, three times as much in some parts of the country as in others, and, at the cheapest, a main element of railroad expense; difficulties of grade, which may make a single mile more costly in maintenance and operation than ten miles of level track; contingencies of climate, which in northern latitudes may wholly suspend traffic at times or make train service in an extraordinary degree both expensive and hazardous ; the enormous cost of bridges and tunnels, and the terminal facilities of great cities—all fairly weigh as causes for varying assessments of tariff. Surely such considerations as these must set aside any attempt at the solution of railroad difficulties by the arbitrary rule of a uniform rate—uniform only in name, for genuine uniformity of charge can only be worked out by a broad view of the whole business of railroading in its full extent and detail, a view which it would be folly to expect a State Assembly or a State Board to take.

The trunk-lines connecting the West with the Atlantic have a Joint Executive Commission at New York, for the establishment and maintenance of rates. Though suffering from the merely voluntary nature of its constitution, and without the power of legally enforcing its agreements, the commission gets along pretty well, mainly through the esteem in which are held the character and ability of its chief commissioner, Mr. Fink. He gives a clear explanation of how co-operation, federation, or what is commonly called "pooling," may solve the problem of fixing rates and making railroads keep to them. Pooling may be explained, to readers unfamiliar with the term, as the gathering into a common fund of all the receipts of a group of railroads (or other corporations), for division according to a prearranged scale of apportionment. Mr. Fink points out that in peace or war the proportions of freight carried by the different through lines remain substantially invariable. He dwells on the powerful motives acting within the railroad business itself to prevent exorbitant charges. Traffic would not grow unless fairly treated, and the efforts of railroad managers have plainly been to reduce rates whenever possible to do so. The pool of which Mr. Fink is chief commissioner has gradually reduced its charges until they have fallen below those of the Erie Canal. The Southwestern pool has constantly reduced its tariff, seeing in that policy the best means for increasing its business and the net profits of its roads. Water competition has a far-reaching effect in railroad tariff, as an illustration will show : A reduction in rates between Chicago and New York, to meet lake and canal tariffs, creates reductions at Louisville, Nashville, and Savannah, for these cities have also their competing routes to New York. All rail routes from Chicago to so interior a point as Atlanta must conform to the total rate made up of the charges from Chicago to New York, from New York to Savannah by sea, and from Savannah to Atlanta by rail. Mr. Fink shows that competition within the pool is powerful to prevent excessive charges—thus the roads running from Indianapolis eastward must meet Chicago competition, otherwise shippers would send their freights to Chicago to go East, and the Indianapolis roads would remain idle. The bitterest complaint against railroads, that of discriminations in favor of individuals and special firms, finds its removal in the pool-system, for, with a fixed percentage of the total earnings of a federation of roads, what temptation can remain to make one particular road do more business than that agreed upon as its share? To the objection that pooling would abolish the incentive to excellence in each road, Mr. Fink answers that the system provides for a periodical reapportionment of percentages of earnings among the lines, and that at such times the public preferences for prompt and well-managed lines would tell, to the punishment of dilatory and badly conducted roads. One of the unavoidable difficulties of pooling must ever be the decision as to the percentage allowable to a new line. Only costly trials of strength seem to be able to bring about such decision.

The prices of various important commodities in the different markets of the Union limit the freights chargeable upon them. Thus, if Liverpool salt is to compete with the American article, its carriage inland must be very cheap; and wider considerations of the same kind have to be borne in mind by those intrusted with the power of making tariffs over the great lines. American grain competes with Russian in the great market of Liverpool, and a question of the tenth of one cent per ton per mile may in the long stretches of American rail-carriage decide for or against the sale of the Iowa or Minnesota farmer's produce. The tea and silk trade of China with Great Britain can choose between two great routes, the direct water-route, or the journey in part made up of the American transcontinental railroads.

A closing argument on behalf of pools remains to be stated. They make each great road the guardian of its district, which would not be the case were there to be a consolidated monopoly instead of a pool. As matters now stand, the Pennsylvania and the Baltimore and Ohio roads prevent a concentration of business on the New York Central, the line on which, as far as simple and direct economy is concerned, the harvests of the West can be cheapest carried to the seaboard. Pools, too, by preventing wars, will tend to make railroading less uncertain and more profitable than it has been, and will thus lead to new lines being constantly built.

The detailed criticism of General Reagan's proposed enactments presents fatal objections, and furnishes a new theme for that school of thinkers who hold that the sphere of legislation does not include the control of any business whatever, which may be safely left to meet its difficulties spontaneously. General Reagan's uniform mileage rate would give the shortest route connecting New York and Chicago the lowest rate; hence that route would command all the business until it could accept no more, when the next shortest would come in for the surplus, and so on, leaving nothing for indirect routes whatever. Besides, in railroad practice after the Chicago rate eastward has been fixed, the St. Louis business comes in, and the competition of the roads directly connecting St. Louis and the Atlantic ports must be met by the routes less directly connecting the termini *via* Chicago. As a matter of fact, the shortest or economically best line fixes the rate, and other lines must base their charges thereupon.

Should there be formed in America a general pool to establish tariffs as the Railway Clearing-House does in England, or the Railway Unions do in Germany, it would probably enter into relations with the Federal Government for the sanction and enforcement of its contracts.

The strong pleas made by the railroad interest do not silence the voice of murmuring. Every great railroad serves without competition important breadths of country, and proofs abound that the interest of a road may not always be a consenting parallel with the interests of its patrons. Charges much higher than justice would fix are exacted from customers, who must submit, and who are not sufficiently injured to be driven from their field. There is something ominous, too, in the way in which coarse and unscrupulous men are getting more and more control of the railroad system of the country. People are asking, "What is to prevent the great railroad presidents from exercising their power arbitrarily, and compassing the ruin of individuals, firms, and localities?" Some of the eminent statesmen and politicians of the republic are of firm belief that the railroads are getting too much power, and that the abuses complained of here and there now are only examples of what may be expected very generally as the years of the near future elapse. The lurid light of "Standard" oil shows how a railroad oligarchy might repeat abuses of its power in the dishonest control of great staples which, like petroleum, form the bases of national wealth. A rise or fall of five cents a bushel in the freight from Chicago to the seaboard affects the value of every farm in the West, and it is easy to see how speculative interests can unwarrantably depress prices for a time so as to enrich the few manipulators of the market.

There is throughout the Union great capacity on the part of the people to organize for political ends, and, when the agitation against the railroads took place in the West a few years ago, the rapid spread of the Granger movement showed the power the public are ready to exert whenever they feel that they suffer grievances capable of remedy, and this dormant force in the last resort will rise to resist any tyranny which railway kings may be foolish enough to exercise. Among the most prominent public men who are of opinion that it is now time that the Federal arm were invoked to repress railroad aggression and who advance the cause of anti-monopoly, may be named Senators David Davis and William Windom, Judge Jeremiah S. Black, and Governor Gray, of Indiana. Judge Black holds the paradoxical opinion that railroads are held by their owners simply as trusts, and that therefore their tariffs should be public, reasonable, and just. Hon. J. M. Mason, of West Virginia, holds that railroads are common carriers who levy tolls and exercise eminent domain, and as such they are subject to government control for the enforcement of reasonable rates. Chief-Justice Waite has decided that a State has the right to regulate any business such as grain-elevating, dedicated to a public use, and this decision is held to apply *a fortiori* to railroads. All authorities agree that each State can, if it chooses, supervise the railroads within its borders in the public interest, and the allowability of Federal control is deduced from that paragraph in the Constitution which says that Congress has power to regulate commerce between the States. Against all this the railroads urge that the essence of property is in control, and that if the Government wishes to manage the lines it should buy them. It is contended that no Government officials can fitly prescribe rules for the regulation of a business so complicated as railroading, and that complaints so far from being abated would increase were the blight of political patronage to fall upon the transportation lines of the country. The party who urge the necessity of Government control of railroads among their arguments give prominence to the fact that an area of public lands, nine times that of Ohio, has been given to railroads to aid in their construction. In reply, the corporations say that these lands formed part of the business consideration on which they began work; and, furthermore, the value of these lands for the most part has been created solely by the existence of railroad facilities.

The debate for and against leaving the railroad problem to solve itself has not shown that the people who wish to invoke control by the Federal Government have numbers or influence or very sound arguments on their side. To throw the management of between six and seven thousand millions of capital into the hands of political partisans, who only represent the people in an indirect way through cumbrous elective machinery, is a proposal which few seriously consider; but, if the Federal Government can not honestly and safely be called upon to control railroads, the establishment of railroad commissions may render important services to the public. Twenty-six of the States have such commissions, intended to supervise and regulate railroads in the public interest, but the variety in the laws creating them, the limits of State jurisdiction in the presence of so many interstate roads, and their general lack of authority, render their efforts but feeble. These commissions depend for success on the degree of good sense which is employed in forming them, in the personal character and ability of their boards, and in the commissioners remaining long enough in office to be able to gain and use experience in their duties. Of the commissions so far established in the Union, that of Massachusetts takes the lead; its guiding principle is not that of force, so popular in Western railroad legislation, but that of publicity, trusting to the influence of an enlightened public opinion. The Massachusetts Commission has authority to obtain and publish in full detail the annual statements of the railroads of the Commonwealth. Their capitals, earnings, expenses, and profits, are all clearly tabulated, as the book-keeping of all the companies is on a uniform and simple plan. The tariffs of the roads are accessible to the commission, which is a bureau where complaints of unjust discrimination can be lodged for inquiry and for correction, as far as its powers admit. These powers the commission believes might be advantageously extended, for the abstract rights of the public without legal remedies are very apt to be disregarded. The authority of the board, however, extends to enforcing for public safety the proper strength, breadth, and height of bridges and tunnels, and such guarding of crossings and employment of mechanical appliances as experience suggests for adoption. All serious and fatal accidents are investigated, and the "Annual Report" of the board is a document which might serve as a model of a business-like State paper.

A system of State commissioners patterned after the Massachusetts board, with a national center of reference, is as much in the way of legislation and public supervision as the leading railroad minds of the country deem advisable at present. The chiefs of the greatest commercial interest of America are quite prepared to accept legislation ; all that they ask is that it be intelligent.

The public must not, however, expect too much from enactment, for, with business morality as it is, why should ideal justice prevail in railroad transactions more than in any other ? The fact which on the broad stage of railroading is odious discrimination, less recognizably pervades the smaller circles of trade where employés permit personal interest or personal friendship to jolt the sacred scales. The view that railroading is a special and public service, in a sense which entitles the people to control it, is not a view which the facts of American politics favor as yielding any practical suggestion.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

DYSPEPSIA.

BEFORE our ancestors colonized the colder latitudes of this planet, the equatorial regions had for ages been inhabited by men or man-like four-handers. The influence of this long abode in the tropics still asserts itself in many peculiarities of our physical constitution. We are but half acclimatized. Wolves are weather-proof ; bears and badgers have managed to inure themselves to the miasma of their winter dens : but the primates of the animal kingdom can neither endure cold nor breathe impure air with perfect impunity ; and of most of our civilized fellow-men, as well as of savages and all the species of our four-handed relatives who have thus far been wintered in northern menageries, it may be said that the sensitiveness of their lungs contrasts strangely with the tough vigor of their digestive organs.

In proportion to his size, a rhesus baboon eats more than a wolf; between morning and night a ceboo monkey will devour his own weight in bananas, and, where the cravings of a naturally vigorous stomach are increased by the stimulus of a cold climate, it seems almost impossible to surfeit a savage with palatable food; his appetite is the faithful exponent of his peptic capacity, and before the fauces positively refuse to ingest there is little danger that the gastric apparatus will fail to digest. Manifold and enormous must have been our sins against the dietary code of Nature before we could succeed in making indigestion a chronic disease. Deviations from the chemical standards of her *menu* are insufficient to account for her wrath. With all their unmistakable structural evidences of a frugivorous purpose, our digestive organs have been permitted to adapt themselves, not only to a carnivorous and herbivorous diet and various innutritive substances, but to a considerable number of positive poisons. The Yakoots live on fish and seal-blubber. The Shoshones stick to bull-beef. The Namaqua Hottentots (who can not plead the exigencies of a cold climate) subsist almost entirely on venison. Several tribes of Northern Brazil eat clay with comparative impunity. Our Saxon forefathers added beer to venison and beef, and when they took to in-door life the stomach protested only by proxy; an utterly wrong diet led, not to dyspepsia, but to scrofulous affections. Excess in moderately unwholesome viands has to be carried to a monstrous degree before the after-dinner torpor turns into a malignant disease; the stomach of a nomad seems to acquire a knack of assimilating a modicum of the ingesta and voiding the rest like so much innutritious stuff. Dr. Robert Moffat saw a Bushman eat twenty pounds of hippopotamus-liver and a bucketful of broiled marrow, besides handfuls of ground-nuts, parched corn, and hackberries—all within twenty-four hours. In the provincial capitals of Northern China, where banquets of forty courses are *de rigueur*, convivial mandarins learn to devour a quantum of comestibles that would torpify a boa-constrictor. Eating-matches of fourteen and fifteen hours did not prevent Vitellius from acquiring distinction as a wrestler.

Daily alcohol-fevers, combined with pepper and mustard inflammations, would ruin the stomach of an ostrich; but in favor of the unfeathered biped Nature accepts such vicarious atonements as gout and dropsy. Thousands of crapulous Bavarian beer-swillers, who are hardly able to walk, are still able to digest their food. In-door life and want of exercise then added their quota of provocatives; but, where the lungs would have rebelled after seven protests, the stomach forgave seventy-seven times. Mediæval prelates, squires, and aldermen tried in vain to exhaust the patience of the long-suffering organ.

But their descendants finally solved that problem. To the alcoholic stimulants of the ancients we have added tea, coffee, tobacco, absinthe, chloral, opium, and pungent spices. Every year increases the number of our elaborately unwholesome-made dishes, and decreases our devotion to the field-sports that helped our forefathers to digest their boar-steaks. We have no time to masticate our food ; we bolt it, and grumble if we can not bolt it smoking hot. The competition of our domestic and public kitchens tempts us to eat three full meals a day, and two of them at a time when the exigencies of our business-routine leave us no leisure for digestion. At night, when the opportunity for that leisure arrives, we counteract the efforts of the digestive apparatus by hot stove-fires and stifling bedrooms. Since the beginning of the commercial-epicurean age of the nineteenth century the votaries of fashion have persistently vied in compelling their stomachs to dispose of the largest possible amount of the most indigestible food under the least favorable circumstances.

That persistence has at last exhausted the self-regulating resources of our digestive organs. But even after such provocations the stomach does not strike work without repeated warnings. The first omen of the wrath to come is the *morning languor*, the hollow-eyed lassitude which proves that the arduous labor of the assimilative organs has made the night the most fatiguing part of the twenty-four hours. The expression of the face becomes haggard and sallow. The tongue feels gritty, the palate parched, in spite of the restless activity of the salivary glands, which every now and then try to respond to the appeals of the distressed stomach. Gastric acidity betrays itself by many disagreeable symptoms ; loss of appetite, however, marks a later stage of the malady. For years the infinite patience of Nature labors every night to undo the mischief of every day, and before noon the surfeited organs again report ready for duty. Habitual excess in eating and drinking sometimes begets an unnatural appetency that enables the glutton to indulge his *penchant* to the last, only with this difference, that the relish for special kinds of food has changed into a vague craving for *repletion*, just as the fondness for a special stimulant is apt to turn into a chronic poison-hunger. This craving after engorgement forms a distinctive symptom of *plethoric dyspepsia*, but even in the first stage of asthenic or nervous dyspepsia the hankering after food is not hunger proper, but a nervous uneasiness, suggesting the idea that a good meal would, somehow, supply the means of relief. The first full meal, however, entails penalties which the sufferer would gladly exchange for the less positive discomfort of the morning. Instinct fails to keep its promise, as a proof that Nature has been supplanted by a deceptive second-nature. Headache, heart-burn, eructations, humming in the ears, nausea, vertigo, and gastric spasms, make the after-dinner hour "the saddest of the sad twenty-four" : a dull mist of discontent broods over the whole afternoon, and yields only to tea and lamp-light. The patient begins to fret under the weight of his afflictions, but still declines to remove the cause. To out-door exercise he objects, not on general principles, but on some special plea or other. He has to husband his strength. The raw March wind would turn his cough into a chronic catarrh. The warm weather would spoil his appetite and aggravate his vertigo. The truth is, that of the large quantum of comestibles ingested only a small modicum is *digested*, and that the system begins to weaken under the influence of indirect starvation. Business routine prevents the dyspeptic from changing his meal-times. He can not reduce the number of his meals; people have to conform to the arrangements of their boarding-house. The stomach needs something strengthening between breakfast and supper. The truth is, that the exertions of the digestive organs alternate with occasional reactions, entailing a nervous depression which can be (temporarily) relieved by the stimulus of a fresh engorgement. Business reasons may really prevent a reduction of working hours, and domestic duties a change of climate or of occupation. The daily engorgement in the mean while goes on as before.

Nature then resorts to more emphatic protests. Sleep comes in the form of a dull torpor that would make a nightmare a pleasant change of programme. The digestive laboratory seems to have lost the discretion of its automatic contrivances ; the process of assimilation, in all its details, obtrudes itself upon the cognizance of the sensorium, and urges the co-operation of the voluntary muscles. Contortions and pressing manipulations have to force each morsel through the gastric apparatus ; the lining of the stomach has become sentient, and shirks its work like a blistered palate. Special tidbits can be traced through the whole course of their abdominal adventures. Undigested green peas roll on like buckshot hot from the smelting-pan of a shot-tower. A grilled partridge crawls along like a reluctant crab, clawing and biting at each step. Nausea and headache strive to relieve themselves in spasmodic eructations. Vertigoes, like fainting-fits, eclipse the eyesight for minutes together. Constipation, often combined with a morbid appetite, suggests distressful speculations on the possible outcome of the accumulating ingesta. The overfed organism is under-nourished to a degree that reveals itself in the rapid emaciation of the patient. The general derangement of the nervous system reacts on the mental faculties, and impairs their efficacy even for the most ordinary business purposes, till the invalid at last realizes the necessity of reform. He tries to reduce the number of his meals ; but the lengthened intervals drag as heavily as the toper's time between drinks. He hopes to appease his stomach by a change of diet, but finds that the resolution has come too late ; the gastric mutiny has become indiscriminate, and protests as savagely against a Graham biscuit as against a broiled pork sausage. He tries pedestrianism, but finds the remedy worse than the evil. The enemy has cut off his means of retreat ; the necessitous system has no strength to spare for such purposes as an effort of the motive organs. But nine out of ten dyspeptics resort to the drug-store. They get a bottle of "tonic bitters." They try Dr. Quack's "Dyspepsia Elixir." They try a "blue pill"—in the hope of rousing Nature, as it were, to a sense of her proper duty.

Now, what such "tonics" can really do for them is this: they goad the system into the transient and abnormal activity incident to the necessity of expelling a virulent poison. With the accomplishment of that purpose the exertion ceases, and the ensuing exhaustion is worse than the first by just as much as the *poison-fever* has robbed the system of a larger or smaller share of its little remaining strength. The stimulant has wasted the organic energy which it seemed to revive. "But," says the invalid, "if a repetition of the dose can relieve the second reaction, would the result not be preferable to the languor of the unstimulated system? Wouldn't it be the best plan to let me support my strength by sticking to my patent tonic?"

Yes, it would be very convenient, especially in times of scarcity, if a starving horse could be supported by the daily application of a patent spur. It would save both oats and oaths. Even a fastidious nag could not help acknowledging the pungency of the goad. But it so happens that spur-fed horses are somewhat short-lived, though at first the diet certainly seems to act like a charm. For a day or two the drug stimulates the activity of the digestive organs as well as of the mental faculties, but the subsequent prostration is so intolerable that the patient soon chooses the alternative of another poison-fever. Before long the pleasant phase of the febrile process becomes shorter and the reaction more severe; the jaded system is less able to respond to the goad, and, in order to make up for the difference, the dose of the stimulant has to be steadily increased. The invalid becomes a bondsman to the drug-store, and hugs the chain that drags him down to the slavery of a confirmed poison-habit.

Circumstances may differ. A dyspeptic who intends to make his own quietus within a month or two, and in the mean while has a certain amount of work to finish, would be justified in stimulating his working capacities by all means, in order to improve to the utmost whatever chances of mundane activity may remain to him. But he who intends to stay has to make up his mind that recovery can not be hoped for till he has not only discontinued his drug, but expiated the burden of sin which the stimulant outrage has added to the original cause of the disease. Nature has to overcome the effects both of malnutrition and of malpractice. The drug has complicated the disease.

In childhood chronic dyspepsia is nearly always the effect of chronic medication. Indigestion is not an hereditary complaint. A dietetic sin *per excessum*, a quantitative surfeit with sweetmeats and pastry, may derange the digestive process for a few hours or so, but the trouble passes by with the holiday. Lock up the short-cakes, administer a glass of cold water, and, my life for yours, that on Monday morning the little glutton will be ready to climb the steepest hill in the county. But stuff him with liver-pills, drench him with cough-sirup and paregoric, and in a month or two he will not be able to satisfy the cravings of the inner boy without "assisting Nature" with a patent stimulant.

But is it fair to denounce a palliative when the radical remedies have lost their efficacy? What dietetic reform can avail a man to whom oatmeal-gruel has become a poison? How can he invigorate his system by exercise if he is hardly able to support himself on his legs? The asthenic stage of the disease can reach a degree when the mere suggestion of gymnastic enterprises is enough to produce a fit of nervous spasms. I have known of dyspeptics who would not have crossed a room to save a pet bird from the claws of a cat, and who would have joined an expedition to the north pole as soon as to the skating-ring. Theirs is a sad plight, for a rule that holds good of unnatural habits in general applies more especially to the chronic establishment of dietetic abuses, namely, that the further we have strayed from nature, the longer and wearier will be the road of reform. Before the invalid can restore the health and vigor of his system, he has to restore his *capacity for exercise.* The first object is to create a healthy demand for nourishment. Under normal circumstances that demand is proportioned to the amount of the organic expenditure. The nursing females of the mammalia require a larger amount of nourishing diet than the ordinary wants of the system would account for. During the age of rapid growth, children eat and digest as much as hard-working men. Diabetes, the first stage of consumption and other wasting diseases, is characterized by an exorbitant appetite. Every increase of muscular activity involves an augmented demand for nourishment; *cæteris paribus*, the man who walks a mile from his shop to his home will digest his supper more easily than he who takes the street-car. The hotel-boarder who makes it a rule to walk up the four flights of stairs to his attic will sleep sounder, and awaken more refreshed, than he who uses the elevator.

But the far-gone dyspeptic who is incapable of an active effort has to begin with a passive method of natural stimulation—the REFRIGERATION-CURE, based on the tonic influence of cold air and cold water. Voracity increases with the distance from the equator. An Esquimau eats a quantum that would crapulate three Hottentots and six Hindoos. A cold winter curtails the profits of boarding-houses. Camping in the open air whets the appetite even without the aid of active exercise. A bracing temperature exacts a sort of automatic exercise: it accelerates the circulation, it promotes the oxidation of the blood, and indirectly stimulates the whole respiratory process.* The

* "Why should sickness prevail during the warm, pleasant weather so much more frequently than during the cold? The reason appears to me very plain. The cold weather

generation of animal caloric has to be increased to balance the depression of the external temperature. Hence the invigorating effect of mountain-air, of sea-bathing, and, in high latitudes, of sea-voyages. The first dose of the tonic can be applied in-doors : sponge and shower baths, or Franklin's *air-baths*—a few minutes' pause between undress and bed-time.

People who have got rid of the night-air superstition can almost defy dyspepsia by sleeping in a *cross-draught*, or, in cold weather, at least near a half-open window. Cold, fresh air is an invaluable aid to the assimilation of non-nitrogenous articles of food (fat meat, butter, etc.). Stifling bedrooms almost neutralize the effects of out-door exercise. Winter is, therefore, on the whole, the most auspicious time for beginning a dyspepsia-cure. In summer a highland sanitarium is the best place to start with, or, for coast-dwellers, a surfy sea-shore. Early rising, a cold bath before breakfast, frequent ablutions, deep draughts of cold water, flavored with Seltzer and sugar or a few drops of raspberry-sirup, an air-bath before going to bed, and wide-open bedroom-windows, will score an important point in favor of Nature—the return of a normal appetite, and with it of renewed strength and mental elasticity. If the after-dinner affliction should show no direct signs of abatement, the patient must bide his time, and, under no circumstances, resort to the drug-exorcism. Temporary blue-devils are far preferable to a persistent blue-pill Beelzebub. But aid Nature by all legitimate means. Masticate thoroughly every mouthful of solid food. Eschew spices. Avoid pickles, cheese, salt meat, sour-krout, and hot drinks. Take a light breakfast, a lighter lunch, postpone the principal meal till the day's work is done, and make the after-dinner hour as pleasant as possible. Court fresh air at all times of the day and the night, and, in the course of two or three weeks, the capacity for active exercise will return. That point gained, the problem of recovery is reduced to a question of perseverance. The distress of the first attempts suggests almost the expediency of an unconditional surrender, but, after a dozen morning promenades in the park, and as many dumb-bell *soirées*, the three chief remedies begin to work hand in hand—exercise, refrigeration, and temperance. Exercise spices non-stimulating food, fresh air promotes digestion, and restored digestion gives strength for more exercise.

There will be fluctuations in the progress of convalescence. The valor of it, the confidence in the possibility of complete expiation, will sometimes falter under the realizing sense of past sins. The very effectiveness of the remedies will demonstrate the almost unpardonable mistake of their long neglect. But the stomach is not implacable, and, in spite of a few fretful relapses, it will, on the whole, accept the terms of reconciliation and ratify the treaty from week to week, till

braces us up, gives us a sharp appetite, and we indulge freely in food which, while the cold weather continues, can be tolerated by the system."—(Dr. C. E. Page.)

the convalescent has reached the maximum, and future average, of two hours per day of active OUT-DOOR EXERCISE. Languid promenades may require an extension of that time; wood-chopping will justify its reduction to an hour and a half. For rainy days there should be a covered wood-shed, or, better yet, an amateur carpenter-shop with a liberal supply of dull saws and thick boards. Asthenic invalids will derive great benefit from horseback-exercise, or even from a buckboard trip—with or without catch-ropes—the great desideratum in antibilious exercises being *concussion*, the sound shaking-up of the whole frame. Trapeze-evolutions, spring-board and dumb-bell practice rank, therefore, highest among the gymnastic specifics; wood-cutting and sawing among the more arduous kinds of manual labor; and trotting down-hill among the various modes of pedestrian exercise. It is worth a dyspeptic's while to hire a sedan-chair to lug him to the top of an out-of-the-way hill, and a boy to run him a race to the foot of it. After a week or so he will be able to dispense with the sedan. At the first symptoms of indigestion, book-keepers, entry-clerks, authors, and editors should at once get a *telescope-desk*. Literary occupations need not necessarily involve *sedentary* habits, though, as the alternative of a standing-desk, I should prefer a Turkish writing-tablet and a square yard of carpet-cloth to squat upon. But Schreber's telescope-desk enables the writer to sit and stand by turns, and has the further advantage of a sloping top that eases the wrist by resting the weight of the arm upon the elbow.

COLD-BATHS (always *before* dinner) may be limited to the summer season; but open bedroom-windows are *de rigueur* the year round. As long as the bedclothes keep the couch warm, the lungs can inhale cold air not only with impunity, but with the most unmistakable benefit to the digestive organs. The cold nights of the South African table-lands enable the Caffre to digest his barbecues of sorghum-beer and rhinoceros-steaks, and the neighborhood of a glacier makes many a Swiss highland hotel a stronghold of gluttony. In the dog-days it can do no harm, in a sequestered region, to take a river-side ramble at a time when only the moonlight watches on the meadows, for out-door exercise on an oppressively sultry day may defeat its object and bring on a fit of retching and nausea. Intensely cold air, on the other hand, is such a powerful tonic that, in midwinter, a ten minutes' trot along an icy pavement will often serve all the digestive purposes of that day, though the convalescent will be surer to have fulfilled all righteousness by adding half an hour's arm-work in the wood-shed. In midsummer dyspeptics sometimes deprecate exercise on the peculiar plea that a long-continued muscular effort acts as a reliable *astringent*, and the testimony of a veteran gymnasium-teacher of my acquaintance seems to confirm the physiological fact. But, in the first place, a transient constipation is no very serious matter, and, besides, the danger can generally be obviated by training early in the morning, or (about three hours after the last meal) in the cool of the evening.

Dietetic reforms should begin with the prescription of a strictly non-stimulating diet. A spoonful of mustard, a glass of small-beer or claret, may seem a mere trifle; but the trouble is that all stimulant-habits are progressive: the pungent spices are apt to slide into pungent tobacco, and the claret into port, or something worse. Fresh apple-vinegar, with a fruity flavor, can perhaps not do much more harm than sweet cider, but salt is not quite above suspicion, and the safest plan is to stick to comestibles that can be eaten without it. Cream, for that and other reasons, is better than fat meat, a whortleberry-soup better than a gravy-soup, and a raspberry-pudding preferable to a blood-pudding. All fried and broiled viands, all pickles, all rancid cheese, butter, and sausages, all smoked meats, are suspicious. Catchup-vials harbor the bottled-up demon of indigestion. But, withal, the diet should not be insipid. Ultra-vegetarians denounce all kinds of fat. Ultra-Grahamites suspect all sorts of sweetmeats. "Let your cook distinctly understand," says one peptic philosopher, "that, on peril of her life, she is to set nothing savory before you." Many hygienic institutes feed their dyspeptics on stale bran-bread, water-gruel, and watery vegetables. Man has a right to decline existence on such terms. Not the naturally palatable, but the unnaturally stimulating, qualities of a dish tempt the dyspeptic to eat to excess. For one man who surfeits himself with sweet grapes or pancakes, a thousand, at least, derange their digestion with strong cheese, or hot-peppered ragoûts. Alcoholic stimulants kill hundreds every year; how many intemperate drinkers have ever killed themselves with fresh milk or lemonade? And can not fruits, flour, milk, eggs, sugar, and orange-juice, furnish the ingredients of a very tolerable meal?—not to mention berries, tubers, and dozens of harmless vegetables that can be creamed and sugared into tidbits to rival the *entrées* of the Frères Provençaux in everything except virulence, *alias* pungency. It is better to improve the digestion than to spoil the appetite, for no man can thrive on a naturally distasteful diet. Nature intended us to be *vegetarians;* but I can not help thinking that the word is misleading by its popular association with the idea of kitchen-vegetables. Our next relatives in the animal kingdom do not live on pot-herbs, but on fruit. The victims of *plethoric dyspepsia*, the chronic gluttons who gorge for the sake of repletion, would stuff themselves with a potful of watery spinach as quick as with an eel-pie; and theirs is a rare, but indeed rather embarrassing predicament: they seem as unable to stop eating as to begin digesting. They are evermore esurient, though as cachectic as a starved Silesian weaver; I have seen gouty gluttons, to whom the sight of a restaurant-window was as tempting as a tavern-sign to a toper. Certain drugs would abridge their *penchant*, but, with it, also, the last traces of a digestive function; and, instead of reducing their appetite, it is better to reduce its capacity for mischief, by limiting the number of their daily meals. For, after all, that capacity is circumscribed by the caliber of the stomach, and, if the quality of the food is unexceptionable, there is no serious danger of a man's eating more at *one* meal than his system, under otherwise favorable circumstances, can dispose of in the course of the next twenty-three hours. The apprehension in *such* cases as to the insufficiency of one meal a day is wholly gratuitous. For more than a thousand years the one-meal system was the rule in two countries that could raise armies of men every one of whom would have made his fortune as a modern athlete—men who marched for days under a load of iron (besides clothes and provisions) that would stagger a modern porter. Even here, abstinence is easier than temperance ; for twenty-three hours of each day it is far easier to abstain from food (though, of course, not from water) than to begin eating and stop in time. Not one glutton in a thousand will do it. Dio Lewis recommends a limited number of dishes—"never put more on the table than you intend to eat" ; but the first mouthful reawakens the passion of Polyphemus, and for those who can not govern their appetite it is just about as easy to call for another dish as to reach for another plateful. But it is an excellent rule to *prolong the pauses* between the several dishes of a full meal, in order to give the stomach time to indicate the real wants of the system. "The ingestion of food," says Dr. Carpenter, "can not *at once* produce the effect of diminishing the feeling of hunger, though it will do so after a short time, so that, if we eat with undue rapidity, we may continue swallowing food long after we have taken as much as the wants of the body require."

The origin of the glutton-habit can often be traced to the mistaken liberality of a host who constantly urges the conviviality of his young guests, or even to the fatuous tenderness of nursing mothers, who so frequently think it their duty, as Dr. Page expresses it, to make a baby "guzzle till it is ready to die with fatty degeneration."

Begin with reducing the number of daily meals, and exercise, a change of climate and of habits will by-and-by help to subdue the baneful *penchant.* Occasional relapses can not be avoided ; but the progressive relief from a number of the worst gastric afflictions will at last induce the veriest cormorant to stick to the one-meal plan.

The best time for that one meal is the end of the working-day—4 or 5 P. M.—when business-cares can be laid aside for the rest of the evening. Asthenic dyspeptics, too—all, at least, who are not completely masters of their own time—had better choose that hour for their principal meal. No other hygienic mistake, not even the stimulant-fallacy, has done so much to make ours a dyspeptic generation as the fatal habit of *after-dinner head-work*—severe mental labor in the study, the school-room, or the counting-house, at a time when the whole strength of the system is claimed by the digestion of a heavy meal. Not only that the progress of digestion is thus interrupted, not only that the body derives no strength from the inert mass of ingesta, but that mass, by undergoing a putrid instead of peptic decomposition, vitiates the humors of the system it was intended to nourish, irritates the sensitive membranes of the stomach, and gradually impairs the vigor of the whole digestive apparatus. Hence the gastric torments of poor overworked teachers, who (unlike happier servants of the public) can not shirk their work, and have to snatch their dinner during a brief interval of the hardest kind of mental drudgery. Hence the sallow complexion, the hollow eyes, and the weary gait of thousands of city clerks, scholars, lawyers, newspaper drudges, and even physicians. Housewives, after dinner, have generally the good sense to rest awhile, often a very good while, and thus manage to digest their food ; for, that their immunity is not a prerogative of their sex is demonstrated by the chlorotic complexion of lady-teachers and boarding-school girls, who have only an hour's recess—physiologically no recess at all, if the school-bell rings right after dinner.

For those who have to drudge the whole afternoon, it would be better to postpone the principal meal to the very end of the day, and laugh at the supposed danger of "sleeping on a full stomach." For what do those who add a supper to an undigested dinner?—only with this difference, that their stomachs are obliged to dispose of an acidulated *mélange*. Animals, in a state of nature, nearly always sleep or rest after a heavy meal ; only the *homo sapiens* disregards the promptings of his instincts, and relies on a dyspepsia-pill.

In most cases, however, the matter could be compromised. Early rising and an unmuddled brain would enable almost any man to go home at 3 or 4 P. M., and counting-house clerks should consent to a reduction of their wages rather than forego the same privilege ; at five, a full meal of milk, farinaceous preparations, and nutritive vegetables, followed by a dessert of fresh or cooked fruit ; then a *siesta* of two full hours, music, conversation, or, *faute de mieux*, an entertaining book ; then, the weather permitting, a ramble in the cool evening air, or light gymnastics ; then rest in undress, an air-bath, and open bedroom-windows.

The general adoption of that plan would soon dissipate a strange and strangely prevalent fallacy : the supposed natural antagonism of the brain and the stomach—the alleged impossibility of combining studious habits with a sound digestion. Restricted to proper hours, head-work is as stimulating as any other kind of labor, and promotes digestion instead of hindering it. The nature-abiding habits of such men as Boileau, Linnæus, Cuvier, Goethe, and Humboldt, enabled them to reconcile the mental strain of their enormous literary activity with the enjoyment of almost uninterrupted health.

Dyspeptics, therefore, need not shirk brain-work, but, as they would shun the pills of a mercury-quack, they should beware of *exasperating mental emotions.* For it is a curious and not quite explained but incontestable fact that a short fit of anger is often enough not only to derange but to completely arrest the digestive process for a whole day. Close behind the stomach is a group of ganglia, the solar plexus, which sends out a large number of nerve-filaments that communicate with the brain, and thus suggest the physiological explanation of the curious phenomenon, though its final or teleological purpose is somewhat less apparent. Haller connects it with the fact that anger vitiates the saliva (*teste*, the virulent bite of enraged animals), and suggests that by a wise arrangement of Nature the suspension of the assimilative process may preserve the chyle from the contamination of malignant humors; and, in connection with the same subject, Camper mentions the circumstance that *fear* often acts as a sudden cathartic, perhaps for the purpose of easing the stomach, and thus preparing the body for emergencies—the necessity of flight, for instance. Speculations of that sort lead to a field of curious but rather recondite biological metaphysics; but the empirical fact remains, and partly suggests the *rationale* of another fact—namely, that pleasurable mental emotions act as a benignant digestive tonic. Hence, perhaps, the peptic beatitude of "jolly paunches," fellows who seem constitutionally unable to see the gloomy side of earthly concernments, and wax fat on the prescription of Democritus, "*Ride, si sapis.*" The autocrat of the dinner-table should, therefore, peremptorily exclude all conversational topics of an irritating character, as well as all business-talk. A remarkable influence on the action of the bowels can be exerted by *mechanical laughter*—I mean, the agitation of the diaphragm by means of a forcible and long-continued chuckle. Laurence Sterne mentions that he was able to keep up this factitious kind of laughter for minutes together, with or without the association of risible ideas. On solitary evenings that talent could be utilized as a physiological compensation for the absence of merry friends.

For the effects of mental worry, and nervousness (often the after-effect of stimulating medication), the best remedy, next to out-door work, is a *liberal allowance of sleep*; and metropolitans who can not afford to join the summer exodus should at least remove their beds to a suburban cottage, far from the sleep-murdering noise of the business centers.

But neither long sleep nor short meals can save dyspeptics who will insist on swallowing their food smoking hot. The walls of the stomach are lined with a nerve-interwoven delicate membrane, which suffers from scalding fluids as much as any other tegumental tissues of the body, and by daily torrefactions becomes either callous or chronically inflamed, and in either case less fit for the performance of its important functions. Our forefathers served their viands steaming hot, but stuck at least to cool drinks, but hot French soups were soon followed by hot tea and hot coffee. The "second breakfast," as the Germans call the eleven-o'clock refreshment, used at least to consist of cold meats; but competing saloon-keepers have now introduced hot lunches, and in our larger cities there is no escape for dyspeptics; "the smoke of their torment ariseth for ever and ever."

The gastric irritability which forms a lingering after-effect of chronic dyspepsia can be better allayed by *a vegetable diet* than by the nutritive extracts which are supposed to aid the work of digestion. The *bulk* of innutritive admixtures somehow excites and maintains the vigor of the digestive organs; and the human organism can not thrive on concentrated nourishment, as for similar reasons the lungs can not be fed on pure oxygen. *Water*, either pure or in organic compounds, is likewise an effective sedative and depuratory; it aids the process of eliminating the indigestible or noxious elements of various articles of food, whose ingestion therefore excites thirst. But, without waiting for that urgent appeal, we should remember that the diet of our instinct-guided relatives contains about ninety per cent of water, and that a dearth of fruit should be compensated by artificial compounds, supplying the requisite amount of fluids in a palatable form. The remedial influence of many famous spas is due to the water as much as to its mineral admixtures. About fifty years ago, the Brooklyn hotels were crowded with visitors, attracted by the fame of a doctor who cured all manner of diseases with pure rain-water. The mystic motto of Thales, "*Ariston men hydor*" ("The best of all things is water"), might perhaps be explained from such facts. Our diet, in fact, is much too dry, and could be improved without resorting to lager-beer, which redeems its deleterious influence to some degree by helping the Germans to digest their pungent comestibles. Water, in some of its combinations, is also an effective aperient; in watermelons and whey, for instance; but still more in conjunction with a dish of *legumina*—peas, lentils, and beans. No constipation can long withstand the suasion of a daily dose of pea-soup, or baked beans, flavored with a modicum of brown butter, and glorified with a cup of cold spring-water; and, moreover, the aperient effect is not followed by an astringent reaction—the cure, once effected, is permanent. Plethoric dyspepsia is almost invariably accompanied by close stools, and the drugs that have been swallowed to ease Nature—for a day—would poison half the living creatures of the American Continent.

But rather forego the beans than eat them with *pork*. The interdict of the Hebrew lawgiver, I suspect, has something to do with the climate-proof health of his countrymen, for in warm weather fat pork is about as digestible as yellow soap. The Hungarian peasants are ravenously fond of it, and neither out-door life nor the vigor of their Turanian stomachs can save them from the consequences. Every summer, and sometimes three and four times a year, the digestive system of the rustic Magyar relieves itself by an expurgative process known as the *tzömör*, or pork-surfeit, a three days' purgatory of heart-burns, nausea, and violent retching, accompanied by a burning thirst and an unspeakable loathing of all solid food. He who weathers the storm, says the traveler Kohl, feels like a new-made man, and reappears at the family table; but so does the pork-pot, and a few months after the respited sinner has another seizure, and groans, "O Jesus, Maria, *meg tzömöretem*—it's got me again!"

After the re-establishment of intestinal digestion, flatulence, vertigo, and that terror of constipated tea-drinkers, dull headache, become less and less frequent; the spell of the deliquium is broken, and the redevelopment of the wasted muscles proves that the system is no longer obliged to feed upon its own tissue. But these first symptoms of improvement should not encourage the patient to relax the rigor of the regimen before he is sure that the gastric inflammation has wholly subsided. As long as spasms and acrid eructations (water-brash) indicate the danger of a relapse, give the stomach all the *rest* you can. Never miss an opportunity that will make it easy to forego a meal or two. There are ways to make a fast-day a very trifling inconvenience, and its remedial value exceeds that of a round-trip to all the spas of the Eastern Continent. In my experiments on the operation of the fasting-cure, I have noticed the curious fact that for the first day or two the clamors of the stomach are restricted to certain hours, and can be induced to waive a disregarded claim. Convalescents who have already reduced the morning lunch to the standard of a Spartan breakfast, a "heathen fig and a thrice-accursed biscuit," can beguile the dinner-hour by diverting pastimes—a boat-trip, a fishing-excursion, a visit to the Zoo—and upon their return home will find that the craving for food has yielded to sleepiness, and the sweetness of the night's rest will be worth seven meals. It is during such periods of undisturbed rest that the work of repair makes its surest progress, and for the first three or four months it would be a good plan to imitate the example of the Ebonite heretics, who observed a weekly fast-day in the Ugolino sense of the word. Water, of course, should never be stinted, and, after a long fast, will have an especially good chance to depurate the vacated passages of the abdominal labyrinth.

An advanced stage of alcoholism (which will be treated in a separate chapter) often results in that malignant form of chronic indigestion known as hepatic or bilious dyspepsia, a complete derangement of the digestive process, accompanied by headaches, which for months defy the influence of an hygienic regimen, and yield only to the heroic remedies of the pedestrian-cure. But, with that exception, ten weeks of strict temperance, fresh air, and moderate exercise, will generally suffice to appease the resentment of the outraged stomach. During the next twelve months the reconciled digestive apparatus helps to redress the impairments of other organs. For it is a generic peculiarity of dyspeptic affections that the symptomatic outlast the idiopathic disorders. After the action of the bowels has become perfectly regular, after fat and sugar have ceased to cause heart-burn, the chronic lassitude—not pain exactly, but a nervous disinclination to active exercise—still lingers about the knee-joints ; the flexor muscles of the upper arm still shirk their work ; headaches that can not always be traced to dietetic backslidings recur at irregular intervals. The countenance is still sallow, the eyesight more or less impaired ; even vertigo and murmurs in the ears occur, without their former gastric concomitants. But at the end of each month the progress in the direction of general health is unmistakable. Mountain excursions marvelously further the good work ; but even the counting-house drudge need not doubt the reward of his perseverance, as long as he sticks to a plain diet, and such exercise as the opportunities of his leisure will offer on all but the busiest days. Unlike consumption (which can only be made non-progressive), dyspepsia can be thoroughly cured. As far as they are capable of repair, injuries to the respiratory organs heal quickly ; gastric ailments with less ease but more completely.

Gymnastics, however, combined with cold-baths, air-baths, deep draughts of cold spring-water, dietetic aperients, temperance, abstinent forenoons, liberal *siestas*, cheerful evenings, and wide-open bedroom-windows, will speed the advent of the time when the after-dinner hour shall cease to be the "saddest of the sad twenty-four"—nay, when digestion, like all normal functions of the animal organism, shall be once more not only a painless but a pleasurable process.

UNWRITTEN HISTORY.*

By Professor T. H. HUXLEY.

I DOUBT not that you all joined in cheering Lord Wolseley and his companions in arms the other day, when they came to Windsor to receive their well-earned honors at the hands of the sovereign. If I had been among you I should have given a special cheer, on my own account, to the general—not so much to the successful soldier as to the man of science, who had thoroughly studied the conditions of the problem with which he had to deal ; who knew what causes would produce certain desired effects; and whose experiments were followed by the predicted results more surely than sometimes happens with those which are made on a lecture-table.

But a much larger interest attaches to the day of Tel-el-Kebir, with all that preceded and followed it, than if it were an isolated experimental investigation of the great "survival of the fittest" prob-

* A lecture to the Eton Volunteer Corps, with some additions.

lem. These events of yesterday are but the latest episodes of a struggle between the social organization of Asia and that of Europe for predominance in the countries which border the Ægean and the Levantine Seas, which has been going on for some thousands of years. To say nothing of earlier events, Marathon, Thermopylæ, Salamis, the expedition of Alexander, the Punic wars of Rome, the Saracen occupation of Spain, the Crusades, the Turkish conquest of the Balkan Peninsula, the Egyptian expedition of the first Napoleon, are names of some of the long score of matches and return-matches played between East and West in the terrible game of war. And, in my judgment, the grandson of the youngest boy here is not likely to see the winner finally declared. For the contest depends not upon mere dynastic interests, or the lust of conquest, but is the inevitable product of the struggle for existence between incompatible forms of civilization, antagonisms of religion, and antipathies of race.

Twenty-four centuries, mainly occupied in fighting, do not afford a very pleasant retrospect at the best, and it would be altogether horrible, were not the affairs of this world so ordered that "there is a soul of good in things evil." No doubt millions of men, women, and children have suffered grievous misery and wrong, and whole nations have been annihilated, as the tide of conquest swept over them—now to the west, and now to the east. All that is sadly obvious, and, to those who can see only that which is obvious, these wars, like all others, must take the guise of purely diabolical evils. But a more patient and penetrating vision may discern that all this suffering is the school fee which the human race has had to pay for its education. As elsewhere, bright and dull pay alike, and the bright profit; which is, perhaps, no great satisfaction to the dull, but it is the rule of the school, and we have to put up with it.

In the present case, the Western nations are the bright boys. Your teachers of history are doubtless careful to point out to you all that ancient Greece owed to its intercourse, whether hostile or peaceful, with the East; all the benefit which Saracen learning on the one hand, and crusading enterprise on the other, conferred on Europe in the middle ages, and how much the Turks, quite unintentionally, did for the revival of learning. It is not to such familiar truths as these that I wish to direct your attention, but rather to the fact that history, in the modern sense of the word, was born of the very earliest of the struggles to which I have adverted.

I say history, in the modern sense of the word, that is, not barely a chronicle of events and record of current traditions or venerable myths, but a narrative based upon evidence which has been critically sifted, and in which the narrator endeavors to trace, amid the tangled occurrences of human life, the thread of natural causation which connects them with the needs and the passions of men. The chronicler is more or less of a gossip, the historian more or less of a man of science. For that which constitutes a man of science is not the pursuit of this or that specialty, but a living faith in the supreme importance of truth, and an unshakable conviction that order reigns over all things, and that chance has no more place in human affairs than elsewhere.

Now, the generation of the science of history took place in this wise: Somewhere in the earlier half of the fifth century, a sort of side skirmish of the Persian wars drove out of house and home a Greek gentleman—one Herodotus, with whose name you will be sufficiently familiar. He was a man of great intelligence and unflagging energy, well versed in all the learning of his time. The magnitude and the interest of the events which had taken place, either within his own memory or within that of men with whom he had talked, seem early to have taken strong hold of his mind, and he determined to devote his life to writing an account of them, in which truth should be sifted from error, and the causation of events displayed to the best of his ability.

With this end in view, Herodotus was not content with collecting and collating all the information which he could obtain from trustworthy sources, but he determined to become personally acquainted with the chief countries and people implicated in the contest. There lay the primary conditions of the problem which "the father of history" had set himself to study; and there is no better evidence of his strong scientific turn than the conviction on which he acted, that, if he would understand these conditions, he must know them of his own knowledge.

Egypt was one of the countries involved in the Persian wars. Herodotus visited the country somewhere about 450 B. C., and he has left a most curious and entertaining account of his own observations, and of the information which he obtained from the priests of Thebes and the *literati* of Heliopolis, with whom his interpreter, or dragoman, as we should now call him, brought him into contact.

I dare say you read the second book of Herodotus, and know a great deal more about it than I do. Nevertheless, it may not be superfluous to remind you that the historian speaks with admiration of the learning of the Egyptians, and of the remarkable pains which they took to preserve the memory of the past in their records. Among a great many other things, they read to him from a papyrus the names of three hundred and thirty monarchs who had reigned over Egypt, from Menes, the first Pharaoh, to their own time.

The average length of the reigns of any long series of Western sovereigns is about twenty-five years, so that, if the records of the Egyptians were to be trusted and the average length of reign among them was the same, Menes should have ascended the throne more than ten thousand years ago.

Within my recollection it was very much the fashion to regard Herodotus as a garrulous old gentleman, who willingly allowed himself to be crammed with interesting fictions; and the pretension of the Egyptians to such prodigious antiquity of their state was regarded as one of the most patent examples of such figments. Yet it is probable that, in respect of this and other pieces of information of like character, the learned Egyptians said no more, not only than they fully believed, but than they might fairly enough think they had good reason for believing; and modern investigations have shown that they were certainly much nearer the truth than sundry of their critics.

Among the achievements of scientific method in this century, none is, to my mind, more wonderful than the disinterment of so much of a past, to all appearance hopelessly dead, by the interpretation of the hieroglyphic and cuneiform inscriptions in which the ancient inhabitants of the valleys of the Nile and the Euphrates chronicled the events of their history. Thanks to the sagacity and the untiring toil of such men as Lepsius—just about to receive the congratulations of all the world on the completion of half a century of fruitful labor—of Birch, of Mariette, of Brugsch, the student of Egyptology, guided by the spirit of scientific criticism, is probably far more accurately informed about the ancient history of Egypt than was the whole College of Heliopolis in Herodotus's time.

An exact chronology of Egyptian history is yet to be constructed; but those best qualified to judge agree that contemporary monuments tell us of the state of Egypt more than five thousand years ago; and since they prove, beyond the possibility of doubt, that the people who erected them possessed a complex social organization, as replete with all the necessaries and conveniences of life as that of any nation in Europe in the middle ages, and not inferior in literature or in skill in the arts of painting, sculpture, and architecture, it is but rational to conclude that, even at this farthest point of time to which written records take us, the Egyptian people had, for long ages, left barbarism behind, and constituted a settled and a civilized polity. So that, whether Menes was followed by three hundred and thirty kings or not, the general impression of the vast antiquity of the Egyptian state which Herodotus received, and has transmitted to us, has full justification.

But that which is so characteristically modern about Herodotus is that he was not satisfied to stop where written records halt, or to accept traditional accounts of an earlier time without discussion. His informants told him that, when Menes began to reign, Lower Egypt was covered with water, a dismal and pestilent swamp, and that the first Pharaoh drained and rendered habitable that alluvial soil which they called "the gift of the Nile."

Herodotus was evidently very much interested in this statement. Perhaps he asked his Heliopolitan friends how they knew this. Perhaps they answered him as they did a countryman of his, "You Greeks always were and always will be children," asking the why of the wherefore. A true saying, which, however it may have been intended, conveys high praise. For it is just because it is true that these mighty children became the fathers of natural knowledge. Men of science are eternal children, always asking questions of Mother Nature, and never content with her answers.

But, whether questions are childlike or childish, depends upon the knowledge and the intelligence of the questioner; and Herodotus, as I have said, was largely endowed with both. Let me remind you that he lived midway between Thales and Aristotle, in the very heart and center of the great age of Greece; and let me also remind you of the fact, of which people too often remain ignorant throughout their school and university career, that, if this was an epoch of great achievements in art, in literature, and in philosophy, it was no less distinguished for the sedulous cultivation of physical science. Democritus, the contemporary of Herodotus, was the great exponent of principles which have played, and still play, a great part in modern scientific speculation. Half a century before Herodotus, Xenophanes had observed petrified marine shells and fish-bones in the quarries of Syracuse and elsewhere; he had drawn the conclusion that the rocks in which they were contained were the hardened mud of the bottom of the sea in which the corresponding animals once lived; and he had laid down the general proposition that the geographical features of our earth are not constant, but that where land now is, sea has been, and where sea is, land has been. And it is a corollary from this proposition that the land which constitutes any country has not always been what it is and where it is, but that it has a history, unwritten save in the hieroglyphics of Nature. Herodotus is not likely to have been ignorant of the speculations of Xenophanes, but it is in evidence that his extensive travels had enabled him to observe facts which led directly to like conclusions. The plain of Ilium and the estuary of the Mæander had shown him rivers at work in the formation of new land, and he adverts to the conclusions to be drawn from the presence of shells in the rocks which bound the Nile Valley.

To a mind thus prepared by an acquaintance with elementary truths of physical science, the first glance at Egypt can not fail to suggest inquiry, and, in fact, Herodotus says as much:

"Any one who sees Egypt, without having heard a word about it before, must perceive, if he has the least intelligence, that the Egypt to which the Greeks go in their ships is a gift of the Nile to the Egyptians."* That is to say, as he elsewhere explains, the rich soil of the great plain, or so-called Delta of Egypt, has been formed out of the deposits left by the Nile during the annual inundation. The region occupied by the delta, he adds, was "evidently, at one time, a gulf of the sea. It resembles, to compare small things with great, the parts about Ilium and Teuthrania, Ephesus, and the plain of the Mæander. In all these regions the land has been formed by rivers, whereof the

* Those and other citations are taken from Rawlinson's "Herodotus."

greatest is not comparable in size with any one of the arms of the Nile." After comparing the valley of the Nile with that of the Red Sea (which Herodotus appears not to have visited, and of the magnitude of which he has a very inadequate conception), he goes on to say: "Now, if the Nile should choose to divert his waters from their present bed into the Arabian Gulf, what is to prevent it from being filled up by the stream within twenty thousand years at most? For my part, I think it might be filled up in half the time. Why, then, should not a gulf of even much larger size have been filled up in the ages before I was born, by a river which is so large and so given to working changes as the Nile?"

It is on the strength of these very sound and just physical considerations that Herodotus tells us he accepted Egyptian tradition:

"Thus I gave credit to those from whom I received this account of Egypt, and am myself, moreover, strongly of the same opinion, since I remarked that the country projects into the sea farther than the surrounding shores, and I observed that there were shells upon the hills." Finally, he inquires into the origin of the population of Egypt:

"I do not believe that the Egyptians came into being at the same time as the delta. I think they have always existed, ever since the human race began. As the land went on increasing, part of the population came down into the new country, part remained in the old settlements."

Thus Herodotus commits himself to four very definite propositions respecting the unwritten history of Egypt:

1. That the delta was once an arm of the sea.
2. That it has been filled up and converted into dry land by the alluvial deposits of the Nile.
3. That this process of conversion into dry land probably took something like twenty thousand years.
4. That the Egyptians existed before Lower Egypt, and migrated thence from Upper Egypt.

And it will be observed that the first three of these propositions at any rate are not mere guesses, but conclusions based upon a process of reasoning from analogy, just as sound in form as any which is to be met with in the discussion of a similar problem in a modern treatise on geology.

Herodotus wrote twenty-three hundred years ago. In the course of twenty-one out of the twenty-three centuries which have elapsed since his time, I am not aware that any one rose above his level in the discussion of such problems as that which he attacked. And some quite modern writers have not yet reached it, for lack of as much knowledge of natural phenomena as Herodotus possessed. Let us look at the facts by the light of such knowledge of elementary physical science as is now happily accessible to every Etonian.

It has often been said, and with perfect truth, that Egypt is a land by itself, unlike any other part of the world. On approaching Alexandria from the sea, nothing can be less attractive than the flat shore which stretches east and west as far as the eye can reach, without an elevation of more importance than bare and barren sand-dunes to break its even line. This monotonous coast extends for two hundred miles between the most extreme of the ancient arms of the Nile, from the Canopic in the west to the Pelusiac in the east, and forms the northwardly turned base-line of the triangular area of Lower Egypt, the shape of which led the Greeks to call it the delta.

In the journey from Alexandria southward to Cairo, the traveler finds himself in a boundless plain, as flat as the flattest part of Lincolnshire or of Holland. At first, rising only here and there above the level of the Mediterranean, it is full of morasses and stagnant lakes of great extent, the waters of which vary from salt to fresh, and from fresh to salt, according as the Nile or the Mediterranean is the predominant contributor to their contents. Beyond this region, the wide expanse of black alluvial soil, intersected by innumerable water-courses, departs from absolute horizontality, rising some three or four inches in the mile. Here and there, low mounds bearing groups of date-palms, or thickets of sycamores and acacias, indicate the deserted site of an ancient city, or preserve from the periodic floods the assemblage of hovels which constitutes a modern Egyptian village. In autumn, the soil, save these mounds and their connecting dikes, disappears under the overflow of the flooded Nile; in early spring, the exuberant vegetation of the young crops no less completely hides it under a carpet of the brightest imaginable green.

For more than a hundred miles, as the crow flies, this is the general character of the country between Alexandria and Cairo. But, long before the latter city is reached, the plain begins to be limited by distant heights which spring up on either hand. First, a ridge of low hills makes its appearance on the western or Libyan side; and then, a range of more distant but bolder and loftier heights shows itself, far away, on the eastern or Arabian horizon. With every advance southward the plain diminishes in extent, while its Libyan and Arabian boundaries approach, until, at Cairo, they are not more than six or seven miles apart.

Nothing can be more sharply contrasted than the aspect of the plain and that of its limitary heights. For the low, rounded ridges on the west and the higher plateau with its steep and cliffy face on the east are utterly waterless—mere wastes of bare rock or sand—without a bush or a patch of soil on which it could grow, to veil their savage nakedness. Under our own pale and faintly-lighted sky, such bare hills and rugged cliffs as those which bound the prospect here and everywhere in Upper Egypt would fitly represent the abomination of desolation. But, framed as they are in an atmosphere of limpid purity, with lights and shades and tints endlessly varying in shape and hue, from hour to hour, and almost from minute to minute, as the sun runs his course, they have a strange and unique beauty. Moreover, in early spring, the edges of the greenery of the plain lie sharply defined against the yellow sands and gray-brown stones of the waste as if it were so much water.

When I was in Cairo, ten years ago, I delighted in wandering about the heights of the Mokattam range, which rise for some four or five hundred feet immediately to the east of the city. The Sahara itself can not better deserve the name of desert than do these stony solitudes. Looking westward at sunset, the vultures, diminished to mere crows, wheeled about the face of the cliffs far below. Beneath and beyond them, the green expanse stretched northward, until it became lost in the horizon; while, toward the west, its even line followed the contour of the Libyan shore, as if it were the veritable sea-water of the Gulf of Herodotus. And sharply defined against the western sky, the great pyramid, which, even in its present mutilated state, reared its summit to the level of my eye, threw its long shadow eastward like the gnomon of an appropriately gigantic dial-plate.

Indeed, the comparison is not far-fetched. For the great shadow has veritably swept, from west to north and from north to east, day after day from the dawn of civilization till now; since the toiling subjects of Chufu, with patient and skillful labor, piled the great stones of his tomb, one upon another, it has marked the birth-hour, and sometimes the death-hour, of each great nation known to history.

For all these ages, day after day, the shadow, as it lengthened eastward, has swept over the weary heads of thousands upon thousands of orderly, cheerful, hard-working men, women, and children, who have been plundered, starved, beaten, decimated, now to serve the ambition or gratify the superstitious vanity of an ancient Pharaoh, and now to enable some thinly varnished savage of a modern Khedive to subsidize his opera troupe in Cairo, and squander the price of their blood among foreign harlots and foreign swindlers.

Six thousand years of grinding oppression, worse than it ever was during the last few centuries, seemed to me a curious reward for laying the foundations of civilization; and yet there was no sign that the great shadow was likely, for another century or so, to mark the hour when Khedive, mudirs, commercial Mamelukes of various nationalities, and all the rest of the "wolves that with privy paw devour apace and nothing said" should be swept away to make room for that even moderately decent and intelligent rule which is all the Egyptian people need to become, at last, a contented and a wealthy nation.

But this, I say, was ten years ago; many things—Tel-el-Kebir among the rest—have happened since then; and perhaps the good time may be coming. At any rate, the great British panacea—constitutional government—is to be administered; and if the Fellaheen sheep do not find their affairs much improved when the representatives of their interests are mostly mongrel Arabo-Turkish wolves (as they certainly will be), they must be unfit for free institutions, and we may wash our hands of them, conscious that we have exhausted the resources of political science in our intelligent efforts to improve their condition.

The extent of the land now under cultivation in Egypt is estimated approximately at 7,300 English square miles—that is to say, its area is about a fifth greater than that of the valley of the Thames (6,160 square miles). One half of this cultivated land lies in the delta, and the other half in Upper Egypt. Under the Pharaohs, the cultivated area was of considerably greater extent; but not even the industry and thrift of the Fellaheen have been able to make head against the ignorance, sloth, and greed of their later rulers.

Above Cairo, the Libyan and the Arabian boundaries of the narrow valley of Upper Egypt, which runs in a southerly direction, through 6° of latitude to Assouan in 24° north, are approximately parallel, here approaching and there diverging from one another, though they are rarely more than ten or fifteen miles apart. The general inclination of the bottom of the long and winding stream, though rather greater than in the delta, does not exceed five or six inches in the mile. Hence, Assouan, some five hundred miles distant, in a direct line, from Alexandria, is little more than three hundred feet above the Mediterranean.

In Upper Egypt there is still less rain than in the delta. For, though violent storms, accompanied by a heavy down-pour, occur at intervals of perhaps twenty years, filling the parched ravines of the desert with short-lived torrents, there is usually either no rain, or, at most, a passing shower, in the course of each year. Hence, not only the boundaries of the valley, but all the country eastward as far as the Red Sea, and all westward (save where a rare oasis breaks the monotony of the waste) for hundreds of miles across the Sahara, over which the same meteorological conditions prevail, is, if it be possible, even more arid and barren than the desert which bounds the delta.

What are known as the "tombs of the kings" are excavated in the walls of a deep gorge which runs from the plain of Thebes far into the Libyan Hills, the steeply escarped faces of which rise twelve hundred feet above the river. From the summit of one of these hills a panorama of appalling desolation presents itself. Except where the Nile lies like a brown ribbon, with a broader or narrower green fringe on either side, north, south, east, and west, the eye rests on nothing but rugged heights of bare rock, separated by a perfect labyrinth of steep-walled valleys. Baked during the day by a cloudless sun, cooled, not unfrequently down to the freezing-point, at night by radiation through the vaporless air, the surface-rocks are shattered by the rapid expansion and contraction which they undergo, as if they had been broken by a road-maker's hammer; and the fragments collect in great heaps at the bottom of every steep incline. Not a blade of grass, not a drop of water, is to be seen anywhere; and yet the form and arrangement of the ravines are such that it is impossible to doubt that they have been formed, like other valleys, by the scoring and denuding action of rapid streams.

I remember that one day, wandering in the desert, northeast of Cairo, in the direction of the petrified forest, I was exceedingly struck with the resemblance of the superficial scorings of the surface of the rocky soil to those which are ordinarily made by rain. I was puzzling myself to account for the fact, when a sudden storm, accompanied by very heavy rain, came up, drenched me to the skin and vanished, all in less than an hour. Immediately after the rain began to fall, every one of the ramified scorings which had interested me was filled by a stream of water, rushing to join with its fellows and flow down some bigger groove to a lower level. It was obvious that the resemblance which had struck me was not deceptive, and that all these ramified scorings were miniature "wadys"—the dry beds of minute rivulets produced by former sudden showers of the same sort as that which I had experienced.

It was a capital lesson in physiography, and I did not forget it when I looked down on the great wadys of the Libyan desert at Thebes. Twelve hours' heavy rain would send a roaring torrent, sweeping before it all the accumulated *débris* of years, down every one of them. And if we suppose the process repeated only every twenty years; still, since the Libyan Hills have been where they are for the last ten thousand years, five hundred repetitions of the application of this most efficient rain-plow would have cut some pretty deep furrows, even if, during all this time, rain has never been more frequent or more abundant than it is now.

Still farther to the south, about El Kab, close upon the twenty-fifth parallel of latitude, the fringe of cultivable land which borders the Nile becomes narrower and narrower, and the limestones in which the valley has hitherto been excavated are replaced by sandstones as far as Assouan. The low hills of such rock (rarely more than two hundred feet high) which lie on each side of the river at Gebel Selsileh, about forty miles north of Assouan, approach one another so closely that the gorge through which the stream passes is little more than one thousand feet wide. There is every reason to believe that the opposite walls of this gorge were once continuous, and that the river swept as a rapid over the correspondingly elevated margin of the sandstone plateau, through which it has since cut its channel back to Assouan, until, at present, its bed, for the forty miles to that place, has no greater inclination than elsewhere.

Near Assouan, under the twenty-fourth parallel, on the frontier of

Nubia, the granitic masses of the desert on the eastern or Arabian side spread suddenly to the westward, and come to the surface in place of the sandstones. In the course of the six or seven miles between Assouan and Philæ the bed of the river rises sixteen feet,* forming a declivity, down which the stream rushes in a rapid, known as the First Cataract. The alluvial soil has almost vanished, and the river flows amid a confused heap of granite blocks, with black and polished surfaces. For some eight degrees of latitude farther south, the granite and sandstone plateau which rises so suddenly at Assouan extends through Nubia, increasing in elevation, until at the foot of the second cataract (Wady Halfa) the level of low Nile reaches 392 feet ; at the third cataract, 659 feet ; at the fourth, 745 feet. Where the White and Blue Niles join, just below Khartoum, in 16° north, the river is 1,212 feet above the sea, or more than 900 feet above its height at Assouan.

Throughout the whole of this course the Nile receives but one affluent, the Atbara, which carries the drainage of a part of Abyssinia into it in about 18° north. And, as this solitary tributary is wholly inadequate to make good the loss which the main stream suffers by evaporation and percolation, on its course through thirteen degrees of one of the hottest and driest climates in the world, the Nile presents the singular spectacle of a river the volume of water in which is conspicuously less than that poured into it by its feeders.

The Blue and the White Niles, which unite to form the main stream close to Khartoum, are in fact very large rivers, each of which drains an immense area abundantly supplied with water. The one receives the overflow of the great equatorial Nyanza lakes and the drainage of the vast swampy region of the Soudan to the north of them, in which the heavy intertropical summer rains accumulate. The other is fed not only by such rains, but by the snows among the mountain-tops of Abyssinia, which melt as the sun advances to the northern tropic.

The height of the water in the Nilometer at Cairo is contingent upon the meteorological conditions of a region more than a thousand miles off ; and the question whether Egypt shall have a year of famine or a year of plenty hangs upon the rainfall in Abyssinia and equatorial Africa. It is as if the prosperity of the agricultural interest in Berkshire depended on the state of the weather in Morocco.

The general course of the Nile is so directly north and south that the thirtieth parallel of east longitude, which traverses the Albert Nyanza Lake on the equator, passes close to the Rosetta mouth at its outfall. The Albert Nyanza is 2,500 feet above the sea ; and, since the length of the part of the great circle inclosed between the points

* The heights of points in the course of the Nile, given in books, are widely discrepant and usually very inaccurate. I am indebted to the eminent civil engineer, Mr. John Fowler, for this and subsequent precise determinations. The height of low Nile above the sea is 303 feet at Assouan, 319 feet at Philæ.

just mentioned is more than two thousand English miles, the mean inclination of the river, if it ran straight, would somewhat exceed a foot per mile. Taking the actual bends into consideration, however, it must be considerably less than this amount.

Without a knowledge of the facts thus briefly sketched, the periodical inundation of the valley of Egypt by the Nile is unintelligible. And, since no one till long after Herodotus's time possessed such knowledge, we may proceed to consider this singular phenomenon without troubling ourselves about his curious speculations as to its causes.

In the month of May and the beginning of June, the Egyptian Nile is little better than a great sluggish ditch, the surface of which, in Upper Egypt, lies many feet below that of its steep banks of irregularly stratified mud and sand. A short distance north of Cairo, it divides into two main branches, which take a northerly course through the delta and finally debouch, the one at Rosetta and the other at Damietta. Innumerable artificial canals connect these arms of the Nile with one another, and branch off east and west for purposes of irrigation; while, in the north, the complex system of water-courses communicates with the series of lakes and marshes, from Mariout, on the west, to Menzaleh on the east, which, as I have already said, occupy a large portion of the area of the delta southward of the sea-coast.

In the latter part of June, about the time of the summer solstice, the motion of the torpid waters of the Nile seaward is quickened, and their level rises, while at the same time they take on a green color. The rise and the flow quicken, and the green color is succeeded by a reddish brown; the water becomes turbid and opaque, and is found to be laden with sediment, varying in consistency from moderately coarse sand, which falls to the bottom at once when the water is still, to mud of impalpable fineness which takes a long time to subside. In fact, when the sun approaches the northernmost limit of his course, as the snows of Abyssinia begin to melt, and the heavy intertropical rains set in, a prodigious volume of water is poured into the White and Blue Niles, and drives before it the accumulated living and dead particles of organic matter which have sweltered in the half-stagnant pools and marshes of the Soudan during the preceding six months. Hence, apparently, the preliminary flow of green water. The Blue Nile and the Atbara must sweep down a vast quantity of river-gravel from the Abyssinian uplands, but it may be doubted whether any of this gets beyond the middle cataracts, except in the condition of fine sand. And I suspect that the chief part, if not the whole, of the coarse sediment of the waters of the high Nile must be derived from Nubia, from the weathering of the rocks, by the heating and cooling process already described, and the action of the winds in blowing the sand thus produced into the stream. The Nile continues to rise for three months until the autumnal equinox, by which time the level of its surface at Assouan is usually forty feet, at Thebes thirty-six feet, at Cairo twenty-four or twenty-five feet, and at Rosetta four feet higher than it is in May ; and, before reaching the delta, it flows at the rate of three or four miles an hour.

Under these circumstances, the river overflows its banks on all sides. When it does so, the movement of the water is retarded or even arrested, and the suspended solid matters sooner or later fall to the bottom, and form a thin layer of sandy mud. When the Nile waters spread out over the great surface of the delta, the retardation is of course very marked. The coarse sediment is soon deposited, and only the very finest particles remain in suspension at the outflow into the Mediterranean. As the sun goes southward, his action on the Abyssinian snows diminishes, the dry season sets in over the catchment basin of the White Nile, and the water-supply of the Nile diminishes to its minimum. Hence, after the autumnal equinox, the Nile begins to fall and its flow to slacken, as rapidly as it rose. By the middle of November, it is half-way back to its summer level, and it continues to fall until the following May. In the dry air of Nubia and of Egypt, evaporation is incredibly rapid, and the Nile falls a prey to the sun. As the old Egyptian myth has it, Osiris is dismembered by Typhon.

Relatively to the bulk of water, the amount of solid matter transported annually by the Nile must be far less than that which is carried down by the rapid streams of mountainous countries in temperate climates—such, for example, as the upper Rhône. We have no very satisfactory estimate of what that amount may be, but I am disposed to think that the ordinary computation, according to which the average deposit over the delta amounts to not more than a layer one-twentieth of an inch thick annually, is, at any rate, not under the mark.

But this is a very interesting question, for it is obvious that, if we may assume that the deposit of the Nile has taken place uniformly at a known rate, it becomes possible, given the thickness of the alluvial deposit in the delta, to calculate the minimum time occupied in its formation. The borings made under the direction of the late Mr. Leonard Horner in the upper part of the delta, and those subsequently conducted by Figari Bey, favor the conclusion that the natural loose soil which fills the flat basin of the delta nowhere exceeds sixty feet in depth. Assuming it to have this thickness in any spot, it follows that, at one twentieth of an inch of deposit per annum, it must have taken at least fourteen thousand four hundred years to accumulate to that thickness at that place. And if so, Herodotus seems, at first, to have made a wonderfully good guess, when he said that the Arabian Gulf and, by implication, that of the delta, might have been filled up in "twenty thousand years, or even half the time."

I am afraid, however, that any such modern estimate has not a much surer foundation than the ancient guess. For, in the first place, there are many reasons for believing that the action of the Nile has not been uniform throughout the whole period represented by the deposit of alluvium; and, in the second place, if it had been, the simple process of division of the total thickness of the alluvium by that of the annual deposit does not by any means necessarily give the age of the whole mass of alluvium in the delta, or, in other words, the time which elapsed during the filling of the delta, as it is sometimes supposed to do.

According to Figari Bey, the deepest, and therefore earliest, alluvium in the delta contains gravel and even bowlders; so that, if these are fluviatile beds, which is, perhaps, not quite certain, they indicate that, at the time when they were deposited, the current of the Nile in this region was much more powerful than it is now, and, consequently, that its annual additions were much more considerable.

If the flow of the Nile in these ancient times was more rapid, the probabilities are that the volume of its waters was greater, and sundry observations have been adduced as evidence that such was the case. Thus, at Semneh, above the second cataract, Lepsius, many years ago, discovered inscriptions of a Pharaoh of the twelfth dynasty, Amenemhat III, who reigned between 2,000 and 3,000 B. C., which registered the level of the highest rise of the Nile at that time. And this level is nearly twenty-four feet higher than that of high Nile at the same place now. Another fact has been connected with this. Between the narrow gorge of the Nile at Selsileh and the first cataract, alluvial deposits, containing shells of animals now living in the river, lie on the flanks of the valley, twenty to thirty feet above the point which high Nile reaches at the present day. It has been suggested that, before the Nile cut the gorge, the sandstone bar at Selsileh, as it were, dammed up the Nile, and caused it to stand at a higher level all the way back to Semneh. But, as the late Dr. Leith Adams long ago argued, the sandstone strata of Selsileh could hardly have played the part thus assigned to them. The deposits in question indicate that the supposed barrier at Selsileh was about thirty feet high; while Semneh is at least one hundred and thirty feet higher than Selsileh.

The cause of the difference of level of the Nile at Semneh, between the days of Amenemhat and now, is surely rather to be sought in the progressive erosion of the Nubian valley. If four thousand years have elapsed since Amenemhat reigned, the removal of one thirteenth of an inch per annum from the bed of the river will be more than enough to account for its present depression. Considering the extraordinary activity of the denuding forces at work in Nubia, I see nothing improbable in this estimate. But, if it is correct, there is no need to suppose that the Nile conveyed a greater body of water four thousand years ago than it does now. Nor is there anything in the ancient records of Egypt which lends support to such an hypothesis.

But we are indebted to Dr. Leith Adams for proof that the Nile, between the first and the second cataracts, once stood very much more than twenty-five feet above its present level. From Assouan to Derr, in fact, he observed abundant patches and continuous terraces of alluvium, containing shells of the same kinds of fresh-water mollusks as those which now inhabit the Nile, one hundred to one hundred and twenty feet above the highest level now reached by its waters; and he concludes that "the primeval Nile was a larger and more rapid river than it is now." I am disposed to think that the "primeval" Nile was so, but I question whether these terraces were made by the river in its youth. I see no reason why they should not be affairs of a geological yesterday—say, a mere twenty or thirty thousand years ago.

There can be no reasonable doubt of the correctness of the view first, so far as I am aware, distinctly enunciated by M. Louis Lartet,* that the whole of the principal valley of the Nile has been excavated by the river itself. I am disposed, for my own part, to think that the Nile might have done this great work if the mass of its waters had never been much greater than now. And, with respect to the innumerable lateral ravines which debouch into the main valley, I think it would not be safe to affirm that they could not have been excavated by the rains, even if the meteorological conditions of the country had never been very widely different from what they are now.

But, in some parts of Lower Egypt, and in the peninsula of Sinai, many of the dry wadys exhibit such massive deposits of more or less stratified materials, that it is hardly credible they can have been formed under anything like existing conditions. Indeed, in some localities, very competent observers have considered that there is good evidence of the former existence of glaciers in the valleys of Sinai. And it is well worthy of consideration whether, as Fraas and Lartet have suggested, these deposits were not contemporaneous with the so-called glacial epoch, when the climate of Northern Europe resembled that of Greenland, and when the Mediterranean covered the Sahara and washed the western flanks of the Libyan range.

Under such changed conditions, Egypt must have been one of the wet countries of the world, instead of one of the driest; and, as there need have been no diminution in the bulk of water poured in by the White and Blue Niles, the accumulation of water in the valley of Egypt, partly in virtue of its own rainfall, and partly by the dimi-

* "Essai sur la Géologie de la Palestine et des Contrées avoisinantes, telles que l'Egypte et l'Arabie," 1869. The Rev. Barham Zincke, in his interesting work "Egypt of the Pharaohs," 1871, has expressed similar conclusions; and I may say that they forced themselves on my own mind in the course of my journey to the first cataract in 1872.

nution of evaporation, may have been immense. Under such circumstances, it is easily conceivable that a swift and voluminous torrent, periodically swollen by the contributions of the great southern affluents, covered the delta with a permanent inundation, and swept down gravel and bowlders into the lowest part of its course.

That the outflow of the Nile once extended far beyond its present limits appears to be certain, for a long, deep, dry valley—so like an ancient river-bed that the Arabs call it the Bahr-bela-Ma, or waterless river—runs from south to north in the Libyan desert along the western edge of the delta, and ends in the Mediterranean shore beyond Taposiris, far to the west of the Canopic mouth, the most westerly of the outlets of the Nile known during the historical period. And, in the extreme east, far beyond the most easterly arm known to the ancients—in fact, in the middle of the Isthmus of Suez, about Lake Timseh—alluvial deposits, containing Nile shells and hippopotamus-bones, show that the Nile once extended into this region, and perhaps poured some portion of its waters into the Red Sea, by way of anticipating the engineering operations of more modern days.

These facts tend to show that any calculation of the age of the delta, based upon the present action of the Nile in the way indicated, may need to be abbreviated. But, on the other hand, there are many obvious considerations which tend the other way.

It is easy to see that the time required for the deposition of a certain thickness of alluvial soil, in any one part of the delta, can only be a measure of the time required to fill up the whole, if the annual sediment is deposited in a layer of even thickness over the entire area. But this is not what takes place. When the river first spread out from the southern end of the delta, it must have deposited the great mass of its solid contents near that end ; and this upper portion of the delta must have been filled up when the lower portion was still covered with water. And, since the area to be covered grew wider, the farther north the process of filling was carried, it is obvious that the northern part of the delta must have taken much longer to fill than the southern. If we suppose that the alluvium about Memphis was deposited at the rate of one twentieth of an inch per annum, and that there are fifty feet of it, ten thousand years may be the minimum age of that particular part of the delta ; but the age of the alluvium of the delta as a whole must be very considerably greater. And indeed there are some indications that the shore-line of the nascent delta remained, for a long time, in the parallel of Athribis, five-and-twenty miles north of Cairo, where the remains of a line of ancient sand-dunes are said to attest the fact. Hence, all attempts to arrive at any definite estimate of the number of years since the alluvial plain of the delta began to be formed, are frustrated. But, the more one thinks of the matter, the more does the impression of the antiquity of the plain grow ; and I, for my part, have no doubt that the extreme term imagined by

Herodotus for the filling up of the Arabian Gulf—twenty thousand years—is very much below the time required for the formation of the delta.

Thus far we have traced the unwritten history of Egypt, and the gulf of the Mediterranean, postulated by Herodotus, is not yet in sight. Nevertheless, at a much more remote epoch—in that called miocene by geologists—the gulf was assuredly there.

Near the tombs of the Caliphs at Cairo (according to Schweinfurth, two hundred feet above the level of the Mediterranean), in the neighborhood of Sakkarah and in that of the great pyramids, the limestone rocks, which look so like a sea-shore, were found by Professor Fraas to display the remains of a veritable coast-line. For they exhibit the tunnels of boring marine mollusks (*Pholades* and *Saxicavæ*), and they are incrusted with acorn-shells, as if the surf had only lately ceased to wash them. At the feet of these former sea-cliffs lie ancient sandy beaches, containing shells of oysters, scallops, and other marine mollusks, with the skeletons of sea-urchins. The specific characters of these marine organic remains leave no doubt that they lived during the miocene, or middle tertiary, epoch. Marine beds of the same age occur at Ain Musa, between Cairo and Suez.

There can be no question, therefore, that, in the miocene epoch, the valley of the delta was, as Herodotus thought it must have been, a gulf of the sea. And, as no trace of marine deposits of this, or of a later age, has been discovered in Upper Egypt, it must be assumed that the apex of the delta coincides with the southern limit of the ancient gulf.

Moreover, there is some curious evidence in favor of the belief that, at this period, however remote as measured by our standards of time, the Nile flowed down from Central Africa as it flows now, but probably in much larger volume. Every visitor to Cairo makes a pilgrimage to the "petrified forest," which is to be seen in the desert a few miles to the northeast of that city. And indeed it is a spectacle worth seeing. Thousands of trunks of silicified trees, some of them twenty or thirty feet long, and a foot or two in diameter, lie scattered about and partly imbedded in the sandy soil. Not a trunk has branches, or roots, or a trace of bark. None are upright. The structure of wood, which has not had time to decay before silicification, is usually preserved in its minutest details. The structure of these trunks is often obscure, as if they had decayed before silicification; and they are often penetrated, like other decayed wood, by fungi, which, along with the rest, have been silicified.*

* See Unger, "Der versteinerte Wald bei Cairo," "Sitzungsberichte der Wiener Akademie," 1858. Dr. Schweinfurth ("Zur Beleuchtung der Frage ueber den versteinerten Wald," "Zeitschrift der deutschen geologischen Gesellschaft," 1882) considers that the trees grew where they are found, but his arguments do not appear to me to be convincing.

Similar accumulations of fossil wood occur on the western side of the delta, about the Natron Lakes and in the Bahr-bela-Ma.

All these trunks have weathered out of a miocene sandstone; and it has been suggested that, when this sandstone was deposited, the Nile brought down great masses of timber from the upper country, just as the Mississippi sweeps down its "rafts" into the Gulf of Mexico at the present day; and that a portion of these, after long exposure and knocking about in the flood, became silted up in the sandy shores of the estuary.

The greater part of the "petrified forest" is at present one thousand feet above the level of the sea, in the midst of the heights which form the eastward continuation of the Mokattam. It has, therefore, shared in the general elevation of the land which took place after the beginning of the miocene epoch. That such elevation occurred is proved by the fact that the marine beds of that period lie upon the upraised limestone plateau of Lower Egypt; and it must have reached seven or eight hundred feet, before the *Pholades* bored the rocky shore of the gulf of the delta.

A flood of light would be thrown on the unwritten history of Egypt by a well-directed and careful re-examination of several points, to some of which I have directed your attention. For example, a single line of borings carried across the middle of the delta down to the solid rock, with a careful record of what is found at successive depths; a fairly exact survey of the petrified forest, and of the regions in which traces of the ancient miocene sea-shore occur; a survey of the Selsileh region, with a determination of the heights of the alluvial terraces between this point and Semneh; and an examination of the contents of the natural caves which are said to occur in the limestone rocks about Cairo and elsewhere—would certainly yield results of great importance. And it is to be hoped that, before our occupation of the country comes to an end, some of the many competent engineer officers in our army will turn their attention to these matters.

But, although so many details are still vague and indeterminate, the broad facts of the unwritten history of Egypt are clear enough. The Gulf of Herodotus unquestionably existed and has been filled up in the way he suggested, but at a time so long antecedent to the farthest date to which he permitted his imagination to carry him, that, in relation to it, the historical period, even of Egypt, sinks into insignificance.

However, we moderns need not stop at the time when the delta was a gulf of the sea. The limestone rocks in which it is excavated and which extend east, west, and south for hundreds of miles, are full of the remains of marine animals, and belong, the latest to the eocene, the oldest to the cretaceous formation. The miocene gulf of the delta was, in fact, only the remains of the wide ocean which formerly extended from Hindostan to Morocco; and at the bottom of which the accumulation of the shells and skeletons of its denizens gave rise to the ooze, which has since hardened into chalk and nummulitic limestone. And it is quite certain that the whole of the area now occupied by Egypt, north of Esneh, and probably all that north of Assouan, was covered by tolerably deep sea during the cretaceous epoch. It is also certain that a great extent of dry land existed in South Africa at a much earlier period. How far it extended to the north is unknown, but it may well have covered the area now occupied by the great lakes and the basins of the White and Blue Niles. And it is quite possible that these rivers may have existed and may have poured their waters into the Northern Ocean, before the elevatory movement—possibly connected with the outpour of the huge granitic masses of the Arabian range and of Nubia—commenced, which caused the calcareous mud covering its bottom to become the dry land of what is now the southern moiety of Upper Egypt, some time toward the end of the cretaceous epoch. Middle and Northern Egypt remained under water during the eocene, and Northern Egypt during the commencement, at any rate, of the miocene epoch; so that the process of elevation seems to have taken effect from south to north at an extremely slow rate. The northward drainage of the equatorial catchment basin thus became cut off from the sea by a constantly increasing plain sloping to the north. And, as the plain gradually rose, the stream, always flowing north, scooped the long valley of Nubia and of Egypt, and probably formed a succession of deltas which have long since been washed away. At last, probably in the middle, or the later part, of the miocene epoch, the elevatory movement came to an end, and the gulf of the delta began to be slowly and steadily filled up with its comparatively modern alluvium.

Thus, paradoxical as the proposition may sound, the Nile is not only older than its gift, the alluvial soil of Egypt, but it may be vastly older than the whole land of Egypt; and the river has shaped the casket in which the gift lies out of materials laid by the sea at its feet in the days of its youth.

The fourth problem of Herodotus—the origin and the antiquity of the Egyptian people—is much more difficult than the other three, and I can not deal with it at the end of a discourse which has already extended to an undue length.

But I may indicate a few cardinal facts which bear on the discussion.

According to Figari Bey's investigations, a marine deposit, which probably is of the same age as the miocene beaches of Cairo and Memphis, forms the floor of the delta. Above this, come the layers of sand with gravel already mentioned, as evidencing a former swifter flow of the river: then follow beds of mud and sand; and only above these, at three distinct levels, evidences of human handiwork, the last and latest of which belong to the age of Ramses II.

It is eminently desirable that these statements should be verified, for the doubts which have been thrown, to some extent justly, upon various attempts to judge the age of the alluvium of the Nile do not affect the proof of the relative antiquity of the human occupation of Egypt, which such facts would afford; and it is useless to speculate on the antiquity of the Egyptian race, or the condition of the delta when men began to people it, until they are accurately investigated.

As to the ethnological relations of the Egyptian race, I think all that can be said is, that neither the physical nor the philological evidence, as it stands, is very satisfactory. That the Egyptians are not negroes is certain, and that they are totally different from any typical Semites is also certain. I am not aware that there are any people who resemble them in character of hair and complexion, except the Dravidian tribes of Central India, and the Australians; and I have long been inclined to think, on purely physical grounds, that the latter are the lowest and the Egyptians the highest members of a race of mankind of great antiquity, distinct alike from Aryan and Turanian on the one side, and from negro and negrito on the other. And it seems to me that the philologists, with their "Cushites" and "Hamites," are tending toward a similar differentiation of the Egyptian stock from its neighbors. But, both on the anthropological and on the philological sides, the satisfactorily ascertained facts are few and the difficulties multitudinous.

I have addressed you to-night in my private capacity of a student of nature, believing, as I hope with justice, that the discussion of questions which have long attracted me would interest you. But I have not forgotten, and I dare say you have not, that I have the honor to stand in a very close official relation to Eton as a member of the Governing Body. And I have reason to think that, in some quarters, I am regarded as a dangerous member of that body, who, if he were not restrained by his colleagues, would endeavor to abolish the traditional studies of the school, and set the sixth form working at the generation of gases and the dissection of crawfishes, to the exclusion of your time-honored discipline in Greek and Latin.

To put the matter very gently, that statement is unhistorical; and I selected my topic for the discourse which I have just concluded, in order that I might show you, by an example, the outside limits to which my scientific fanaticism would carry me, if it had full swing. Before the fall of the second empire, the French liberals raised a cry for "Liberty as in Austria." I ask for "Scientific Education as in Halicarnassus," and that the culture given at Eton shall be, at any rate, no narrower than that of a Greek gentleman of the age of Pericles.

Herodotus was not a man of science, in the ordinary sense of the word; but he was familiar with the general results obtained by the "physiologists" of his day, and was competent to apply his knowledge rationally. If he had lived now, a corresponding education would certainly have put him in possession of the very simple facts which I have placed before you; and the application to them of his own methods of reasoning would have taken him as far as we have been able to go. But, thirty years ago, Herodotus could not have obtained as much knowledge of physical science as he picked up at Halicarnassus in any English public school.

Long before I had anything to do with the affairs of Eton, however, the Governing Body had provided the means of giving such instruction in physical science as it is needful for every decently-educated Englishman to possess. I hear that my name is sometimes peculiarly connected (in the genitive case) with certain new laboratories; and, if it is to go down to posterity at all, I would as soon it went in that association as any other, whether I have any claim to the left-handed compliment or not. But you must recollect that nothing which has been done, or is likely to be done, by the Governing Body, is the doing of this or that individual member; or has any other end than the deepening and widening of the scheme of Eton education, until, without parting with anything ancient that is of perennial value, it adds all that modern training which is indispensable to a comprehension of the conditions of modern life.—*Macmillan's Magazine.*

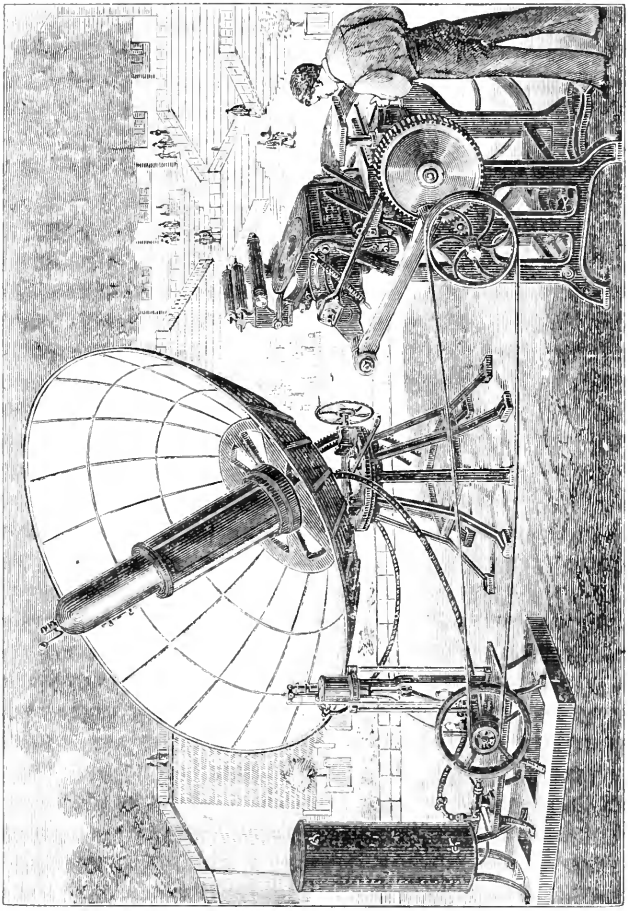
MACHINES DRIVEN BY SOLAR RAYS.

By GASTON TISSANDIER.

OUR readers have already been informed* respecting the solar machines constructed by MM. Mouchot and Abel Pifre, in which the heat of the sun is employed, either directly or through the agency of steam generated directly by it, as the source of power, and of their successful application to certain purposes in Algeria. M. Pifre, who is an assistant to M. Mouchot in his engineering work in Algeria, has continued his experiments, and made some improvements in the machines, by which their operation has been rendered more effective. The principal improvement is in the form of the reflector, or insolator, by means of which the rays of the sun are concentrated upon the boiler or other object to be heated. M. Mouchot's reflector was in the form of a simple hollow cone, formed with a straight line of projection. M. Pifre bends the line of projection so as to give it three different inclinations, and thereby obtains for the surface of his mirror a form nearly like that of a paraboloid. An interesting experiment upon the possibility of adapting the apparatus of M. Pifre to a European sun

* "Popular Science Monthly," vol. xviii, p. 283, and vol. xviii, p. 432.

was made on the 6th of August last, in the Garden of the Tuileries, Paris, on the occasion of the festival of the *Union Française de la jeunnesse*. An insolator, the reflector of which had an extreme diameter of three and a half metres, or nearly twelve feet, was set up near the steps of the Jeu de Paume. The steam generated in the boiler, which was placed in the focus of the mirror, was applied to a small



Printing a Newspaper by Solar Heat.
Experiment by M. Abel Pifre in the Garden of the Tuileries, Paris, August 6, 1882.

vertical engine of thirty kilogrammetres power, and this was connected with a Maroni press. Although the sun was not very hot, and the radiation was interrupted by frequent clouds, the press was kept in regular operation from one o'clock in the afternoon till half-past five, printing on an average five hundred copies an hour of a journal specially prepared for the occasion, and called "Soleil-Journal" (Sun-Journal). This little experiment is not likely just yet to produce a revolution in the art of printing, but its success may enable us to judge, in some degree, how useful the insolators may be made in latitudes where the solar radiation is more intense and more constant than in Paris. The engraving correctly represents the arrangement of the apparatus. M. Pifre's insolator is shown in the center, with its great parabolic mirror. The engine which it drove is shown by the side of it, while on the right and in the foreground may be seen the press printing the journal. We have a right to believe that heliodynamics may at some future time be usefully and profitably employed in hot countries.

THE GREAT BRIDGE AND ITS LESSONS.

ADDRESS BY ABRAM S. HEWITT.

TWO hundred and seventy years ago the good ship Tiger, commanded by Captain Adraien Block, was burned to the water's edge as she lay at anchor, just off the southern end of Manhattan Island. Her crew, thus forced into winter quarters, were the first white men who built and occupied a house on the land where New York now stands; "then," to quote the graphic language of Mrs. Lamb, in her history of the city, "in primeval solitude, waiting till commerce should come and claim its own. Nature wore a hardy countenance, as wild and as untamed as the savage landholders. Manhattan's twenty-two thousand acres of rock, lake, and rolling tableland, rising at places to a height of one hundred and thirty-eight feet, were covered with somber forests, grassy knolls, and dismal swamps. The trees were lofty, and old, decayed, and withered limbs contrasted with the younger growth of branches; and wild flowers wasted their sweetness among the dead leaves and uncut herbage at their roots. The wanton grape-vine swung carelessly from the topmost boughs of the oak and the sycamore; and blackberry and raspberry bushes, like a picket-guard, presented a bold front in all possible avenues of approach. The entire surface of the island was bold and granitic, and in profile resembled the cartilaginous back of the sturgeon." This primeval scene was the product of natural forces working through uncounted periods of time; the continent slowly rising and falling in the sea like the heaving breast of a world asleep; glaciers carving patiently through ages the deep estuaries; seasons innumerable clothing the hills with alternate bloom and decay.

The same sun shines to-day upon the same earth; yet how transformed! Could there be a more astounding exhibition of the power of man to change the face of Nature than the panoramic view which presents itself to the spectator standing upon the crowning arch of the bridge whose completion we are here to-day to celebrate in the honored presence of the President of the United States, with their fifty millions; of the Governor of the State of New York, with its five millions;

and of the mayors of the two cities, aggregating over two millions of inhabitants? In the place of stillness and solitude, the footsteps of these millions of human beings; instead of the smooth waters, "unvexed by any keel," highways of commerce ablaze with the flags of all nations; and where once was the green monotony of forested hills, the piled and towering splendors of a vast metropolis, the countless homes of industry, the echoing marts of trade, the gorgeous palaces of luxury, the silent and steadfast spires of worship!

To crown all, the work of separation wrought so surely, yet so slowly, by the hand of time, is now reversed in our own day, and "Manahattaa" and "Seawanhaka" are joined again as once they were before the dawn of life in the far azoic ages.

"It is done!
Clang of bell and roar of gun
Send the tidings up and down.
How the belfries rock and reel!
How the great guns, peal on peal,
Fling the joy from town to town!"

"What hath God wrought!" were the words of wonder which ushered into being the magnetic telegraph, the greatest marvel of the many marvelous inventions of the present century. It was the natural impulse of the pious maiden who chose this first message of reverence and awe, to look to the Divine Power as the author of a new gospel. For it was the invisible, and not the visible agency, which addressed itself to her perceptions. Neither the bare poles nor the slender wire, nor even the small battery, could suggest an adequate explanation for the extinction of time and space which was manifest to her senses, and she could only say, "What hath God wrought!"

But when we turn from the unsightly telegraph to the graceful structure at whose portal we stand, and when we contrast the airy outline of its curves of beauty, pendent between massive towers suggestive of art alone, with the overreaching vault of heaven above and the ever-moving flood of waters beneath, the work of Omnipotent Power, we are irresistibly moved to exclaim, "What hath *man* wrought!"

Man hath indeed wrought far more than strikes the eye in this daring undertaking, which, by the general judgment of engineers, stands to-day without a rival among the wonders of human skill. It is not the work of any one man or of any one age. It is the result of the study of the experience and of the knowledge of many men in many ages. It is not merely a creation; it is a growth. It stands before us to-day as the sum and epitome of human knowledge; as the very heir of the ages; as the latest glory of centuries of patient observation, profound study, and accumulated skill, gained, step by step, in the never-ending struggle of man to subdue the forces of Nature to his control and use.

In no previous period of the world's history could this bridge have been built. Within the last hundred years the greater part of the knowledge necessary for its erection has been gained. Chemistry was not born until 1776, the year when political economy was ushered into the world by Adam Smith, and the Declaration of Independence was proclaimed by the Continental Congress, to be maintained at the point of the sword by George Washington. In the same year Watt produced his successful steam-engine, and a century has not elapsed since the first specimen of his skill was erected on this continent. The law of gravitation was indeed known a hundred years ago, but the intricate laws of force which now control the domain of industry had not been developed by the study of physical science, and their practical applications have only been effectually accomplished within our own day, and, indeed, some of the most important of them during the building of the bridge. For use in the caissons, the perfecting of the electric light came too late, though happily in season for the illumination of the finished work.

This construction has not only employed every abstract conclusion and formula of mathematics, whether derived from the study of the earth or the heavens, but the whole structure may be said to rest upon a mathematical foundation. The great discoveries of chemistry, showing the composition of water, the nature of gases, the properties of metals, the laws and processes of physics, from the strains and pressures of mighty masses to the delicate vibrations of molecules, are all recorded here. Every department of human industry is represented, from the quarrying and the cutting of the stones, the mining and smelting of the ores, the conversion of iron into steel by the pneumatic process, to the final shaping of the masses of metal into useful forms, and its reduction into wire, so as to develop in the highest degree the tensile strength which fits it for the work of suspension. Every tool which the ingenuity of man has invented has somewhere, in some special detail, contributed its share in the accomplishment of the final result.

> "Ah! what a wondrous thing it is
> To note how many wheels of toil
> One word, one thought can set in motion!"

But without the most recent discoveries of science, which have enabled steel to be substituted for iron—applications made since the original plans of the bridge were devised—we should have had a structure fit, indeed, for use, but of such moderate capacity that we could not have justified the claim which we are now able to make, that the cities of New York and Brooklyn have constructed and to-day rejoice in the possession of the crowning glory of an age memorable for great industrial achievements.

This is not the proper occasion for describing the details of this undertaking. This grateful task will be performed by the engineer in the final report, with which every great work is properly committed to the judgment of posterity. But there are some lessons to be drawn from the hasty considerations I have presented, which may encourage and comfort us as to the destiny of man and the outcome of human progress.

What message, then, of hope and cheer does this achievement convey to those who would fain believe that love travels hand in hand with light along the rugged pathway of time? Have the discoveries of science, the triumphs of art, and the progress of civilization, which have made its construction a possibility and a reality, promoted the welfare of mankind and raised the great mass of the people to a higher plane of life?

This question can best be answered by comparing the compensation of the labor employed in the building of this bridge with the earnings of labor employed upon works of equal magnitude in ages gone by. The money expended for the work of construction proper on the bridge, exclusive of land damages and other expenses, such as interest, not entering into actual cost, is nine million ($9,000,000) dollars. This money has been distributed in numberless channels—for quarrying, for mining, for smelting, for fabricating the metals, for shaping the materials, and erecting the work, employing every kind and form of human labor. The wages paid at the bridge itself may be taken as the fair standard of the wages paid for the work done elsewhere. These wages are:

	Average.	
Laborers	$1 75	per day.
Blacksmiths	3 50 to $4 00	"
Carpenters	3 00 to 3 50	"
Masons and stone-cutters	3 50 to 4 00	"
Riggers	2 00 to 2 50	"
Painters	2 00 to 3 50	"

Taking all these kinds of labor into account, the wages paid for work on the bridge will thus average $2.50 per day.

Now, if this work had been done at the time when the Pyramids were built, with the skill, appliances, and tools then in use, and if the money available for its execution had been limited to nine million ($9,000,000) dollars, the laborers employed would have received an average of not more than two cents per day, in money of the same purchasing power as the coin of the present era. In other words, the effect of the discoveries of new methods, tools, and laws of force, has been to raise the wages of labor more than a hundred-fold in the interval which has elapsed since the Pyramids were built. I shall not weaken the suggestive force of this statement by any comments upon the astounding evidence of progress, beyond the obvious corollary that such a state of civilization as gave birth to the Pyramids would now be the signal for universal bloodshed, revolution, and anarchy. I do not underestimate the hardships borne by the labor of this century.

They are, indeed, grievous, and to lighten them is, as it should be, the chief concern of statesmanship. But this comparison proves that through forty centuries these hardships have been steadily diminished; that all the achievements of science, all the discoveries of art, all the inventions of genius, all the progress of civilization, tend, by a higher and immutable law, to the steady and certain amelioration of the condition of society. It shows that, notwithstanding the apparent growth of great fortunes, due to an era of unparalleled development, the distribution of the fruits of labor is approaching, from age to age, to more equitable conditions, and must, at last, reach the plane of absolute justice between man and man.

But this is not the only lesson to be drawn from such a comparison. The Pyramids were built by the sacrifices of the living for the dead. They served no useful purpose, except to make odious to future generations the tyranny which reduces human beings into beasts of burden. In this age of the world such a waste of effort would not be tolerated. To-day the expenditures of communities are directed to useful purposes. Except only works designed for defense in time of war, the wealth of society is now mainly expended in opening channels of communication for the free play of commerce and the communion of the human race. An analysis of the distribution of the surplus earnings of man after providing food, shelter, and raiment, shows that they are chiefly absorbed by railways, canals, ships, bridges, and telegraphs. In ancient times these objects of expenditure were scarcely known. Our bridge is one of the most conspicuous examples of this change in the social condition of the world and of the feeling of men. In the middle ages, cities walled each other out, and the fetters of prejudice and tyranny held the energies of man in hopeless bondage. To-day men and nations seek for free intercourse with each other, and the whole force of the intellect and energy of the world is expended in breaking down the barriers, established by Nature or created by man, to the solidarity of the human race.

And yet in view of this tendency, the most striking and characteristic feature of the nineteenth century, there still are those who believe and teach that obstruction is the creator of wealth; that the peoples can be made great and free by the erection of artificial barriers to the beneficent action of commerce, and the unrestricted intercourse of men and nations with each other. If they are right, then this bridge is a gigantic blunder, and the doctrine which bids us to love our neighbors as ourselves is founded upon a misconception of the Divine purpose.

But the bridge is more than an embodiment of the scientific knowledge of physical laws, or a symbol of social tendencies. It is equally a monument to the moral qualities of the human soul. It could never have been built by mere knowledge and scientific skill alone. It required in addition the infinite patience and unwearied courage by which great results are achieved. It demanded the endurance of heat and cold and physical distress. Its constructors have had to face death in its most repulsive form. Death, indeed, was the fate of its great projector, and dread disease the heritage of the greater engineer who has brought it to completion. The faith of the saint and the courage of the hero have been combined in the conception, the design, and the execution of this work.

Let us then record the names of the engineers and foremen who have thus made humanity itself their debtor, for the successful achievement which is not the result of accident or of chance, but is the fruit of design, and of the consecration of all personal interest to the public weal. They are: John A. Roebling, who conceived the project and formulated the plan of the bridge; Washington A. Roebling, who, inheriting his father's genius, and more than his father's knowledge and skill, has directed the execution of this great work from its inception to its completion; aided in the several departments by Charles C. Martin, Francis Collingwood, William H. Payne, George W. McNulty, Wilhelm Hilderbrand, Samuel R. Probasco, and E. F. Farrington, Arthur V. Abbott, William Van der Bosch, Charles Young, and Harry Tupple, who, in apparently subordinate positions, have shown themselves peculiarly fitted to command, because they have known how to serve. But the record would not be complete without reference to the unnamed men by whose unflinching courage, in the depths of the caissons, and upon the suspended wires, the work was carried on amid storms, and accidents, and dangers, sufficient to appall the stoutest heart. To them we can only render the tribute which history accords to those who fight as privates in the battles of freedom, with all the more devotion and patriotism because their names will never be known by the world whose benefactors they are. One name, however, which will find no place in the official records, can not be passed over here in silence. In ancient times when great works were constructed, a goddess was chosen, to whose tender care they were dedicated. Thus the ruins of the Acropolis to-day recall the name of Pallas Athene to an admiring world. In the middle ages the blessing of some saint was invoked to protect from the rude attacks of the barbarians and the destructive hand of time the building erected by man's devotion to the worship of God. So, with this bridge will ever be coupled the thought of one through the subtile alembic of whose brain, and by whose facile fingers, communication was maintained between the directing power of its construction and the obedient agencies of its execution. It is thus an everlasting monument to the self-sacrificing devotion of woman, and of her capacity for that higher education from which she has been too long debarred. The name of Mrs. Emily Warren Roebling will thus be inseparably associated with all that is admirable in human nature, and with all that is wonderful in the constructive world of art.

This tribute to the engineers, however, would not be deserved if there is to be found any evidence of deception on their part in the origin of the work, or any complicity with fraud in its execution and completion. It is this consideration which induced me to accept the unexpected invitation of the trustees to speak for the city of New York on the present occasion. When they thus honored me, they did not know that John A. Roebling addressed to me the letter in which he first suggested (and, as far as I am aware, he was the first engineer to suggest) the feasibility of a bridge between the two cities, so constructed as to preserve unimpaired the freedom of navigation. This letter, dated June 19, 1857, I caused to be printed in the "Journal of Commerce," where it attracted great attention because it came from an engineer who had already demonstrated, by successfully building suspension bridges over the Schuylkill, the Ohio, and the Niagara Rivers, that he spoke with the voice of experience and authority. This letter was the first step toward the construction of the work, which, however, came about in a manner different from his expectations, and was finally completed on a plan more extensive than he had ventured to describe. It has been charged that the original estimates of cost have been far exceeded by the actual outlay. If this were true, the words of praise which I have uttered for the engineers who designed and executed this work ought rather to have been a sentence of censure and condemnation. Hence the invitation, which came to me unsought, seemed rather to be an appeal from the grave for such vindication as it was within my power to make, and which could not come with equal force from any other quarter.

Engineers are of two kinds—the creative and the constructive. The power to conceive great works demands imagination and faith. The creative engineer, like the poet, is born, not made. If to the power to conceive is added the ability to execute, then have we one of those rare geniuses who not only benefit the world but add new glory to humanity. Such men were Michael Angelo, Leonardo da Vinci, Watt, Wedgwood, Brunel, and Stephenson; and such a man was John A. Roebling. It was his striking peculiarity that, while his conceptions were bold and original, his execution was always exact and within the limits of cost which he assigned to the work of his brain. He had made bridges a study, and had declared in favor of the suspension principle for heavy traffic, when the greatest living authorities had condemned it as costly and unsafe. When he undertook to build a suspension-bridge for railway use, he did so in the face of the deliberate judgment of the profession, that success would be impossible. George Stephenson had condemned the suspension principle and approved the tubular girder for railway traffic. But it was the Nemesis of Stephenson's fate that, when he came out to approve the location of the great tubular bridge at Montreal, he should pass over the Niagara River in a railway-train, on a suspension-bridge, which he had declared to be an impracticable undertaking.

When Roebling suggested the bridge over the East River, his ideas were limited to the demands of the time, and controlled by the necessity for a profitable investment. He had no expectation that the two cities would embark in the enterprise. Indeed, in one of his letters so late as April 14, 1860, he says, "As to the corporations of New York and Brooklyn undertaking the job, no such hope may be entertained in our time." In eight years thereafter, these cities had undertaken the task upon a scale of expense far exceeding his original ideas of a structure to be built exclusively by private capital for the sake of profit.

How came this miracle to pass? The war of the rebellion occurred, delaying for a time the further consideration of Roebling's ideas. This war accustomed the nation to expenditures on a scale of which it had no previous conception. It did more than expend large sums of money. Officials became corrupt, and organized themselves for plunder. In the city of New York especially, the government fell into the hands of a band of thieves, who engaged in a series of great and beneficial public works, not for the good they might do, but for the opportunity which they would afford to rob the public treasury. They erected court-houses and armories; they opened roads, boulevards, and parks; and they organized two of the grandest devices for transportation which the genius of man has ever conceived: a rapid-transit railway for New York, and a great highway between New York and Brooklyn. The bridge was commenced, but the ring was driven into exile by the force of public indignation, before the rapid-transit scheme, since executed on a different route by private capital, was undertaken. The collapse of the ring brought the work on the bridge to a stand-still.

It was a timely event. The patriotic New-Yorker might well have exclaimed, just before this great deliverance, in the words of the consul of ancient Rome, in Macaulay's stirring poem:

"And if they once may win the bridge,
What hope to save the town?"

Meanwhile, the elder Roebling had died, leaving behind him his estimates and the general plans of the structure, to cost, independent of land damages and interest, about $7,000,000. This great work, which, if not "conceived in sin," was "brought forth in iniquity," thus became the object of great suspicion, and of a prejudice which has not been removed to this day. I know that to many I make a startling announcement when I state the incontrovertible fact that no money was ever stolen by the ring from the funds of the bridge; that the whole money raised has been honestly expended; that the estimates for construction have not been materially exceeded, and that the excess of cost over the estimates is due to purchases of land which were never included in the estimates, to interest paid on the city subscriptions, and to the cost of additional height and breadth of the bridge and the increase in strength rendered necessary by a better comprehension of the volume of traffic between the two cities. The items covered by the original estimate of $7,000,000 have thus been raised to $9,000,000, so that $2,000,000 represents the addition to the original estimates, and for this excess, amounting to less than thirty per cent, there is actual value in the bridge in increased dimensions and strength, whereby its capacity has been greatly increased.

The carriage-ways, as originally designed, would have permitted only a single line of vehicles in each direction. The speed of the entire procession, more than a mile long, would therefore have been limited by the rate of the slowest; and every accident causing stoppage to a single cart would have stopped everything behind it for an indefinite period. It is not too much to say that the removal of this objection, by widening the carriage-ways, has multiplied manifold the practical usefulness of the bridge.

The statement I have made is due to the memory not only of John A. Roebling, but also of Henry C. Murphy, that great man, who devoted his last years to this enterprise; and who, having, like Moses, led the people through the toilsome way, was permitted only to look, but not to enter, upon the promised land.

This testimony is due also to the living trustees, and to the engineers who have controlled and directed this large expenditure in the public service—the latter, in the conscientious discharge of professional duty; and the former, with no other object than the welfare of the public, and without any other possible reward than the good opinion of their fellow-citizens.

I do not make this statement without a full sense of the responsibility which it involves, and I realize that its accuracy will shortly be tested by the report of experts who are now examining the accounts. But it will be found that I have spoken the words of truth and soberness. When the ring absconded, I was asked by William C. Havemeyer, then the Mayor of New York, to become a trustee, in order to investigate the expenditures, and to report as to the propriety of going on with the work. This duty was performed without fear or favor. The methods by which the ring proposed to benefit themselves were clear enough, but its members fled before they succeeded in reimbursing themselves for the preliminary expenses which they had defrayed. With their flight a new era commenced, and, during the three years when I acted as a trustee, I am sure that no fraud was committed, and that none was possible. Since that date the board has been controlled by trustees, some of whom are thorough experts in bridge-building, and the others men of such high character that the suggestion of malpractice is improbable to absurdity.

The bridge has not only been honestly built, but it may be safely asserted that it could not now be duplicated at the same cost. Much money might, however, have been saved if the work had not been delayed through want of means, and unnecessary obstacles interposed by mistaken public officials. Moreover, measured by its capacity, and the limitations imposed on its construction by its relation to the interests of traffic and navigation, it is the cheapest structure ever erected by the genius of man. This will be made evident by a single comparison with the Britannia Tubular Bridge, erected by Stephenson over the Menai Strait. He adopted the tubular principle because he believed that the suspension principle could not be made practical for railway-traffic, although he had to deal with spans not greater than 470 feet. He built a structure that contained 10,540 tons of iron, and cost £601,000, or about $3,000,000. Fortunately, he has left a calculation on record as to the possible extension of the tubular girder, showing that it would reach the limits in which it could bear only its own weight (62,000 tons) at 1,570 feet. Now, for a span of 1,600 feet, the Brooklyn Bridge contains but 6,740 tons of material, and will sustain seven times its own weight. Its cost is $9,000,000, whereas a tubular bridge for the same span would contain ten times the weight of the metal, and, though costing twice as much money, would be without the ability to do any useful work.

Roebling, therefore, solved the problem which had defied Stephenson, and upon his design has been built a successful structure at half the cost of a tubular bridge that would have fallen when loaded in actual use. It is impossible to furnish any more striking proof of the genius which originated and of the economy which constructed this triumph of American engineering.

We have thus a monument to the public spirit of the two cities, created by an expenditure as honest and as economical as those which gave us the Erie Canal, the Croton Aqueduct, and the Central Park. If it had been otherwise, it would have been a monument to the eternal infamy of the trustees and of the engineers under whose supervision it has been erected; and this brings me to the final consideration which I feel constrained to offer on this point.

During all these years of trial and false report a great soul lay in the shadow of death, praying only to stay long enough for the completion of the work to which he had devoted his life. I say a great soul, for in the spring-time of youth, with friends and fortune at his command, he gave himself to his country, and for her sake braved death on many a well-fought battle-field. When restored to civil life, his health was sacrificed to the duties which had devolved upon him as the inheritor of his father's fame and the executor of his father's plans. Living only for honor, and freed from the temptations of narrow means, how is it conceivable that such a man—whose approval was necessary to every expenditure—should, by conniving with jobbers, throw away more than the life which was dear to him that he might fulfill his destiny and leave to his children the heritage of a good name and the glory of a grand achievement? Well might this suffering hero quote the words of "Hyperion": "Oh, I have looked with wonder upon those who, in sorrow and privation, and bodily discomfort, and sickness, which is the shadow of death, have worked right on to the accomplishment of their great purposes; toiling much, enduring much, fulfilling much; and then, with shattered nerves and sinews all unstrung, have laid themselves down in the grave and slept the sleep of death, and the world talks of them while they sleep! And as in the sun's eclipse we can behold the great stars shining in the heavens, so in this life-eclipse have these men beheld the lights of the great eternity, burning solemnly and forever!"

And now what is to be the outcome of this great expenditure upon the highway which has been constructed between the two cities, for which Dr. Storrs and I have the honor to speak to-day? That Brooklyn will gain in numbers and in wealth with accelerated speed is a foregone conclusion. Whether this gain shall in any wise be at the expense of New York is a matter in regard to which the great metropolis does not concern herself. Her citizens are content with the knowledge that she exists and grows with the growth of the whole country, of whose progress and prosperity she is but the exponent and the index. Will the bridge lead, as has been forcibly suggested, and in some quarters hopefully anticipated, to the union of the two cities under one name and one government? This suggestion is in part sentimental and in part practical. So far as the union in name is concerned, it is scarcely worth consideration, for in any comparison which our national or local pride may institute between this metropolis and the other great cities of the world, its environment, whether in Long Island, Staten Island, or New Jersey, will always be included. In considering the population of London, no one ever separates the city proper from the surrounding parts. They are properly regarded as one homogeneous aggregation of human beings.

It is only when we come to consider the problem of governing great masses that the serious elements of the question present themselves, and must be determined before a satisfactory answer can be given. The tendency of modern civilization is toward the concentration of population in dense masses. This is due to the higher and more diversified life which can be secured by association and co-operation on a large scale, affording not merely greater comfort and often luxury, but actually distributing the fruits of labor on a more equitable basis than is possible in sparsely settled regions and among feeble communities. The great improvements of our day in labor-saving machinery and its application to agriculture enable the nation to be fed with a less percentage of its total force thus applied, and leave a larger margin of population free to engage in such other pursuits as are best carried on in large cities.

The disclosures of the last census prove the truth of this statement. At the first census in 1790 the population resident in cities was 3·3 per cent of the total population. This percentage slowly gained at each successive census, until in 1840 it had reached 8·5 per cent. In fifty years it had thus gained a little over 5 per cent. But in 1850 it rose to 12·5 per cent, in 1860 it was 16·1 per cent; in 1870 it was 20·9 per cent, having in this one decade gained as much as in the first fifty years of our political existence. In 1880 the population resident in cities was 22·5 per cent of the whole population.

Contemporaneous with this rapid growth of urban population have grown the complaints of corrupt administration and bad municipal government. The outcry may be said to be universal, for it comes from both sides of the Atlantic; and the complaints appear to be in direct proportion to the size of cities. It is obvious, therefore, that the knowledge of the art of local government has not kept pace with the growth of population. I am here by your favor to speak for the city of New York, and I should be the last person to throw any discredit on its fair fame; but I think I only give voice to the general feeling when I say that the citizens of New York are satisfied neither with the structure of its government nor with its actual administration, even when it is in the hands of intelligent and honest officials. Dissatisfied as we are, no man has been able to devise a system which commends itself to the general approval, and it may be asserted that the remedy is not to be found in devices for any special machinery of government. Experiments without number have been tried, and suggestions in infinite variety have been offered, but to-day no man can say that we have approached any nearer to the idea of good government which is demanded by the intelligence and the wants of the community.

If, therefore, New York has not yet learned to govern itself, how can it be expected to be better governed by adding half a million to its population and a great territory to its area, unless it be with the idea that a "little leaven leaveneth the whole lump"? Is Brooklyn that leaven? And if not, and if possibly "the salt has lost its savor, wherewith shall it be salted?" Brooklyn is now struggling with this problem—it remains to be seen with what success; but meanwhile it is idle to consider the idea of getting rid of our common evils by adding them together.

Besides, it is a fundamental axiom in politics, approved by the experience of older countries as well as of our own, that the sources of power should never be far removed from those who are to feel its exercise. It is the violation of this principle which produces chronic revolution in France, and makes the British rule so obnoxious to the Irish people. This evil is happily avoided when a natural boundary circumscribes administration within narrow limits. While, therefore, we rejoice together at the new bond between New York and Brooklin, we ought to rejoice the more that it destroys none of the conditions which permit each city to govern itself, but rather urges them to a generous rivalry in perfecting each its own government, recognizing the truth that there is no true liberty without law, and that eternal vigilance, which is the only safeguard of liberty, can best be exercised within limited areas.

It would be a most fortunate conclusion if the completion of this bridge should arouse public attention to the absolute necessity of good municipal government, and recall the only principle upon which it can ever be successfully founded. There is reason to hope that this result will follow, because the erection of this structure shows how a problem, analogous to that which confronts us in regard to the city government, has been met and solved in the domain of physical science.

The men who controlled this enterprise at the outset were not all of the best type ; some of them, as we have seen, were public jobbers. But they knew that they could not build a bridge, although they had no doubt of their ability to govern a city. They thereupon proceeded to organize the knowledge which existed as to the construction of bridges, and they held the organization thus created responsible for results. Now, we know that it is at least as difficult to govern a city as to build a bridge, and yet, as citizens, we have deliberately allowed the ignorance of the community to be organized for its government, and we then complain that it is a failure. Until we imitate the example of the ring, and organize the intelligence of the community for its government, our complaint is childish and unreasonable. But we shall be told that there is no analogy between building a bridge and governing a city. Let us examine this objection. A city is made up of infinite interests. They vary from hour to hour, and conflict is the law of their being. Many of the elements of social life are what mathematicians term "variables of the independent order." The problem is to reconcile these conflicting interests and variable elements into one organization which shall work without jar, and allow each citizen to pursue his calling, if it be an honest one, in peace and quiet.

Now, turn to the bridge. It looks like a motionless mass of masonry and metal : but, as a matter of fact, it is instinct with motion. There is not a particle of matter in it which is at rest even for the minutest portion of time. It is an aggregation of unstable elements, changing with every change in the temperature and every movement of the heavenly bodies. The problem was, out of these unstable elements to produce absolute stability ; and it was this problem which the engineers, the organized intelligence, had to solve, or confess to inglorious failure. The problem has been solved. In the first construction of suspension-bridges it was attempted to check, repress, and overcome their motion, and failure resulted. It was then seen that motion is the law of existence for suspension-bridges, and provision was made for its free play. Then they became a success. The bridge before us elongates and contracts between the extremes of temperature from fourteen to sixteen inches ; the vertical rise and fall in the center of the main span ranges between two feet three inches and two feet nine inches; and before the suspenders were attached to the cable it actually revolved on its own axis through an arc of thirty degrees, when exposed to the sun shining upon it on one side. You do not perceive this motion, and you would know nothing about it unless you watched the gauges which record its movement.

Now, if our political system were guided by organized intelligence, it would not seek to repress the free play of human interests and emotions, of human hopes and fears, but would make provision for their development and exercise, in accordance with the higher law of liberty and morality. A large portion of our vices and crimes are created either by law or its maladministration. These laws exist because organized ignorance, like a highwayman with a club, is permitted to stand in the way of wise legislation and honest administration, and to demand satisfaction from the spoils of office and the profits of contracts. Of this state of affairs we complain, and on great occasions the community arises in its wrath and visits summary punishment on the offenders of the hour, and then relapses into chronic grumbling until grievances sufficiently accumulate to stir it again to action.

What is the remedy for this state of affairs? Shall there be no more political parties, and shall we shatter the political machinery which, bad as it is, is far better than no machinery at all? Shall we embrace nihilism as our creed, because we have practical communism forced upon us as the consequence of jobbery and the imposition of unjust taxes?

No, let us rather learn the lesson of the bridge. Instead of attempting to restrict suffrage, let us try to educate the voters; instead of disbanding parties, let each citizen within the party always vote, but never for a man who is unfit to hold office. Thus parties, as well as voters, will be organized on the basis of intelligence.

But what man is fit to hold office? Only he who regards political office as a public trust, and not as a private perquisite to be used for the pecuniary advantage of himself, or his family, or even his party. Is there intelligence enough in these cities, if thus organized within the parties, to produce the result which we desire? Why, the overthrow of the Tweed ring was conclusive evidence of the preponderance of public virtue in the city of New York. In no other country in the world, and in no other political system than one which provides for and secures universal suffrage, would such a sudden and peaceful revolution have been possible. The demonstration of this fact was richly worth the twenty-five or thirty millions of dollars which the thieves had stolen. Thereafter and thenceforth there was no doubt whether our city population, heterogeneous as it is, contains within itself sufficient virtue for its own preservation. Let it never be forgotten that the remedy is complete, that it is ever present, that no man ought to be deprived of the opportunity of its exercise, and that, if it be exercised, the will of the community can never be paralyzed. Our safety and our success rest on the ballot in the hands of freemen at the polls, deliberately deposited, never for an unworthy man, but always with a profound sense of the responsibility which should govern every citizen in the exercise of this fundamental right.

If the lesson of the bridge, which I have thus sought to enforce, shall revive the confidence of the people in their own power, and induce them to use it practically for the election of good men to office, then indeed will its completion be a public blessing worthy of the new era of industrial development in which it is our fortunate lot to live.

Great indeed has been our national progress. Perhaps we, who belong to a commercial community, do not fully realize its significance and promise. We buy and sell stocks, without stopping to think that they represent the most astonishing achievements of enterprise and skill in the magical extension of our vast railway system; we speculate in wheat, without reflecting on the stupendous fact that the plains of Dakota and California are feeding hungry mouths in Europe; we hear that the Treasury has made a call for bonds, and forget that the rapid extinction of our national debt is a proof of our prosperity and patriotism, as wonderful to the world as was the power we exhibited in the struggle which left that apparently crushing burden upon us. If, then, we deal successfully with the evils which threaten our political life, who can venture to predict the limits of our future wealth and glory—wealth that shall enrich all; glory that shall be no selfish heritage, but the blessing of mankind? Beyond all legends of Oriental treasure, beyond all dreams of the golden age, will be the splendor, and majesty, and happiness of the free people dwelling upon this fair domain, if, as may be fairly anticipated, they shall then have learned how to make equitable distribution among themselves of the fruits of their common labor. As our own Bryant sang as long ago as 1821:

> "Here the free spirit of mankind at length
> Throws its last fetters off; and who shall place
> A limit to the giant's untamed strength,
> Or curb its swiftness in the forward race!
> Far, like the comet's way, through infinite space,
> Stretches the long, untraveled path of light
> Into the depths of ages; we may trace
> Distant, the brightening glory of its flight,
> Till the receding rays are lost to human sight."

At the ocean gateway of such a nation, well may stand the stately figure of "Liberty enlightening the World"; and, in hope and faith, as well as gratitude, we write upon the towers of our beautiful bridge, to be illuminated by her electric ray, the words of exultation, *Finis coronat opus.*

SELECTION IN GRAIN-GROWING.

By JAMES CHEESMAN.

THE principle of selection has long been appreciated by stock-breeders, and they have largely profited by the application of its teachings. As applied to the growth of cereals it has not found a very wide acceptance, not having had time to force itself on the attention of the average farmer. The founder of the practice of selecting grain for seed is Major Hallett, F. L. S., Brighton, England. In 1861 he planted ten grains of wheat, from a variety known there as Bellevue Talavera wheat, which up to that time had been sown as a spring wheat, and was declared to be quite incapable of withstanding the frost of winter. Nine of the ten plants from these grains were killed by the severe frost, but the other plant, although from the same ear, remained as healthy and vigorous as any of the winter varieties of wheat by their side. From this surviving plant seed has been selected and grown year after year as a winter wheat. Close observation shows that in the cereals, as throughout nature, no two plants or grains are exactly alike in productive power, and hence that of any two or greater number of grains or plants one is always superior to all the others, although the superiority can only be ascertained by actual field tests. It may consist in several particular characteristics, as power to withstand frost; prolificness; size and character of ear; size, form, quality and weight of grain; length and stiffness of straw; powers of tillering; rapidity of growth; and many others.

Throughout continued observations and experiments, extending over twenty years, the grower has found only three instances recorded in which there were two ears on a plant containing an equal number of grains, and one of these related to the Bellevue Talavera wheat, which must be considered quite exceptional as to variation. In both the other instances there was only a low stage of development, the equally finest two ears of each plant containing but 59 and 49 respectively. In every case where the plant presented an ear containing 60 grains and upward the next best ear was of less contents than the finest one. In twenty such instances taken consecutively and without omission, and referring to seven varieties of wheat, the average difference between the contents of the first and second ears was seven and a half grains. The difference in four of these instances was only one grain, but in other four it amounted to from seventeen to nineteen grains. The superior productive power of a grain over that of another may consist in a greater number of ears upon the plants it produces, or in their individually containing a greater number of grains.

During these investigations no single circumstance more forcibly illustrated the necessity for repeated selection than the fact that, of the grains in the same ear, one is found to excel greatly all the others in vital power, as in the case of the Bellevue Talavera. The original two ears together contained 87 grains ; these were all planted singly. One of them produced ten ears containing 688 grains, and not only could the produce of no other single grain compare with them, but the finest ten ears which could be collected from the produce of the whole of the other 86 grains contained only 598 ; yet supposing that this superior grain grew in the smaller of the two original ears, and that this contained but 40 grains, there must still have been 39 of these 86 grains which grew in the same ear. So far as regards *contents* of ears.

The next year the grains from the largest ear of the finest plant of the previous year were planted singly, twelve inches apart, in a continuous row ; one of them produced a plant consisting of fifty-two ears ; those next to and on either side of it of twenty-nine and seventeen ears respectively ; and the finest of all the other plants consisted of only forty ears.

The following are the *chief* points of the standard in the order of their importance, but all have to be duly considered :

1. Hardihood of constitution.
2. Trueness of type.
3. Quality of sample.
4. Productiveness.
5. Power of tillering.
6. Stiffness and toughness of straw.
7. Earliness of ripening.

The system of selection here pursued is as follows : A grain produces a plant, consisting of many ears. Then are planted the grains from these ears in such a manner that each ear occupies a row by itself, each of its grains occupying a hole in this row, the holes being twelve inches apart every way. At harvest, after the most careful study and comparison of the plants from all these grains, the finest one is selected, which is proof that its parent-grain was the best of all, under the peculiar circumstances of that season. This process is repeated annually, starting every year with the *proved* best grain, although the verification of this superiority is not obtained until the following harvest.

The subjoined statement will illustrate this system of selection, as the facts given are due to its influence alone : the kind of seed, the land, and the system of culture employed were precisely the same for every plant for four consecutive years ; neither was any manure used, nor any artificial means of fostering the plants resorted to.

The following table shows the character of each additional generation of selection :

YEAR.	EARS SELECTED.	Height.	Containing grains.	Number of ears on finest stool.
		Inches.		
1857	Original ear	$4\frac{3}{8}$	47	..
1858	Finest ear	$6\frac{1}{4}$	79	10
1859	Finest ear	$7\frac{3}{4}$	91	22
1860	*Ears imperfect from wet season*	..	..	39
1861	Finest ear	$8\frac{3}{4}$	123	52

Thus, by means of repeated selection *alone*, the length of the ears has been doubled, their *contents* nearly trebled, and the "tillering" power of the seed increased fivefold.

The following table gives similar increased contents of ear obtained in three other varieties of wheat :

Grains in original ear.	KIND OF WHEAT.	Grains in improved ear.
45	Original Red commenced in 1857	123
60	Hunter's White commenced in 1861	124
60	Victoria White commenced in 1862	114
32	Golden Drop commenced in 1864	96

It was supposed by ancient writers that the powers of grains differed in relation to their positions in the ear. This Major Hallett investigated in 1858, by planting the grains of ten ears on a plan showing their several positions in the ear. The only general result, among most conflicting ones, was that the smallest grains, those most remote from the center of growth, exhibited throughout, most unexpectedly, a vigor equal to that of the largest ; and that the remarked worst grains, in one or two instances, did not by any means fall so far short of the good ones as had been expected. Frequent trials have also been made of the comparative power of large and small, plump and thin grains, and, in the case of oats, which produce a small grain attached to a large one, trials as to their respective powers—with uniform results, viz., that, in good grains of the same pedigree, neither mere size nor situation in the ear supplies any indication of the superior grain.

Very close observation during many years led to the discovery that the variations in the cereals which Nature presents to us are not only hereditary, but that they proceed upon a fixed principle, and from them has been educed the following law of development of cereals :

1. Every fully-developed plant, whether of wheat, oats, or barley, presents an ear superior in productive power to any of the rest on that plant.

2. Every such plant contains one grain which, upon trial, proves more productive than any other.

3. The best grain in a given plant is found in its best ear.

4. The superior vigor of this grain is transmissible in different degrees to its progeny.

5. By repeated careful selection the superiority is accumulated.

6. The improvement, which is at first rapid, gradually, after a long series of years, is diminished in amount, and eventually so far arrested that practically a limit to improvement in the desired quality is reached.

7. By still continuing to select, the improvement is maintained, and *practically* a fixed type is the result.

Thin Seeding with Selection.—Let us discuss what is possible by a combination of thin seeding with selection. In order to do this, we must look at the present modes of cultivating the cereals. Confining ourselves for the moment to wheat alone, we know that from two to five bushels per acre are sown. The bushel of ordinary wheat contains 700,000 grains and more, and, taking two bushels per acre as the quantity sown, we have about 1,500,000 grains per acre. Major Hallett has counted at harvest the number of ears upon a quarter of an acre of wheat (drilled 20th of November with one and a half bushel of seed per acre, and which proved an exceptionally heavy crop of fifty-six bushels per acre), and the number of ears found was 934,120 per acre, or not so many ears as the grains sown. Here it is evident, from the number of grains sown, that either the natural powers of tillering could not have been exercised, or that the greater part of the seed must have been sown uselessly. Doubtless some of the grains did produce more than one ear, but this only makes the case still worse for the remainder. Not only was the number of ears below that of the grains sown, but each ear was but the stunted survivor of a struggle for existence. A high authority has said that, if a square yard of thickly-sown wheat be counted in spring, and the supposed number of ears then recorded, it would be found that ninety per cent of them would be found missing at harvest. Beyond all question, in thickly-sown wheat, very many of what appear as stems in the spring die away before harvest, and have thus grown not only uselessly, but in the struggle for existence have *starved and stunted those which ultimately came to ears.*

In ordinary English crops the number of ears produced per acre being taken as about 1,000,000, and the crop as 34 bushels, we have, at 700,000 grains per bushel, 23,800,000 grains per acre, or an average per ear of only 23 to 24 grains; and, if more than 1,000,000 ears per acre be claimed, it must be at the expense of their contents. Five imperial pints (= 6·1 American measure) of wheat per acre planted in September, 12 inches × 12 inches, gave 1,001,880 ears per acre, or 67,760 ears in excess of those produced on the other side of the hedge from 1½ bushel, or *more than thirteen times the seed.* Again, 6·1 pints (American measure) of wheat planted 12 inches × 12 inches, October 17th, gave 958,320 ears per acre; and planted similarly, October 4th, 966,792 per acre; while one bushel, planted October 15th, gave only 812,160.

Two plants of 24 ears each gave 1,911 and 1,878 grains, or 79 per ear; 20 ears per foot, at 48 grains only per ear, would produce 88 bushels per acre. All the conditions of time and space being fulfilled, we can obtain from a *single parent-grain* as many ears as are ordinarily obtained from *twenty grains*, with this most important advantage, viz.: these ears being produced from plants which have attained (or nearly so) perfect development of their growth, contain more than double the common number of grains, and their contents may be largely increased by the continued annual selection of the most vigorous parent-grains. These small quantities may be drilled on a large scale in the following manner: The object is to insure perfect *singleness* and regularity of plant, with uniformity of depth. The two latter may be obtained by the drill, as may the former also by adopting the following plan: The seed-cups ordinarily used in drilling wheat are so large that they deliver in *bunches* of grains, consisting of six or seven, which fall together within a very small area, from which a less produce will be obtained than if it had been occupied by a single grain. The additional grains are thus not only wasted, but are positively injurious. By using seed-cups which are only large enough to contain one grain at a time, *a stream of single grains* is delivered, and the desired object, viz., the depositing of *grains singly*, at once attained. The intervals *in* the rows will not be exactly uniform, but *they will be sufficiently so for all practical purposes.* The width of these intervals will, of course, depend on the speed with which the seed-barrel revolves, which can be regulated at will by adjusting the gear which drives it. By this mode of drilling, the advantage of the "broad-cast" system is obtained (equal distribution), as the rows may be close together, and the grains as thin *in* the rows as may be desired.

The crop should be hoed, as soon and as frequently as possible, with a horse-hoe. If the seed has been sown early, this should be done *in the autumn*, as it causes the plants to tiller and occupy the whole ground before winter sets in. It is essential to the success of thin seeding to keep the land perfectly free from weeds during the growth of the crop.

Now, what are the advantages of Major Hallett's system? A bushel of pedigree wheat (original red) produced from single grains, planted 12 inches × 12 inches, contains about 460,000 grains, while a bushel of ordinary wheat contains 700,000 or more grains. Therefore, in two crops consisting of exactly the same number of grains, the crop from thin seeding would be upward of 70 bushels against 46 bushels per acre. Again, a bushel of pedigree barley, produced from grains planted singly, contains 390,400 grains; while a bushel of ordinary barley contains upward of 550,000, or, in two crops of equal *numbers* of grains, the one would be 55 bushels, the other 39 bushels, per acre.

Thus in the increased size alone we get an increased crop of forty to fifty per cent.

The saving of seed from such a practice is immense. The wheat area of the United States is not less than 40,000,000 acres, and the average seeding is very much higher than two bushels per acre. But, if these figures be taken as a basis, we shall not err on the wrong side. To plant grain at the rate of one berry to each square foot would be equal to 43,560 grains per acre of 4,840 square yards, or less than two English quarts. This shows that the farmers of the United States have it in their power to reduce their consumption of seed-wheat from 80,000,000 bushels to 2,500,000. Good seed-wheat ought certainly to be worth a dollar a bushel out West, and is worth very much more in the East; but on this showing we have a possible saving of $77,500,000 in seed only for the wheat-crop alone. One dollar and a half per head of the population is worth attention.

The roots of wheat sown in August become by the middle of October so developed as to render it quite safe from lifting by the frost, and attacks of wire-worm would be almost unknown. If winter wheat were all drilled by the 10th of September, the entire fall would be at the farmer's disposal for clearing the land and sowing spring crops early. The crop could not become winter-proud, or be laid by the summer rains. The harvest would be from two to three weeks earlier. The harvest being over at least a fortnight earlier, would be of immense advantage in clearing the land. Seasons are frequently most unfavorable to late-sown cereals, but they are scarcely ever so to early-sown ones. On well-farmed lands, on the common practice, the average contents of the wheat-ears must be from 20 to 30. Were it grown on Major Hallett's system, the average contents would be, at the very least, from 40 to 60, and far more likely from 60 to 90; for under such a system so small an ear as one of 40 grains is quite the exception. And this increase of the *contents* of the ears would be obtained without any diminution of their number; the crop, in fact, would be doubled where now fairly good farming yields 30 bushels to the acre. These promises are not illusions, since a good many men in European countries, and in the United States also, have accomplished great results in agriculture by the application of commonly accepted principles of science. Major Hallett has himself grown 216 bushels from three acres with one bushel of seed, or 72 bushels to the acre; and over a whole field 82 bushels of barley, weighing 57 pounds to the bushel, from only two gallons of seed per acre.

In reference to the point of time of sowing, it must be borne in mind that the *rate* of growth for wheat during the different months in England is as follows:

Wheat sown on September 1st		comes up in	7 days.
" " October 1st	In a mild autumn,	" "	14 "
" " November 1st		" "	21 "
" " December 1st		" "	28 "

Taking this as the relative rate of wheat-growth, when it is up, then wheat which is up on the 1st of September makes in the first fifteen days of that month a growth equal to that of the whole of October; in the next ten days a growth equal to that of the whole of November; and, in the last five days of September, a growth equal to that of the first twenty days of December; or, in other words, wheat up on September 1st has a double autumn for growth before winter sets in; and, indeed, the case is in reality much stronger than this, for, if winter were to set in early, there would be for wheat sown at the end of October little or no autumn growth above-ground. The importance of every day (especially the early days) of September growth can not be overrated. To illustrate this, Miss Hallett made two very accurate drawings, which her father produced publicly. They were taken on December 30th, of two plants of wheat, each from a single *grain*, one of which was up on September 1st, the other on September 19th, and had thus lost the growth (after having come up) of the first nineteen days of September, the development of the earlier being double that of the later. These facts clearly point to the necessity of sowing in August. Nature, too, in shedding the grain in August, seems to indicate it as the proper time, or rather as a not unfit time, or the species would not be perpetuated. Within the present century it was the custom of many English farmers to go to wheat-sowing whenever it rained during harvest.

In determining the *space* to be assigned to each grain, we must deal with seed the result of continued selection, for the vital powers of the different grains of ordinary wheat are so *very* unequal that it would be impossible to fix upon any uniform distance. In planting grains of wheat in August, singly and twelve inches apart each way, all the requisite conditions of time and space seem to be best fulfilled, as will be seen further on. Wheat has been planted September 9th, 9 inches × 9 inches, and produced at the rate of 108 bushels per acre. It must be borne in mind at all times that it is a matter for mature study and judgment to correctly apportion the quantity of seed to the time of sowing, *and to all the existing surrounding circumstances.* A large quantity of seed sown early is just as much opposed to reason as a small quantity of seed sown late, and in fact more so, as in the first case it will become winter-proud and can not succeed, while the season may be such as to enable the last to do so. As a general basis, the drilling of wheat on a large scale might be conducted between the end of August and the 10th of September, at the rate of two to three gallons per acre; for each week later to the end of September, a gallon extra. When observing the unimpeded growth of cereals, there is seen to exist a striking variation in their modes of growth and powers of production. The superiority of some individuals over others is so marked in various ways as to lead irresistibly to the conclusion that it must be hereditary, and on this fact the whole argument for selected seed-grain rests.

Let it not be supposed, from what has been stated, that the use of artificial fertilizers is sought to be prejudiced. On the contrary, if improvement can be secured without them, it will be immensely greater when aided by them. But while the purchase of good seed of pedigree stock in small quantity, though the farmer bought it at six dollars (Major Hallett frequently obtains five), would be a very economical proceeding if he does not use more than two gallons, the cost of which would only be one dollar and a half per acre, whereas buying common seed at one dollar, and using two to three bushels, involves a greater outlay. Therefore, in proposing this reform, it will be seen that it does not mean spending more, but less, on seed. The weeding, if done properly, may cost two dollars per acre; and if, after this, the grower has any money to spend on fertilizers, let him invest by all means. As a general rule, it may be confidently asserted that what would be saved in the outlay for seed would pay the cost of horse-hoeing.

Considering how rapid is the improvement of the process of selection during the first five years, its effect on the wheat-crop of the country would be enormous. If we take 500,000,000 bushels of wheat as the present product (which is much less than it is), then doubling the crop and adding at the very least fifty per cent improvement in quality to the grain, we should obtain an increase of about $750,000,000, without bringing an additional acre into cultivation. I have not said much of the effect on the corn-crop, but on a crop of 1,750,000,000 bushels, at an average value of 38 cents, would, if but fifty per cent increase, in five years could be realized on 27·5, be astounding. To-day, the area in corn is not less than 65,000,000 acres; 12·50 bushels increase, at 40 cents per bushel, would be five dollars an acre, or $325,000,000: $1,075,000,000 of additional food in the short space of five years would give a new impetus to the milling trade in this country, and the hog-business would grow with a rapidity out of all proportion to its past career. Neither steel nor electricity can promise anything so great in so short a time, and no reform accomplished in this century will be able to measure this one.

Who will be the first to carry out such a scheme? In the Washington Department of Agriculture and in several other parts of the country, pedigree cereals have been used, but the results have not been taken much advantage of. The experimentalists of the State College farming-stations are especially qualified to lead in so important a work. The time is not far distant when intensive rather than extensive culture must be the rule of American farming. Already, in the East and in the South, men are finding it pays better to cultivate 100 acres well than 300 acres carelessly. When the hunger for large areas abates, we may hope to see attention paid to better cultivation.

The toil and misery, disappointment and mortification of skimming broad acres for meager results must give place to farming for profit. The change, when it comes, will be aided to some extent by professional guides and public men, but the foundation for it is within. The farmer is a near neighbor of hard facts, and living in days when everything is questioned, and nothing is taken for granted—when every institution in the land has to make good its claim to existence by the results produced—he is not likely to be deceived, or to grab any longer at the shadow for the substance. His wealth and happiness consist not in the number of his acres so much as in the principles of his farm practice. He will discover, as many of his *confrères* have already done, that the future of American agriculture will be determined by the extent to which fundamental truths of science are applied.

THE CAUSE OF SEA-SICKNESS.

By ROBERT W. LOVETT.

WHEN such an apparently simple disorder as sea-sickness exists in the midst of mankind for at least two thousand years, claiming yearly more victims, and all in spite of the best efforts of medical mankind to overcome it, it becomes of interest to inquire whether this is because its true nature has never been understood, or because it is essentially incurable.

The phenomena of sea-sickness are too well known to need detailed description. Violent and persistent vomiting is associated with it in most minds, and is the prominent symptom in most cases; but there are also a cold, clammy skin, headache, continuous nausea, great prostration, and indifference, the whole being accompanied by nervous irritability, and, in most cases, intense mental depression.

Plutarch was, perhaps, the first theorist on the subject. He thought that sea-sickness was caused by the smell of the salt-water; and, following him, men have propounded theory after theory, only to leave us of to-day with a large stock of theories, and but few good results to show for them.

Perhaps the most acceptable theory to-day is the one which places the origin of the trouble in the inner ear. The ear consists of three parts: the outer of these runs in as far as the drum; the middle part is inside of the drum, and contains the chain of ear-bones; while the inner ear is a complicated affair, containing the essential organ of hearing.

As far as we are concerned, the inner ear is a membranous bag filled with fluid, and situated in the solid bone. From the back part of this bag run out three semicircular tubes communicating at both their ends with the bag or vestibule. These run in three different planes, and are lined with hair-like nerve-filaments, which are much more abundant and more sensitive at the anterior part of the tubes. The tubes are filled with liquid in which float little calcareous particles, the otoliths. These tubes are known as the semicircular canals. It was difficult to see what connection with the sense of hearing these canals could possibly have, and some time ago it was noticed that injuries to these impaired the sense of hearing in no way, but caused most curious effects in the loss of equilibrium.

For instance, in pigeons, when the vertical canal was cut, the bird turned a series of back somersaults ; and, when the horizontal canal was cut, the pigeon whirled around in an horizontal plane, in every case tending to rotate in the plane of the canal which was cut. And what is especially interesting to us is, that in these and other experiments iritation or injury to these canals was almost invariably followed by vomiting. Experiments, by Professor Ferrier and others, point to a very close relation between these canals and the sense of equilibrium, and an especially strong suggestion is given by the disease known as labyrinthine vertigo, or Ménière's disease. This is characterized by an irritated and congested condition of these semicircular canals, due to some internal cause, and its symptoms are the same throbbing in the head, the pale, cold skin, and vomiting, as in sea-sickness, and in addition the patient reels and staggers, being unable to keep his balance. In this disease we seem to have the exact reverse of sea-sickness, the irritated condition of the canals causing the unusual movements of the body ; whereas in sea-sickness we have the unusual movements of the body which result from the pitching of the ship, causing the irritation of the canals, and in both cases the irritated state of the semicircular canals is accompanied by vomiting. The mechanical explanation of why such irregular motion should cause irritation of the canals seems simple. By the pitching movements of the ship, which are by far the worst, the head is carried backward and forward through a long arc. At the end of the descent the head stops, but by its inertia the fluid in the canals rushes on and washes the otoliths up against the nerve-filaments at the front of the canals. These are extremely sensitive, and the repetition of this process a few times serves to establish an excessive irritation which is expressed by giddiness and vomiting. Why such gradual motions should cause sea-sickness, while much more violent ones, such as horseback-riding, do not, can only be explained by saying that in the more violent ones the individual has a stimulus to adapt his positions to the motion, which he has not in the often unnoticed pitching of a ship. At any rate, this theory explains why lying down should afford relief, as the otoliths then rest at the back and less sensitive part of the canals ; and it also explains why riding backward should cause nausea and giddiness, as here, of course, the otoliths drag behind and irritate the anterior parts of the canals.

Moreover, in some recent inquiries addressed to deaf-mutes upon another subject, the fact was noticed that all who were insusceptible to dizziness on account of the impairment of their semicircular canals by disease reported themselves also exempt from sea-sickness.

But the semicircular canals must not receive all the credit. The viscera of the abdomen are very full of blood, and irritated in sea-sickness, and this condition will cause vomiting, as shown by very many experiments on animals. The intestines are attached loosely to the backbone by a fold of membrane containing some very large blood-vessels. Ordinarily the intestines are held up and supported in place by the muscles of the abdomen, and consequently do not drag too heavily on their attachment. But in sea-sickness, it is said, either on account of confused messages sent to them from the irritated semicircular canals, or because of the novelty and uncertainty of the motions of the ship, these muscles are unable to tell when to contract and when to relax, thus affording but poor support to the intestines. Consequently by their inertia the intestines bulge forward at the end of each descent of the ship, thereby stretching and irritating their attachment, and in consequence the abdominal blood-vessels are engorged with blood, and this condition is expressed by vomiting, which is merely Nature's effort to equalize the circulation. Force is lent to this view of sea-sickness by the fact that jumping from a great height causes fearful nausea on reaching the ground—in this case also the intestines pushing forward the abdominal wall and stretching their attachment.

There is probably a minor kind of sea-sickness, caused by the mere churning about of food in the stomach, irritating the nerves there as they would be irritated by a dose of mustard. This is often the sort experienced in small boats, and is at once relieved by vomiting.

The power of the imagination as one of the causes of sea-sickness ought not to go without some mention. Whether or not it is more powerful here than in other diseases it would be hard to say, but so prominent is the mental effort that Mr. Bache some years ago wrote a very interesting article on the subject, in which he maintained that sea-sickness was wholly of mental origin; that the idea of motion was the result of the concurrent testimony of the senses; and that in a new motion, where there was a conflict of impressions, the brain was disturbed. He said that motion caused nausea in two cases—1. When the motion of the observer's body is in doubt; 2. When the motion is acknowledged by the mind but the motion is not felt. But, however attractive this may be, it offers us little that is tangible. Of the very many other causes suggested, it seems only necessary to name the prominent ones. Naylor suggested spasm of the capillaries of the brain. Barris attributed it to the instability of surrounding objects. Stocker thinks it largely due to a partial vacuum in the lungs. Wollaston believed it was caused by the rise and fall of blood in the brain, as the mercury would rise and fall in a barometer, under like conditions; and Dr. Barker considers it the result of the sudden changes in the relations of the fluids and solids in the body.

Whether or not the individual is to be sick, and the duration and extent of his sickness, seem to depend to a certain extent on the general condition of the system, and also somewhat upon wholly unknown conditions, in many cases the most robust yielding the first. In this connection it is an interesting fact that children under three or four years are almost invariably exempt from sea-sickness, although ordinarily they vomit so much more readily than adults.

This is no place for the discussion of remedies. Bromide of sodium is the prominent one just at present, and probably does lessen the nervous susceptibility somewhat; but let its advocates read the glowing testimonials in favor of Chapman's ice-bags for the spine, nitrite of amyl, champagne, chloral, and all the rest. The belt to support the abdomen seems a rational remedy, but it was first proposed for that use in 1814, and but few to-day have even heard of it, and it seems fair to assume that suffering mankind would not have discarded a really efficient remedy.

In conclusion, what I have tried to show is, that the stomach is not the cause of the disorder, although generally the seat of it; that the organs irritated seem to be the semicircular canals of the ear, or the abdominal viscera, or both, which become full of blood and cause vomiting, which seems rather an effort of Nature to equalize the circulation than any desire on the part of the stomach to rid itself of its contents.

METERS FOR POWER AND ELECTRICITY.*

By C. VERNON BOYS, Esq.

THE subject of this evening's discourse, "Meters for Power and Electricity," is unfortunately, from a lecturer's point of view, one of extreme difficulty; for it is impossible to fully describe any single instrument of the class without diving into technical and mathematical niceties which this audience might well consider more scientific than entertaining. If, then, in my endeavor to explain these instruments and the purposes which they are intended to fulfill, in language as simple and as untechnical as possible, I am not so successful as you have a right to expect, I must ask you to lay some of the blame on my subject and not all on myself.

I shall at once explain what I mean by the term "meter," and I shall take the flow of water in a trough as an illustration of my mean-

* Address at the Royal Institution of Great Britain, delivered Friday, March 2, 1883.

ing. If we hang in a trough a weighted board, then, when the water flows past it, the board will be pushed back; when the current of water is strong, the board will be pushed back a long way; when the current is less, it will not be pushed so far; when the water runs the other way, the board will be pushed the other way. So, by observing the position of the board, we can tell how strong the current of water is at any time. Now, suppose we wish to know, not how strong the current of water is at this time or at that, but how much water altogether has passed through the trough *during* any time, as, for instance, one hour. Then, if we have no better instrument than the weighted board, it will be necessary to observe its position continuously, to keep an exact record of the corresponding rates at which the water is passing, every minute, or better every second, and to add up all the values obtained. This would, of course, be a very troublesome process. There is another kind of instrument which may be used to measure the flow of the water: a paddle-wheel or screw. When the water is flowing rapidly, the wheel will turn rapidly; when slowly, the wheel will turn slowly; and, when the water flows the other way, the wheel will turn the other way, so that, if we observe how fast the wheel is turning, we can tell how fast the water is flowing. If, now, we wish to know how much water altogether has passed through the trough, the number of turns of the wheel, which may be shown by a counter, will at once tell us. There are, therefore, in the case of water, two kinds of instruments, one which measures *at* a time, and the other *during* a time. The term meter should be confined to instruments of the second class only.

As with water so with electricity, there are two kinds of measuring instruments: one, of which the galvanometer may be taken as a type, which shows by the position of a magnet how strong a current of electricity is *at* a time; and the other, which shows how much electricity has passed *during* any time. Of the first, which are well understood, I shall say nothing; the second, the new electric meters and the corresponding meters for power, are what I have to speak of to-night.

It is hardly necessary for me to mention the object of making electric meters. Every one who has had to pay his gas bill once a quarter probably quite appreciates what the electric meters are going to do, and why they are at the present time attracting so much attention. So soon as you have electricity laid on in your houses, as gas and water are laid on now, so soon will a meter of some sort be necessary in order that the companies which supply the electricity may be able to make out their quarterly bills, and refer complaining customers to the faithful indications of their extravagance in the mysterious cupboard in which the meter is placed.

The urgent necessity for a good meter has called such a host of inventors into the field that a complete account of their labors is more than any one could hope to give in an hour. Since I am one of this host, I hardly like to pick out those inventions which I consider of value. I can not describe all ; I can not act as a judge and say these only are worthy of your attention, and I do not think I should be acting fairly if I were to describe my own instruments only and ignore those of every one else. The only way I see out of the difficulty is to speak more particularly about my own work in this direction, and to speak generally on the work of others.

I must now ask you to give your attention for a few minutes to a little abstract geometry. We may represent any changing quantity, as, for instance, the strength of an electrical current, by a crooked line. For this purpose we must draw a straight line to represent time, and make the distance of each point of the crooked line above the straight line a measure of the strength of the current at the corresponding time. The size of the figure will then measure the quantity of electricity that has passed, for, the stronger the current is, the taller the figure will be, and the longer it lasts the longer the figure will be ; either cause makes both the quantity of electricity and the size of the figure greater and in the same proportion : so the one is a measure of the other. Now, it is not an easy thing to measure the size of a figure, the distance round it tells nothing ; there is, however, a geometrical method by which its size may be found. Draw another line, with a great steepness where the figure is tall, and with a less steepness where the height is less, and with no steepness or horizontal where the figure has no height. If this is done accurately, the height to which the new line reaches will measure the size of the figure first drawn ; for, the taller the figure is, the steeper the hill will be : the longer the figure, the longer the hill ; either cause makes both the size of the figure and the height of the hill greater, and in the same proportion : so the one is a measure of the other ; and so, moreover, is the height of the hill, which can be measured by a scale, a measure of the quantity of electricity that has passed.

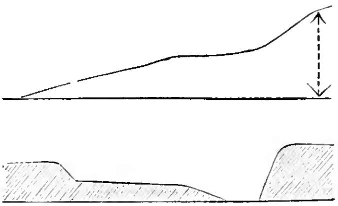


FIG. 1.

The first instrument that I made, which I have called a "cart" integrator, is a machine which, if the lower figure is traced out, will describe the upper. I will trace a circle, the instrument follows the curious bracket-shaped line that I have already made sufficiently black to be seen at a distance, the height of the new line measures the size of the circle, the instrument has squared the circle. This machine is a thing of mainly theoretical interest ; my only object in showing it is to explain the means by which I have developed a practical and automatic instrument of which I shall speak presently. The guiding principle in the cart integrator is a little three-wheeled cart, whose front wheel is controlled by the machine. This, of course, is invisible at a distance, and therefore I have here a large front wheel alone. On moving this along the table, any twisting of its direction instantly causes it to deviate from its straight path; now, suppose I do not let it deviate, but compel it to go straight, then at once a great strain is put upon the table, which is urged the other way. If the table can move, it will instantly do so. A table on rollers is inconvenient as an

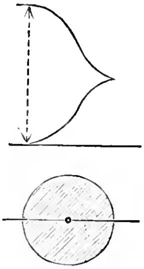


Fig. 2.

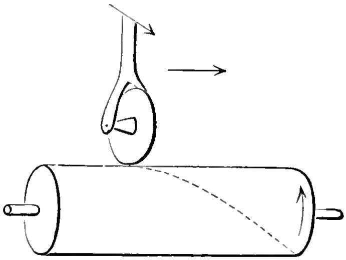


Fig. 3.

instrument, let us therefore roll it round into a roller, then on moving the wheel along it the roller will turn and the amount by which it turns will correspond to the height of the second figure drawn by the cart integrator. If, therefore, the wheel is inclined by a magnet under the influence of an electric current, or by any other cause, the whole amount of which we wish to know, then the number of turns of the roller will tell us this amount; or to go back to our water analogy, if we had the weighted board to show current strength, and had not the paddle-wheel to show total quantity, we might use the board to incline a disk in contact with a roller, and then drag the roller steadily along by clock-work. The number of turns of the roller would give the quantity of water. Instruments that will thus add up continuously indications at a time, and so find amounts during a time, are called integrators.

The most important application that I have made at present of the integrator described is what I have called an engine-power meter.

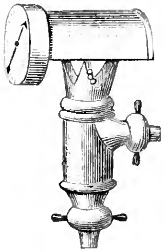


Fig. 4.

The instrument is on the table, but, as it is far too small to be seen at a distance, I have arranged a large model to illustrate its action. The object of this machine is to measure how much work an engine has done during any time, and show the result on a dial, so that a workman may read it off at once without having to make any calculations.

Before I can explain how work is measured, perhaps I had better say a few words about the meaning of the word "work." Work is done when pressure overcomes resistance, producing motion. Neither motion nor pressure alone is work. The two factors, pressure and motion, must occur together. The work done is found by multiplying the pressure by the distance moved. In an engine, steam pushes the piston first one way then the other, overcomes resistance, and does work. To find this, we must multiply the pressure by the motion at every instant and add all the products together. This is what the engine-power meter does, and it shows the continuously growing result on a dial. When the piston moves, it drags the cylinder along ; where the steam presses, the wheel is inclined. Neither action alone causes the cylinder to turn, but when they occur together the cylinder turns, and the number of turns registered on a dial shows with mathematical accuracy how much work has been done.

In the steam-engine work is done in an alternating manner, and it so happens that this alternating action exactly suits the integrator. Suppose, however, that the action, whatever it may be, which we wish to estimate, is of a continuous kind, such for instance as the continuous passage of an electric current. Then if, by means of any device, we can suitably incline the wheel, so long as we keep pushing the cylinder along, so long will its rotation measure and indicate the result ; but there must come a time when the end of the cylinder is reached. If, then, we drag it back again, instead of going on adding up, it will begin to take off from the result, and the hands on the dial will go backward, which is clearly wrong. So long as the current continues, so long must the hands on the dial turn in one direction. This effect is obtained in the instrument now on the table, the electric energy meter, in this way : Clock-work causes the cylinder to travel backward and forward by means of what is called a mangle-motion, but, instead of moving always in contact with one wheel, the cylinder goes forward in contact with one and back in contact with another on its opposite side. In this instrument the inclination of the wheels is effected by an arrangement of coils of wire, the main current passing through two fixed concentric solenoids, and a shunt current through a great length of fine wire on a movable solenoid, hanging in the space between the others. The movable portion has an equal number of turns in opposite directions, and is therefore unaffected by magnets held near it. The effect of this arrangement is that the energy of the current, that is, the quantity multiplied by the force driving it, or the electrical equivalent of mechanical power, is measured by the slope of the wheels, and the amount of work done by the current during any time, by the number of turns of the cylinder, which is registered on a dial. Professors Ayrton and Perry have devised an instrument which is intended to show the same thing. They make use of a clock, and cause it to go too fast or too slow by the action of the main on the shunt current ; the amount of wrongness of the clock, and not the time shown, is said to measure the work done by the current. This method of measuring the electricity by the work it has done is one which has been proposed to enable the electrical companies to make out their bills.

The other method is to measure the amount of electricity that has passed, without regard to the work done. There are three lines on which inventors have worked for this purpose: The first, which has been used in every laboratory ever since electricity has been understood, is the chemical method. When electricity passes through a salt solution, it carries metal with it, and deposits it on the plate by which the electricity leaves the liquid. The amount of metal deposited is a measure of the quantity of electricity. Mr. Sprague and Mr. Edison have adopted this method; but, as it is impossible to allow the whole of a strong current to pass through a liquid, the current is divided; a small proportion only is allowed to pass through. Provided that the proportion does not vary, and that the metal never has any motions on its own account, the increase in the weight of one of the metal plates measures the quantity of electricity.

The next method depends on the use of some sort of integrating machine, and this, being the most obvious method, has been attempted by a large number of inventors. Any machine of this kind is sure to go, and is sure to indicate something, which will be more nearly a measure of the electricity as the skill of the inventor is greater.

Meters for electricity of the third class are dynamical in their action, and I believe that what I have called the vibrating meter was the first of its class. It is well known that a current passing round iron makes it magnetic. The force which such a magnet exerts is greater when the current is greater, but it is not simply proportional; if the current is twice or three times as strong, the force is four times or nine times as great; or, generally, the force is proportional to the square of the current. Again, when a body vibrates under the influence of a controlling force, as a pendulum under the influence of gravity, four times as much force is necessary to make it vibrate twice as fast, and nine times to make it vibrate three times as fast; or, generally, the square of the number measures the force. I will illustrate this by a model. Here are two sticks nicely balanced on points, and drawn into a middle position by pieces of tape to which weights may be hung. They are identical in every respect. I will now hang a one-pound weight to each tape, and let the pieces of wood swing. They keep time together absolutely. I will now put two pounds on one tape. It is clear that the corresponding stick is going faster, but certainly not twice as fast. I will now hang on four pounds. One stick is going at exactly twice the pace of the other. To make one go three times as fast, it is obviously useless to put on three pounds, for it takes four to make

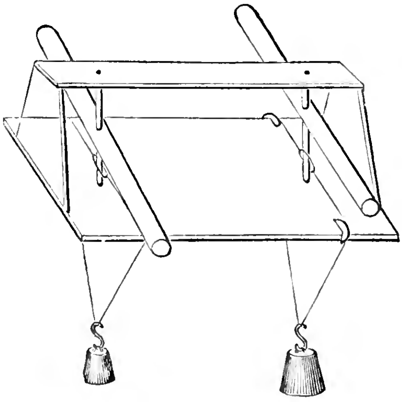


Fig. 5.

it go twice as fast. I will hang on nine pounds. One now goes exactly three times as fast as the other. I will now put four pounds on the first, and leave the nine pounds on the second : the first goes twice while the second goes three times. If instead of a weight we use electro-magnetic force to control the vibrations of a body, then twice the current produces four times the force ; four times the force produces twice the rate ; three times the current produces nine times the force ; nine times the force produces three times the rate, and so on : or the rate is directly proportional to the current strength. There is on the table a working meter made on this principle. I allow the current that passes through to pass also through a galvanometer of special construction, so that you can tell by the position of a spot of light on a scale the strength of the current. At the present time there is no current ; the light is on the zero of the scale, the meter is at rest. I now allow a current to pass from a battery of the new Faure-Sellon-Volckmar cells which the Storage Company have kindly lent me for this occasion. The light moves through one division on the scale, and the meter has started. I will ask you to observe its rate of vibration. I will now double the current ; this is indicated by the light moving to the end of the second division on the scale : the meter vibrates twice as fast. Now the current is three times as strong, now four times, and so on. You will observe that the position of the spot of light and the rate of vibration always correspond. Every vibration of the meter corresponds to a definite quantity of electricity, and causes a hand on a dial to move on one step. By looking at the dial, we can see how many vibrations there have been, and therefore how much electricity has passed. Just as the vibrating sticks in the model in time come to rest, so the vibrating part of the meter would in time do the same, if it were not kept going by an impulse automatically given to it when required. Also, just as the vibrating sticks can be timed to one another by sliding weights along them, so the vibrating electric meters can be regulated to one another so that all shall indicate the same value for the same current, by changing the position or weight of the bobs attached to the vibrating arm.

The other meter of this class, Dr. Hopkinson's, depends on the fact that centrifugal force is proportional to the square of the angular velocity. He therefore allows a little motor to drive a shaft faster and faster, until centrifugal force overcomes electro-magnetic attraction, when the action of the motor ceases. The number of turns of the motor is a measure of the quantity of electricity that has passed.

I will now pass on to the measurement of power transmitted by belting. The transmission of power by a strap is familiar to every one in a treadle sewing-machine or an ordinary lathe. The driving force depends on the difference in the tightness of the two sides of the belt, and the power transmitted is equal to this difference multiplied by the speed; a power-meter must, therefore, solve this problem—it must subtract the tightness of one side from the tightness of the other side, multiply the difference by the speed at every instant, and add all the products together, continuously representing the growing amount on a dial. I shall now show for the first time an instrument that I have devised, that will do all this in the simplest possible manner. I have here two wheels connected by a driving-band of India-rubber, round which I have tied every few inches a piece of white silk ribbon. I shall turn one a little way, and hold the other. The driving-force is indicated by a difference of stretching: the pieces of silk are much farther apart on the tight side than they are on the loose. I shall now turn the handle, and cause the wheels to revolve; the motion of the band is visible to all. The India-rubber is traveling faster on the tight side than on the loose side, nearly twice as fast; this must be so, for, as there is less material on the tight side than on the loose, there would be a gradual accumulation of the India-rubber round the driven pulley, if they traveled at the same speed; since there is no accumulation, the tight side must travel the fastest. Now, it may be shown mathematically that the difference in the speeds is proportional both to the actual speed and to the driving strain; it is therefore a measure of the power or work being transmitted, and the difference in the distance traveled is a measure of the work done. I have here a working machine which shows directly on a dial the amount of work done; this I will show in action directly. Instead of India-rubber, elastic steel is used. Since the driving-pulley has the velocity of the tight side, and the driven of the loose side of the belt, the difference in the number of their turns, if they are of equal size, will measure the work. This difference I measure by differential gearing which actuates a hand on a dial. I may turn the handle as fast as I please; the index does not move, for no work is being done. I may hold the wheel and produce a great driving-strain; again the index remains at rest, for no work is being done. I now turn the handle quickly, and lightly touch the driven wheel with my finger. The resistance, small though it is, has to be overcome; a minute amount of work is being done, the index creeps around gently. I will now put more pressure on my finger, more work is being done, the index is moving faster; whether I increase the speed or the resistance, the index turns faster; its rate of motion measures the power, and the distance it has moved, or the number of turns, measures the work done. That this is so I will show by an experiment. I will wind up in front of a scale a seven-pound weight; the hand has turned one third around; I will now wind a twenty-eight-pound weight up the same height; the hand has turned four thirds of

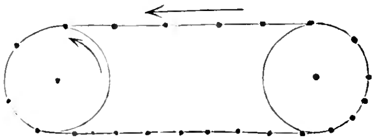


Fig. 6.

a turn. There are other points of a practical nature with regard to this invention which I can not now describe.

There is one other class of instruments which I have developed, of which time will let me say very little. The object of this class of instruments is to divide the speed with which two registrations are being effected, and continuously record the quotient. In the instrument on the table two iron cones are caused to rotate in time with the registrations; a magnetized steel reel hangs on below. This reel turns about, and runs up or down the cones until it finds a place at which it can roll at ease. Its position at once indicates the ratio of the speeds which will be efficiency, horse-power per hour, or one thing in terms of another. Just as the integrators are derived from the steering of an ordinary bicycle, so this instrument is derived from the double steering of the "Otto" bicycle.

Though I am afraid that I have not succeeded in the short time at my disposal in making clear all the points on which I have touched, yet I hope that I have done something to remove the very prevalent opinion that meters for power and electricity do not exist.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

IV.—ALBUMEN AND ITS CHANGES.

LET us now make practical application of the laws of albumen coagulation that were demonstrated in the test-tube experiment. The non-professional student may do this at the breakfast fireside. The apparatus required is a saucepan large enough for boiling a pint of water—the materials two eggs.

Cook the first in the orthodox manner by keeping it in boiling water three and a half minutes. Then place the second in this same boiling water; but, instead of keeping the saucepan over the fire, place it on the hearth and leave it there, with the egg in it, about ten minutes or more. A still better way of making the comparative experiment is to use for the second egg a water-bath, or *bain marie* of the French scientific cook; a vessel immersed in boiling or nearly boiling water, like a glue-pot, and therefore not quite so hot as its source of heat. In this case a thermometer should be used, and the water surrounding the egg be kept at or near 180° Fahr. Time of immersion about ten minutes or more.

A comparison of results will show that the egg that has been cooked at a temperature of more than 30° below the boiling-point of water is tender and delicate, evenly so throughout, no part being hard while another part is semi-raw and slimy.

I said "ten minutes or more," because, when thus cooked, a prolonged exposure to the hot water does no mischief; if the temperature of 160° is not exceeded, it may remain for half an hour; in fact, the perfection of cooking, according to my experience (I always cook my own eggs when I have the opportunity and can spare the time), is attained when kept at 160° about twenty minutes. The 180° is above-named because the rising of the temperature of the egg itself is due to the difference between its own temperature and that of the water, and, when that difference is very small, this takes place very slowly, besides which the temperature of the water is, of course, lowered in raising that of the cold egg.

In order to test this principle severely, I have just made the following experiment: At 10.30 P. M. I placed a new-laid egg in a covered stone-ware jar, of about one pint capacity, and filled this with boiling water; then wrapped the jar in many folds of flannel—so many that, with the egg, they filled a hat-case in which I placed the bundle—and left it there until breakfast-time next morning, ten hours later.

On unrolling, I found the water cooled down to 95°, that the yolk of the egg was hard, but the white only just solidified and much softer than the yolk. On repeating the experiment, and leaving the egg in its flannel coating for four hours, the temperature of the water was 123°, and the egg in similar condition—the white cooked in perfection, delicately tender, but the yolk too hard. A third experiment of twelve hours, water at 200° on starting, gave similar result as regards the state of the egg.

This brings out a fact hitherto unknown to either cooks or chemists, viz., that the yolk coagulates firmly at a lower temperature than the white. Whether this is due to a different condition of the albumen itself or the action of the other constituents on the albumen, requires further research to determine.

When eggs are cooked in the ordinary way, the three and a half minutes' immersion is insufficient to allow the heat to pass fully to the middle of the egg, and therefore the white is subjected to a higher temperature than the yolk. In my experiment there was time for a practically uniform diffusion of the heat throughout.

I shall describe hereafter what is called the "Norwegian" cooking apparatus, wherein fowls, etc., are cooked as the eggs were in my hat-case.

Albumen exists in flesh as one of its juices, rather than in a definitely organized condition. It is distributed between the fibers of the lean (i. e., the muscles), and it lubricates the tissues generally, besides being an important constituent of the blood itself—of that portion of the blood which remains liquid when the blood is dead, i. e., the serum. As blood is not an ordinary article of food, excepting in the form of "black-puddings," its albumen need not be here considered, nor the debated question of whether its albumen is identical with the albumen of the flesh.

Existing thus in a liquid state in our ordinary flesh-meats, it is liable to be wasted in the course of cookery, especially if the cook has only received the customary technical education and remains in technological ignorance.

To illustrate this, let us suppose that a leg of mutton, a slice of cod, or a piece of salmon, is to be cooked in water, "boiled," as the cook says. Keeping in mind the results of the previously-described experiments on the egg-albumen, and also the fact that in its liquid state albumen is diffusible in water, the reader may now stand as scientific umpire in answering the question whether the fish or the flesh should be put in hot water at once, or in cold water, and be gradually heated. The "big-endians" and the "little-endians" of Lilliput were not more definitely divided than are certain cookery authorities on this question in reference to fish. I refer to the two which are practically consulted in my own household, that by Mrs. Beeton, and some sheet-tablets hanging in the kitchen. Mrs. Beeton says pour cold water on the fish, the tablets say immerse in hot water.

Confining our attention at present to the albumen, what must happen if the fish or flesh is put in cold water, which is gradually heated? Obviously a loss of albumen by exudation and diffusion through the water, especially in the case of sliced fish or of meat exposing much surface of fibers cut across. It is also evident that such loss of albumen will be shown by its coagulation when the water is sufficiently heated.

Practical readers will at once recognize in the "scum" which rises to the surface of the boiling water, and in the milkiness that is more or less diffused throughout it, the evidence of such loss of albumen. This loss indicates the desirability of plunging the fish or flesh at once into water hot enough to immediately coagulate the superficial albumen, and thereby plug the pores through which the inner albuminous juice otherwise exudes.

But this is not all. There are other juices besides the albumen, and these are the most important of the *flavoring* constituents, and, *with the other constituents of animal food,* have great nutritive value; so much so, that animal food is quite tasteless and almost worthless without them. I have laid especial emphasis on the above qualification, lest the reader should be led into an error originated by the bone-soup committee of the French Academy, and propagated widely by Liebig—that of regarding these juices as a concentrated nutriment when taken alone.

They constitute collectively the *extractum carnis,* which, with the addition of more or less of gelatine (the less the better), is commonly sold as Liebig's "Extract of Meat." It is prepared by simply mincing lean meat, exposing it to the action of cold water, and then evaporating down the solution of extract thus obtained.

I shall return to this on reaching the subjects of clear soups and beef-tea, at present merely adding, as evidence of the importance of retaining these juices in cooked meat, that the extracts of beef, mutton, and pork may be distinguished by their specific flavors. Some "Extract of Kangaroo," sent to me many years ago from Australia by the Ramornie Company, made a soup that was curiously different in flavor from the other extract similarly prepared by the same company. Epicures pronounced it very choice and "gamy." When these juices are removed from the meat, mutton, beef, pork, etc., the remaining solids are all alike, so far as the palate alone can distinguish.

Let us now apply these principles practically to the case of a leg of mutton. First, in order to seal the pores, the meat should be put into boiling water; the water should be kept boiling for five or ten minutes. A coating of firmly-coagulated albumen will thus envelop the joint. Now, instead of boiling or "simmering" the water, set the saucepan aside, where the water will retain a temperature of about 180°, or 32° below the boiling-point. Continue this about half as long again, or double the usual time given in the cookery-books for boiling a leg of mutton, and try the effect. It will be analogous to that of the egg cooked on the same principles, and appreciated accordingly.

The usual addition of salt to the water is very desirable. It has a threefold action: first, it directly acts on the superficial albumen with coagulating effect; second, it slightly raises the boiling-point of the water; and, third, by increasing the density of the water, the "exosmosis," or oozing out of the juices, is less active. These actions are slight, but all co-operate in keeping in the juices.

I should add that a leg of mutton for boiling should be fresh, and not "hung" as for roasting. The reasons for this hereafter.

V.—FISH.

"Please, mum, the fish would break to pieces," would be the probable reply of the unscientific cook, to whom her mistress had suggested the desirability of cooking fish in accordance with the principles expounded in my last. Many kinds of fish would thus break if the popular notions of "boiling" were carried out, and the fish suddenly immersed in water that was agitated by the act of ebullition. But this difficulty vanishes when the true theory of cookery is understood and practically applied by cooking the fish from beginning to end without ever boiling the water at all.

In the case of the leg of mutton, chosen as a previous example, the plunging in boiling water and maintenance of boiling-point for a few minutes was unobjectionable, as the most effectual means of obtaining the firm coagulation of a superficial layer of albumen; but, in the case of fragile fish, this advantage can only be obtained in a minor degree by using water just below the boiling-point, for the breaking of the fish by the agitation of the boiling water does more than merely disfigure it when served; it opens outlets to the juices, and thereby depreciates the flavor, besides sacrificing some of the nutritious albumen.

To demonstrate this experimentally, take two equal slices from the same salmon, cook one according to Mrs. Beeton and other orthodox authorities by putting it into cold water, or pouring cold water over it, then heating up to the boiling-point. Cook the other slice by putting it into water nearly boiling (about 200° Fahr.), and keeping it at about 180° to 200°, but never boiling at all. Then dish up, examine, and taste. The second will be found to have retained more of its proper salmon color and flavor, the first will be paler and more like cod, or other white fish, owing to the exosmosis or oozing out of its characteristic juices.

I was surprised, and at first considerably puzzled, at what I saw of salmon-cooking in Norway. As this fish is so abundant there (two cents per pound would be regarded as a high price in the Tellemark), I naturally supposed that large experience, operating by natural selection, would have evolved the best method of cooking it, but found that, not only in the farm-houses of the interior, but at such hotels as the Victoria, in Christiania, the usual cookery was effected by cutting the fish into small pieces and soddening it in water in such wise that it came to table almost colorless, and with merely a faint suggestion of what we prize as the rich flavor of salmon. A few months' experience and a little reflection solved the problem. Salmon is so rich, and has so special a flavor, that when daily eaten it soon palls on the palate. Everybody has heard the old story of the clause in the indentures of the Aberdeen apprentices, binding the masters not to feed the boys on salmon more frequently than twice a week. If the story is not true it ought to be, for salmon every day would have the same effect as the daily breakfasts of boiled fat pork and dumplings on the voracious hero of another story.

By boiling out the rich oil of the salmon, the Norwegian reduces it nearly to the condition of codfish, concerning which I learned a curious fact from the two old Doggerbank fishermen with whom I had a long sailing-cruise from the Golden Horn to the Thames. They agreed in stating that codfish is like bread, that they and all their mates lived upon it (and sea-biscuits) day after day for months together, and never tired, while richer fish ultimately became repulsive if eaten daily. This statement was elicited by an immediate experience. We were in the Mediterranean, where the bonetta was very abundant, and every morning and evening I amused myself by spearing them from the martingale of the schooner, and so successfully that all hands (or rather mouths) were abundantly supplied with this delicious, dark-fleshed, full-blooded, and high-flavored fish. I began by making three meals a day on it, and at the end of about a week was glad to return to the ordinary ship's fare of salt-junk and chickens.

This is not exactly a digression, seeing that the philosophy of the appetite is fundamental to that of cookery. A healthy, unvitiated appetite is an index to the requirements of nutrition. Other illustrations of this will be presented as we proceed.

Another important constituent of animal food is *gelatin* or *gelatine.* It constitutes a large proportion of the whole bulk of the animal; it is, in fact, the main constituent of the animal tissues, the walls of the cells of which animals are built up being composed of gelatin. I will not here discuss the question of whether Haller's remark, "Dimidium corporis humani gluten est" ("Half of the human body is gelatin"), should or should not now, as Lehmann says, "be modified to the assertion that half of the solid parts of the animal body *are convertible, by boiling with water*, into gelatin." Lehmann and others give the name of "glutin" to the component of the animal tissue as it exists there, and gelatin to it when acted upon by boiling water. Others indicate this difference by naming the first "gelatin," and the second "gelatine."

The difference upon which these distinctions are based is directly connected with my present subject, as it is just the difference between the raw and the cooked material, which, as we shall presently see, consists mainly in solubility.

Even the original or raw gelatine varies materially in this respect. There is a decidedly practical difference between the solubility of the cell-walls of a young chicken and those of an old hen. The pleasant fiction which describes all the pretty gelatine preparations of the table as "calf's-foot jelly," is founded on the greater solubility of the juvenile hoof, as compared with that of the adult ox or horse, or to the parings of hides about to be used by the tanner. All these produce gelatine by boiling, the calves' feet with comparatively little boiling.

Besides these differences there are decided varieties, or, I might say, species of gelatine, having slight differences of chemical composition and chemical relations. There is *chondrine,* or cartilage gelatine, which is obtained by boiling the cartilages of the ribs, larynx, or joints for eighteen or twenty hours in water. Then there is *fibroine,* obtained by boiling spiders' webs and the silk of silk-worms or other caterpillars. These exist as a liquid inside the animal, which solidifies on exposure. The fibers of sponge contain this modification of gelatine.

Another kind is *chitine*, which constituted the animal food of St. John the Baptist, when he fed upon locusts and wild honey. It is the basis of the bodily structure of insects; of the spiral tubes which permeate them throughout, and are so wonderfully displayed when we examine insect anatomy by aid of the microscope, also of their intestinal canal, their external skeleton, scales, hairs, etc. It similarly forms the true skeleton and bodily framework of crabs, lobsters, shrimps, and other crustacea, bearing the same relation to their shells, muscles, etc., that ordinary gelatine does to the bones and softer tissues of the vertebrata; it is "the bone of their bones, and the flesh of their flesh."

It is obtainable by boiling these creatures down, but is more difficult of solution than the ordinary gelatine of beef, mutton, fish, and poultry. To this difficulty of solution in the stomach is to be attributed, I suspect, the nightmare that follows lobster-suppers.

I once had an experience of the edibility of the shells of a crustacean. When traveling, I always continue the pursuit of knowledge in restaurants by ordering anything that appears on the bill of fare that I have never heard of before, or can not translate or pronounce. At a Neapolitan restaurant, I found "*Gambers di mare*" on the *carta*, which I translated "Leggy things of the sea," or sea-creepers, and ordered them accordingly. They proved to be shrimps fried in their shells, and were very delicious—like white-bait, but richer. The chitine of the shells was thus cooked to crispness, and no evil consequences followed. If reduced to locusts, I should, if possible, cook them in the same manner, and, as they have similar chemical composition, they would doubtless be equally good.

Should any epicurean reader desire to try this dish (the shrimps, I mean), he should fry them as they come from the sea, not as they are sold by the fishmonger, these being already boiled in salt-water (usually in sea-water) by the shrimpers who catch them, the chitin being indurated thereby.

The introduction of fried and tinned locust as an epicurean delicacy would be a boon to suffering humanity, by supplying industrial compensation to the inhabitants of districts subject to periodical plagues of locust invasion. The idea of eating them appears repulsive *at first*, so would that of eating such creepy-crawly things as shrimps, if no adventurous hero had made the first exemplary experiment. Chitine is chitine, whether elaborated on the land or secreted in the sea. The vegetarian locust and the cicala are free from the pungent essential oils of the really unpleasant cockchafer.

VI.—GELATINE AND ITS CHANGES.

Those who are disposed to bow too implicitly to mere authority in scientific matters will do well to study the history and the treatment which gelatine has received from some of the highest of these authorities. Our grandmothers believed it to be highly nutritious, prepared it in the form of jellies for invalids, and estimated the nutritive value of their soups by the consistency of the jelly which they formed on cooling, which thickness is due to the gelatine they contain. Isinglass, which is simply the swim-bladder of the sturgeon and similar fishes cut into shreds, was especially esteemed, and sold at high prices. This is the purest natural form of gelatine.

Everybody believed that the callipash and callipee of the alderman's turtle-soup contributed largely to his proverbial girth, and those who could not afford to pay for the gelatine of the reptile made mock-turtle from the gelatinous tissues of calves'-head and pigs'-feet. The delicacies of the Orient, the edible birds'-nests, the sea-slugs, etc., so highly esteemed for their nutritious properties, are varieties of gelatine.

About fifty or sixty years ago the French Academy of Sciences appointed a bone-soup commission, consisting of some of the most eminent *savants* of the period. They worked for above ten years upon the problem submitted to them, that of determining whether or not the soup made by boiling bones until only their mineral matter remained solid, is or is not a nutritious food for the inmates of hospitals, etc. In the voluminous report which they ultimately submitted to the Academy, they decided in the negative.

Baron Liebig became the popular exponent of their conclusions, and vigorously denounced gelatine, as not merely a worthless article of food, but as loading the system with material that demands wasteful effort for its removal.

The Academicians fed dogs on gelatine alone, and found that they speedily lost flesh, and ultimately died of starvation. A multitude of similar experiments showed that gelatine alone would not support animal life, and hence the conclusion that pure gelatine is worthless as an article of food, and that ordinary soups containing gelatine owed their nutritive value to their other constituents. According to the above-named report and the statements of Liebig, the following, which I find on a wrapper of Liebig's "Extract of Meat," is justifiable: "This extract of meat differs essentially from the gelatinous product obtained from tendons and muscular fiber, inasmuch as it contains eighty per cent of nutritive matter, while the other contains four or five per cent." Here the four or five per cent allowed to exist in the "gelatinous product" (i. e., ordinary kitchen stock or glaze) is attributed to the constituents it contains over and above the pure gelatine.

Subsequent experiments, however, have refuted these conclusions. I must not be tempted to describe them in detail, but only to state the general results, which are, that while animals fed on gelatine-soup, formed into a soft paste with bread, lost flesh and strength rapidly, they recovered their original weight when to this same food only a very small quantity of the sapid and odorous principles of meat were added. Thus, in the experiments of Messrs. Edwards and Balzac, a young dog that had ceased growing, and had lost one fifth of its original weight when fed on the bread and gelatine for thirty days, was next supplied with the same food, but to which was added, twice a day, only two tablespoonfuls of soup made from horse-flesh. There was an increase of weight on the first day, and "in twenty-three days the dog had gained considerably more than its original weight, and was in the enjoyment of vigorous health and strength."

All this difference was due to the savory constituents of the four tablespoonfuls of meat-soup, which soup contained the juices of the flesh, to which, as already stated, its flavor is due.

The inferences drawn by M. Edwards from the whole of his experiments are the following: "1. That gelatine alone is insufficient for alimentation. 2. That, although insufficient, it is not unwholesome. 3. That gelatine contributes to alimentation, and is sufficient to sustain it when it is mixed with a due proportion of other products which would themselves prove insufficient if given alone. 4. That gelatine extracted from bones, being identical with that extracted from other parts—and bones being richer in gelatine than other tissues, and able to afford two thirds of their weight of it—there is an incontestable advantage in making them serve for nutrition in the form of soup, jellies, paste, etc., always, however, taking care to provide a proper admixture of the other principles in which the gelatine-soup is defective. 5. That to render gelatine-soup equal in nutritive and digestible qualities to that prepared from meat alone, it is sufficient *to mix one fourth of meat-soup with three fourths of gelatine-soup;* and that, in fact, no difference is perceptible between soup thus prepared and that made solely from meat. 6. That in preparing soup in this way, the great advantage remains that, while the soup itself is equally nourishing with meat-soup, three fourths of the meat which would be requisite for the latter by the common process of making soup are saved and made useful in another way—as by roasting, etc. 7. That jellies ought always to be associated with some other principles to render them both nutritive and digestible." *

The reader may make a very simple experiment on himself by preparing first a pure gelatine-soup from isinglass, or the prepared gelatine commonly sold, and trying to make a meal of this with bread alone. Its insipidity will be evident with the first spoonful. If he perseveres, it will become not merely insipid, but positively repulsive; and, should he struggle through one meal and then another, without any other food between, he will find it, in the course of time (varying with constitution and previous alimentation), positively nauseous.

Let him now add to it some of Liebig's "Extract of Meat," and he will at once perceive the difference. Here the natural appetite foreshadows the result of continuing the experiment, and points the way to correcting the errors of the Academicians and Baron Liebig. The jellies that we take at evening parties, or the jujubes used as sweetmeats, are flavored with something positive. I have tasted "Blue-Ribbon" jellies that were wretchedly insipid. This was not merely owing to the absence of alcohol, of which very little can remain in such preparations, but rather to the absence of the flavoring ingredients of the sherry. The *Rahat Lakoum*, or "lumps of delight," sold in the streets of Constantinople, is gelatine flavored with the unfermented juices of fruit. A privileged visit which I once made to the monster kitchen of the Old Seraglio of his Majesty the Sultan (at Stamboul) lives perpetually in my memory, so sweetly, so vividly, and so grate-

* London, "Nouveaux Élémens d'Hygiène," second edition, vol. ii, p. 73.

fully, that when I find myself defending the Turk against the Russian and all his other enemies, my conscience sometimes inquires whether those lumps of delight prepared for the Sultana by his Highness the Grand Confectioner, and presented to me by him as a sample of his masterpiece, may, or may not, have ever after influenced my politics. It was gelatine glorified, once tasted never to be forgotten.

It would seem that gelatine alone, although containing the elements required for nutrition, requires something more to render it digestible. We shall probably be not far from the truth if we picture it to the mind as something too smooth, too neutral, too inert, to set the digestive organs at work, and that it therefore requires the addition of a decidedly sapid something that shall make these organs act. I believe that the proper function of the palate is to determine our selection of such materials ; that its activity is in direct sympathy with that of all the digestive organs ; and that, if we carefully avoid the vitiation of our natural appetites, we have in our mouths, and the nervous apparatus connected therewith, a laboratory that is capable of supplying us with information concerning some of the chemical relations of food which is beyond the grasp of the analytical machinery of the ablest of our scientific chemists.

There is another element of flesh so intimately connected with gelatine and so much like it, that I must describe its properties before going further into the subject of practical cookery of animal food. I refer to *fibrine*, which will form the subject of my next paper.—*Knowledge.*

INSECTIVOROUS PLANTS.

By SALLIE L. ANDREW.

It was, I think, during the summer of 1876 that Mr. Darwin's most interesting work on "Insectivorous Plants" fell into my hands, and was read with the delight which the "fairy-tales of science" that came from his hand must ever inspire. As a matter of course, I procured, at once, some plants of the *Drosera rotundifolia*, and began a series of amateur experiments, which were to me so interesting that I began to wish all plants might have been created with the same marvelous properties.

While my mind was thus employed, I began to notice that the plants of the common garden *Petunia* (*P. grandiflora*) were almost always quite freely powdered with the dead or apparently dying bodies of small insects, which seemed to be held fast, either by the hairs with which every part of this plant is covered, or by the gummy, sweetish exudations therefrom. I made pilgrimages to other gardens than our own, invariably finding the petunia-plants covered with the small captives.

It was not until the summer of 1881 that I had access to a good microscope, since which time I have spent many hours in trying to penetrate this mystery. In this I have been greatly assisted by my friend Dr. J. H. W. Meyer, who was at first very skeptical in regard to my confident assertions that here was a new insectivorous plant, but who grew more and more interested, and finally became an enthusiastic convert.

Upon our first examination, we found that the hairs—*tentacles* we have learned to call them—varied in length, were somewhat thickened at the base, usually three-celled, the last cell being expanded into a spherical shape. Small protuberances were often found upon the sides of the hairs (Fig. 1), but more commonly upon the bulbous tip. Sometimes these cells seemed to me to have a decidedly spiral form, but of this I could never be quite sure. The tentacles were extremely flexible, sometimes turning sharply backward, as in Fig. 2.

I have made many observations, with a hand-magnifier, upon the plants in the garden. I found the freshly-captured insects most plen-

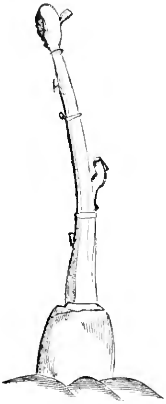


Fig. 1.

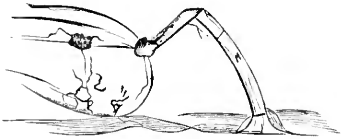


Fig. 2.

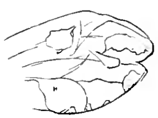


Fig. 4.

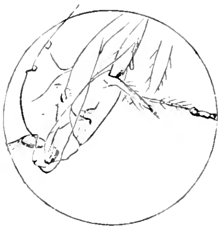


Fig. 3.

Fig. 5.

tiful about nightfall, at which time the petunia-blossoms emit a powerful odor, and the clamminess of the leaves and stems is most noticeable. I have seen insects as large as the common red ant struggle and die, and have found the horny wings of small *Coleoptera*, but most frequently I have found small spiders, gnats, etc.

When an insect alights upon a leaf (I say leaf, although the hairs upon the stems, calyxes, and even the outer and lower portions of the flower-tubes are quite as vigorous, and as often successful), it at first manifests much alarm, runs with as much strength as possible up and down and under the leaf, lifting its feet with more and more of an effort, until at last, either benumbed or exhausted, its motions are almost imperceptible, and sometimes for an hour will occur at such long intervals that one decides half a dozen times that death must already have taken place. On one occasion, a branch bearing a lively little insect was cut from the plant, put into water, and the leaf on which the insect was struggling placed under the microscope about six o'clock in the evening, and watched until eleven, by which time life was undoubtedly extinct. During these hours the fight for existence was most interesting, the tentacles one by one discharging their fluid, first by casting drops between the wings—an almost invariable proceeding—thus destroying their usefulness by gumming them firmly together (as in Figs. 3, 4). Then the tips of the tentacles, by this

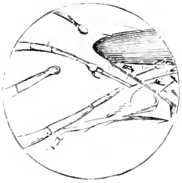


Fig. 6.

Fig. 7.

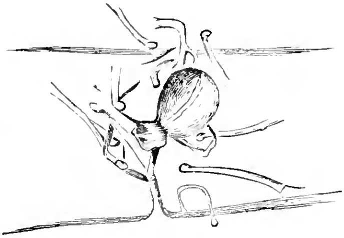


Fig. 8.

time so much excited as to have quite lost their spherical form, are inserted between the joints about the head, and among the hairs of the feet and legs (as in Figs. 5, 6, 7), the stronger members being firmly pinioned by the stronger tentacles (as Fig. 8), while the small hairs are discharging their fluid. This fluid seems to be somewhat tenacious.

Small seeds and bits of sand are sometimes caught in the same manner, but rather daintily, as if the plant merely wished to see if it were worth while or not (as in Fig. 9). I have never seen them *inclosed* by the hairs, as are the animal substances.

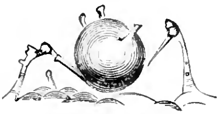


Fig. 9.

These are some of the things that I have seen. I do not know what may be the motive of the plant; what it does with the insect, the last stage of whose strange eventful history I have so often seen in a dry, withered carcass, or a few detached and macerated limbs (Fig. 10). I do know, however, that the plant begins its depredatory career as early as the unfolding of the second pair of leaves from the cotyledons, and continues it up to the time of the first frosts.

Fig. 10.

And so, having come to where, for me, the "thus far" ends and the "no farther" begins, I beg to call the attention of those interested in insectivorous plants to the *Petunia*, which fills every waste place in our gardens.

CONSTRUCTIVE ELEMENTS OF THE EAST RIVER BRIDGE.

By F. A. FERNALD.

THE New York Bridge Company, having for its object the building of the suspension-bridge between New York and Brooklyn across the East River, was chartered by the State Legislature April 16, 1867. The work was begun by this company, and continued until its control was transferred to the two cities, June 5, 1874, from which time until the completion of the structure it was carried on by a board of trustees. John A. Roebling was at first chosen chief-engineer, but, dying two years later, he was succeeded by his son and associate, Colonel Washington A. Roebling.

The engineer's plans and estimates were submitted in September, 1867, and were finally approved in the spring of 1869. The mechanical work was begun on the site of the Brooklyn tower January 3, 1870. The finished tower rises 278 feet above high-water mark, and measures from top to foundation 316 feet. It is faced above water with granite, but is built partly of blue limestone. At the water-level the tower is 140 feet wide and 59 feet thick; the roadway passes through it at a height of 119 feet 3 inches by means of two archways each 117 feet high, and 33 feet 9 inches wide at the base. Where this tower stands, the river-bed is a compact conglomerate of clay, sand, and bowlders, in which its foundation rests at a depth of 44½ feet below high-water mark. The lowest course of masonry rests on a layer of pine-beams 15 feet thick, i. e., the roof of the caisson used to carry down the foundation. Under the roof of the caisson are built 72 brick pillars, 9½ feet high, and the rest of the space is filled in with a solid concrete. The Brooklyn tower was finished in May, 1875. The New York tower differs from this in being three feet wider, and in extending down for 78½ feet below high-water mark, where it reaches some spurs of the bed-rock, making the total height of the tower 350 feet. The roof of the caisson was made 22 feet thick, so as to support the greater weight of masonry to be built upon it during its descent. This tower was finished in July, 1876. Neither has as yet settled two inches.

The four cables are each 15¾ inches in diameter, over two thirds of a mile long (3,578½ feet), and each consists of 5,282 galvanized steel wires, not twisted as in a small wire rope, but lying parallel from end to end. No. 7 wire was used, which is a little over one eighth of an inch thick, and each cable was made in nineteen strands. The coils of wire for one strand were spliced together, so that each strand consists of a continuous wire running back and forth across the river, and at each end passing around a grooved piece of iron called a shoe. The running out and regulating of the wires occupied a year and four months. After the strands of each cable were made, they were united in one bundle, which was wound from end to end with wire. All the wire used had received five coats of oil, and the bundle received another coat before the wrapping; finally, the finished cable was painted with white-lead and oil. Where the cables pass through the tops of the towers, they rest in grooves on iron plates, called saddles, which are 13 feet long, 4 feet 1 inch wide, and 4 feet 3 inches thick in the highest part. The saddles lie lengthwise under the cables, and their tops are rounded so as to afford an easier bearing. Each saddle is supported on 40 wrought-iron rollers, 3½ inches in diameter, which rest in grooves on an iron saddle-plate.

The nineteen shoes, around which the separate strands of a cable are looped, are bolted to as many iron bars, which are 12 feet long, 9 inches wide, and 3 inches thick. These bars are laid side by side in two courses, ten in the lower and nine in the upper. They are bolted to another set of similar bars by means of pins running through eyes in the ends of all the bars in each course. In this way chains of bars are formed, each consisting of ten links, which reach backward and downward to the anchor-plates, both plates and chains being imbedded in the masonry of the anchorage. The anchor-plates are elliptical, star-shaped masses of iron, measuring 17½ by 16 feet. There is a series of holes in the middle of each, through which the last links of the chains are passed and fastened by bolts. Four of these plates lie horizontally beneath and close to the rear wall of each anchorage. The mass of stone which holds these plates down measures 129 by 119 feet at the base, is 89 feet high on the front and 85 feet at the back. The site of the Brooklyn anchorage was dug down to the water-level, and a platform of timber was laid under water, upon which the first course of stone was laid. The soil on the New York side was so loose that piles had to be driven in order to secure a firm foundation.

From the terminus the roadway rises to the top of the anchorage over a series of arches which gradually increase in height. Streets run through some of the archways, under the approaches, and the others are to be fitted up with fronts and floors, and let as warehouses. The length of the New York approach is something over a quarter of a mile (1,562½ feet), that of the Brooklyn approach is 971 feet.

From the anchorages to the towers stretch the landward spans of the bridge, each nearly one fifth of a mile (930 feet) long, while the central span, from tower to tower, measures nearly a third of a mile (1,595½ feet). These three spans are attached to the cables by means of wire ropes. The suspender-ropes vary in length from 170 feet next the towers to 3 feet in the middle of the main span, and each is attached to a wrought-iron band 5 inches wide, which encircles the cable. The band holds a socket into which the end of the suspender is set, and fastened by a pin driven down between the wires, which are then bent over it, and the socket is filled up with melted lead. Each suspender is tested to sustain 100 tons, but the greatest weight that can come upon any one is 10 tons.

Besides being suspended in this way from the cables, the spans are further secured for 437 feet each way from the towers by stay-ropes, 27 of which start from each saddle-plate, and, spreading out like the sticks of a fan, are attached, at intervals of 15 feet, to the bottom chords of the trusses.

There are six vertical trusses which inclose the five ways into which the roadway is divided. The top chords of the two outer trusses are $9\frac{1}{2}$ feet above the roadway, those of the other four are 16 feet. Each truss has a slip-joint in the middle of each span to allow for expansion and contraction of the structure from heat and cold. For a hundred feet out from the towers these trusses are said to be able to support themselves, not adding their weight to the strain on the cables.

The floor-beams, which lie crosswise, at intervals of $7\frac{1}{2}$ feet, are 86 feet long, and each consists of two sections spliced end to end. To each beam are attached four suspenders, one from each cable, except for 250 feet out from the anchorages, where the cables dip below the roadway, the floor-beams resting on pillars above them, and in the archways of the towers, where the beams rest upon the masonry. The beams are triangular lattice-girders, having a top and a bottom chord connected by vertical posts and diagonal braces. They are 32 inches wide and $9\frac{3}{8}$ inches thick. Alternating with these main floor-beams are lighter beams which are fastened to them by cross-ties.

The three spans are protected against lateral swaying by four stays from each corner of each tower, which run out just under the roadway, and are attached to the truss at the opposite side at different distances. Beyond these are other similar stays running from side to side. Further, the two outer cables are drawn inward, and the two inner ones outward, as they recede from the towers, so that each opposes its weight in the form of an arch to lateral movement. The suspenders also tend to prevent swaying, for, instead of descending vertically, each is drawn in toward its half of the bridge.

The total length of the bridge and approaches is over a mile and an eighth (5,989 feet). The middle of the main span is 135 feet above high-water mark, at 90° Fahr. This is sufficient for the bulk of the shipping that uses the East River, but the largest ships have to take down their highest spars to clear it. The cable-wire, trusses, and floor-beams are all of steel, this being the first steel suspension-bridge ever built. The total weight of the suspended portion, including the cables, is 14,680 tons, and the total load that can come upon it is 3,100 tons. To support these 17,780 tons we have the cables, with a united strength of 54,244 tons, and in addition the trusses and stays, which bear no small part of the weight. Engineer Roebling says that the cables are strong enough to pull up the anchorages, but, as each of these weighs 60,000 tons, they probably will never be called upon to perform that feat.

The roadway on the approaches is 100 feet wide, on the spans 85 feet. The outside avenues are for vehicles, the next two are car-tracks, and a footway 16 feet wide occupies the middle. This latter is paved with asphalt as far as the anchorage, and is only three feet above the driveways. Here it rises by a flight of steps to a plank walk twelve feet above the driveways, from which a clear view over both sides of the bridge can be had. To prevent danger in case the brakes should fail to control a train coming down the incline of the roadway, the car-tracks are kept at the same level for the last 600 feet on each approach, which brings them out at about the level of the elevated roads. The cars are to be propelled by means of an endless wire rope, which will run between the rails of each track, over grooved wheels, set upright $22\frac{1}{2}$ feet apart. Motion is communicated to the rope by two stationary engines located on the Brooklyn side. It is calculated that the cars can take 80,000 passengers across in an hour, that 50,000 more can cross on the promenade, while the driveways will accommodate nearly 1,500 vehicles an hour.

The roadway is lighted by 70 electric lights, set on posts upon the trusses that run between the car-tracks and carriage-ways.

The bridge, which had been fourteen years in building, was formally opened May 24, 1883. Up to April 1st there had been paid out on the work $14,429,003.25, and the expenses then remaining to be met will bring the cost up to nearly $16,000,000. In length of span the Brooklyn Bridge surpasses every other bridge in the world. The span of Roebling's Niagara suspension-bridge is 821 feet, a little more than half as great; the span of the suspension-bridge at Fribourg, built in 1832, the longest in Europe, is 870 feet; while Roebling's Cincinnati bridge, which has the second longest span in the world, measures 1,057 feet between the towers, or about two thirds the length of the East River span.

THE INDUSTRIAL POSITION OF WOMEN.

By EMILY BLACKWELL, M. D.

AMONG all the questions affecting women, and society through women, there is none more vital than that of their industrial position. It is conceded that women should work, but there is a great difference of opinion as to what their work is, and how they should do it. This difference of public opinion is not merely a matter of theory; it leads to very positive practical results, for the support of public opinion is necessary to make work in any special direction possible.

No one can work independently of others. The training that qualifies for any pursuit, the necessary relations to others engaged in it, the patronage which pays for it—all these are absolutely requisite for its successful prosecution, and these are given or withheld by the force of public opinion. The point at issue in this discussion is, How far can women advantageously take part in the great system of modern industry? Is the effort they are making to enter occupations from which they have hitherto been excluded justifiable? Is it the expression of a real need? Will their success be a benefit or an injury to themselves and to society?

Upon this subject there are two views, the holders of which are endeavoring to enlist on their side this final arbiter of the question, the force of public opinion. On one side it is held that women urgently need greater facilities for work; a wider range of occupations, in order to give them greater power of self-support; that many grave social evils result from this want. It is maintained that the claims accompanying this effort, for equal general and special education, for participation in any kind of work which women feel that they can do, for employment in any occupation for which they have fitted themselves, are just; that the movement is in the direction of progress, and that it is the interest of society to support it. On the other side it is urged that woman has her own peculiar sphere, that of domestic life and work. This, well understood and followed, is sufficient for her. She is unfitted by her physical and mental constitution for the occupations carried on by men. Success in the effort she is making in this direction is impossible. The attempt is leading her to do violence to her own organization, to abandon or slight domestic life, and to become an inferior competitor instead of a companion to man. Progress is to be sought, not by favoring the effort, but by promoting such an extension of home-life as shall render it unnecessary.

Both parties are agreed as to the paramount importance of domestic life. This being admitted, the objection to non-domestic work for women is based upon the implied supposition that, were domestic life as universal as it should be, the domestic work connected with it would be sufficient to absorb the great body of women-workers.

To estimate the force of this objection, let us consider what is meant by the terms domestic life and domestic work. There are two elements in the domestic position of women: first, their personal relation to the family as wives and mothers; secondly, the work which necessarily devolves upon them in the fulfillment of the duties of these relations. The first, the personal relation, is a fixed and constant element. It grows out of the constitution of human beings, and exists under every form of society. It attains its highest expression wherever the union of one man and one woman is the foundation of the family.

Here we find most marked the personal affection, the intimate companionship, the community of interests, the common responsibility and care for the children, which are the characteristics of the family. The related life of the group so formed constitutes domestic life. But if the personal relations of woman to the family are thus fixed and enduring, her industrial relation to it is by no means so unchanging. The work which she must do for it varies according to external conditions. There is no one kind of work which absolutely belongs to domestic life ; there is hardly any kind of work that has not in some phase of society been considered to belong to it.

In the savage state, women built the wigwam, raised the corn, prepared the clothes, carried on in its rudest and most elementary form all the work which is to-day the object of modern industry. But since these simple forms of labor have developed into architecture and agriculture and manufactures, it is held that women can not follow their old occupations under their new forms, under penalty of personal deterioration and social disaster. It is the conditions under which work is done, apparently, which constitute it domestic work, rather than the nature of the work itself. Weaving was domestic work when done at home, but ceased to be so when done in a factory.

Domestic work, therefore, is all work for the family which, under our present arrangements, must be done at home, upon a small scale, by individual workers, free from the organization and competition of business. Precisely in the degree that outside occupations partake of any of these characteristics of domestic work, are they considered appropriate to women. On the other hand, how feminine soever the nature of a work, as soon as it is seized upon by the modern system of outside labor, begins to be carried on upon a large scale, and to be subject to the laws of business competition, it thenceforth ceases to belong to women. It has departed from the conditions of domestic work.

If this definition of domestic work be correct, two questions naturally arise in connection with it : 1. Will the work now done at home always continue to be so done? 2. If the conditions of domestic work are those most favorable to the well-being of women, what is the reason of their growing distaste for domestic service? The answers to these two questions are very closely connected with each other, and with the main question of the industrial position of women.

When we consider, on one hand, how pressing and increasing an evil is the lack of skillful and reliable servants, how severely the want of efficient service weighs upon the mothers of families, and, on the other hand, how liberal is the compensation and how certain the employment for women having even a moderate degree of skill in housework, there seems, at first sight, some truth in the assertion that the difficulty with women is not the want of work, but the inclination to shirk their own work in order to invade that of men. The complaint of the difficulty incident to finding well-paid work does not come from our domestic servants. The Irish girl finds work from the day of her landing. and begins almost immediately to send remittances of money to her friends at home. The American girl, thrown upon her own resources, struggles miserably to keep soul and body together upon the scanty wages of the shop or the factory. Yet so decided is the disinclination to domestic service, the largest and most profitable field for women to work, that American women have virtually abandoned it. The Irish girls gradually absorb the same distaste, and are less available as they become Americanized. We already hear the suggestion in favor of the Chinese, that they are needed to supplant the Irish servants, as the Irish have taken the place of Americans.

Is not the cause of this dislike to be found in the servile nature of domestic service, which renders it necessary to bring in a constant succession of servile labor to fill it? Is it not just in proportion as women rise above the servile tone of feeling that they become restive in the position, and will sacrifice comfort and pecuniary advantage to escape from it? Almost every feature of domestic service partakes of this repellent character. On entering it, the woman, like the slave, drops the surname which marks her as a member of a family of a social connection, for the personal name which sinks her at once into a rank below that in which social connection is recognized. Reversing the natural order of things, the woman addresses the children and young men of the family by terms of respect implying superiority, while they address her by the familiar name implying inferiority. She abandons family life, having no daily intercourse with her relatives as do out-door workers living in their own homes. She loses her personal freedom, for she is always under the authority of her employer. She can never leave the house without permission; there is no hour of the day in which she is not at the bidding of her mistress; there is no time in her life, except the few stated seasons of absence, for which she may not be called to account. Though her accommodations are probably far better than she would have at home, their relative inferiority renders them less acceptable than the poorer quarters in which she shares freely the best there is to have. Every distinction of dress which is a badge of domestic service is universally felt to be derogatory. It is creditable to a man to refuse any domestic position that entails the wearing of a livery, while the uniform of even the lowest ranks of the public service—of the policeman or the postman—is assumed with satisfaction. The white cap and apron that become almost a uniform when worn by the graduates of the training-schools for nurses, as the mark of a superior class, are assumed with reluctance as an accompaniment of domestic service.

Precisely in the degree in which house-work has this character it is shunned. When American women do engage in domestic work out of their own families, it is not the easiest and best-paid positions which they prefer. They are not to be found as nurses, seamstresses, and chambermaids in wealthy families, but rather as the sole workers in small and simple country families, where they have the kitchen to themselves, and the contrast between the social position of themselves and their employers is not so great.

In all such matters feeling is quicker than reason. Every woman instinctively feels that, in exchanging the position of an outside worker for that of domestic service, she descends one step in the social scale, and approaches one degree nearer to personal servitude. Upon what does this servile nature of domestic service depend? It is not due simply to difference of wealth and social standing; that difference exists everywhere between the employer and the employed. It is due to the conditions under which the work is done in the house, each servant dependent upon the mistress in the details of her personal life, doing work more or less undefined in its nature, amount, and time of doing. These conditions imply a direct, perpetual, personal subordination, necessarily servile. It is the absence of these conditions that renders non-domestic work independent, instead of servile. The limitation of the work within certain hours, outside of which all subordination or accountability to the employer ceases, the freedom of personal life thus gained, the more defined nature of the work, its larger scale, the numerous workers engaged in it—all these characteristics render the relation between employer and employed a business, not a personal one.

We can only imagine the servile character absent from domestic service in a state of society so simple and homogeneous that the work of each family was done by its own women; and one in which there were so few women not required at home that they could be absorbed by those families in which there was a paucity of women, and there work upon an equal footing with the wives and daughters. Is there anything in the tendencies of modern life pointing to such a state of society? Are they not sweeping us in an entirely different direction? Would it not be more in accordance with the forces shaping modern life to suppose that the problem of domestic service will be solved rather by changing the mode in which domestic work is done, than the relative position of mistress and servant? Will not such a change be the natural result of a continuance of the process which has already transferred one occupation after another from the sphere of domestic work to that of business organization? Is it not inevitable that all the material arrangements of life shall ultimately thus be taken possession of?

There is no reason why what is now done by domestic service should always continue to be so done. As weaving and tailoring have gone, so the making of women's and children's clothing is now going. There is no reason inherent in the nature of things why washing, cooking, mending, etc., should not go also, and be done by business organizations from outside, instead of by domestic service. Thus domestic work will be reduced to the minimum, to that part most intimately connected with the personal life of the family. The need of domestic service will diminish in the same proportion, and the problem it presents will be solved by its diminution, or gradual disappearance; while domestic life will be more and more freed from the necessity of carrying on a variety of domestic work.

The obstacles to be overcome in bringing about this result do not differ in kind from those which are disappearing elsewhere before the ingenuity and perseverance of business enterprise. The difficulties in the way of supplying cooked instead of raw food are very similar to those being now overcome in the transport of delicate and perishable food, and in the preserving such food in perfection through the whole year. There is no reason why bakers should necessarily supply inferior bread, or why cooking done on a large scale should always be inferior to that done at home. That the work which remains to be so dealt with is the most difficult to be thus treated is the reason it has remained to the last. That our efforts in this direction are as yet attended by imperfect success is no proof that this will always be the case. Until business organization has advanced so far as to do the work as well as the same can be done at home, and more conveniently and cheaply, its imperfection will keep up our present system of domestic service.

It may be objected that so radical a change in the conditions of household work must imply the destruction of the home as we at present understand it. But why should this be the result of the changes to come, any more than of the equally great changes that have been already accomplished? The dread of it arises from the same sort of feeling which has made it so difficult for geologists to accept the fact that the wonderful changes recorded upon the surface of the earth have been accomplished by the same agencies which are at work upon it to-day, so silently as to be imperceptible to the multitude.

It may be objected that the failure to marry is the reason so many women are seeking employment; and that, were marriage sufficiently universal, the immense majority of women would be occupied in their own homes. Facts do not seem to bear out this view. The proportion of persons who pass through life unmarried is comparatively small. The mass of working-women is composed not of middle-aged single women, to whom alone the criticism could refer that they have preferred other work to marriage. The great bulk is composed of young women under twenty-five, whose families can not afford to support them for the sake of their domestic work, and the majority of these will probably eventually marry. There is also a considerable number of married women who, by the death or inability of the husband, are thrown back upon the necessity of self-support. This last is a much larger class than is usually supposed. It would probably at least equal the number of single women of corresponding age—that is, of women who have remained single to middle life.

As a matter of fact, support through marriage can not be co-extensive with the need of support for women. It does not cover the whole period of working-life, and it fails to be a support in a considerable proportion of cases.

It would seem that there must be a fallacy in the view that would make the natural provision for honorable and satisfactory support depend upon a relation that does not cover the whole need in any case, and can not be certainly counted upon in any individual case. The same tendency toward complexity of conditions and relations, which makes equality in domestic service a thing of the past rather than of the future, would lead us to anticipate that the number of women workers must increase rather than diminish. In taking methods for improving their condition we must look forward rather than backward, to means which are in harmony with influences now at work, rather than to such as would require a return of conditions which have passed away.

We believe, therefore, that a careful consideration of the movements which have gone on and are going on in social life leads to the following conclusions :

1. There is no necessary connection between domestic life and domestic work.

2. Domestic life means the united life of the members of a family, and is a constant social element.

3. Most of the work now done as domestic work is only so done because it has not yet been brought within the grasp of business organization. The range of such work is constantly growing narrower.

4. Our method of doing it by domestic service is imperfect, because domestic service involves a servile relation that does not exist in non-domestic labor.

But if all work tends thus irresistibly to become organized into departments of business, the question of the future industrial position of women is settled. They must follow their work under its new forms, or cease to work at all. Extremes meet, and the organization of industry must end by giving back to women what it began by taking from them, a place in the varied work of the world.

So far from the perfection of domestic life being imperiled by the gradual substitution of non-domestic for domestic labor, many advantages would be thereby gained :

1. It would help to free marriage from any but personal considerations. The question as to the capacity of a woman for house-work would become as foreign to that of her desirability as a wife as is now her ability as a tailor. It would be a wife only, not also a domestic, that the young man would need to seek.

Still more important a change would it be were marriage, to women, only the entrance into a wider and happier social state, and need never be regarded as the only recognized business opening.

2. It would bring more varied ability to the service of domestic life.

Despite the many kinds of work which have been gradually taken out of the housekeeper's hands, her position still calls for a variety of faculties rarely combined in one woman; and household life is in most families correspondingly imperfect. The business ability that makes a good housekeeper, in the sense of a good provider for material needs, of a capacity to use money to advantage, and to secure order and perfection of work, is one thing. To be a good educator, to possess the faculty of understanding and training children, is another. Neither of these qualifications is necessarily connected with the gifts and tastes which are required to make the home a social center, to bring its inmates into the friendly and easy relations to other families upon which its social standing depends, and which, under the present state of things, are so essential to the welfare of its young people as they approach the age for marriage. The mother of a family, whether rich or poor, must be a sort of "Jack of all trades," and often goes through life with the discouraging sense that, in one or other of these important departments, her good intentions will never supply the lack of natural faculty. The less complicated and extensive the work that necessarily devolves upon a woman in her household, the more chance for its successful accomplishment. The more she can call upon skillful help, the less likely the family will be to suffer from her deficiency in any direction.

There is nothing which would seem more absolutely dependent upon the mother than the care and training of very young children. Yet the careful study of the best modes of training these early years, which has come in with the Kindergarten, shows how far the nursery alone is from meeting their needs; how early and how much skilled teachers, other children, a variety of apparatus, that is, outside help, are desirable for the best interests of the child, as well as for the assistance of the mother.

3. Another great advantage that would come from a general recognition that the occupation of women in non-domestic work tends inevitably to increase, would be the impulse it would give to the industrial training of girls. Parents do not think it worth while to educate their daughters for any pursuit, because they consider industrial occupation for a girl an undesirable exception, not to be provided for. An immense amount of misery would be avoided did custom require that every girl should be taught some paying work. It should be considered more obligatory in the case of girls than of boys, thus to guarantee them the possibility of independence, both because they are less able to make opportunities for themselves when unexpectedly called upon to do so, and because of the greater dangers to which helpless-

ness exposes them. There is no greater source of suffering and vice among women than the fallacy of taking for granted that they will not need to support themselves.

4. The wider the range of occupations for women, the more numerous will be the points at which the lives of men and women touch. One of the objects to be accomplished by advancing civilization is the bringing of men and women into easy and natural companionship. Under existing circumstances almost the only meeting-ground for young men and women is in society. Those who can not take an active part in this are almost shut off from acquaintance with the opposite sex. Numbers of girls educated at girls' schools, and afterward living at home in narrow circumstances, or going into work conducted by and among women, remain single because they pass the age for marriage without sufficient opportunity for meeting men of their own standing, or make unsatisfactory marriages, because they do not choose from knowledge, but accept the only opportunity that offers. The same is true of young men not in society. Their life is passed almost exclusively among men from their school-days upward. Their acquaintance with women of their own age is extremely limited and superficial. The more complete the separation of men and women in work, the more must this division in life be the result. The more numerous the common interests and occupations in which they meet in recognized and honorable companionship, the more numerous the chances for suitable and happy marriage. So far, therefore, from deploring the encroachments of business organization on domestic work as a danger to the happiness of domestic life, we should see in them an agency which will lead to its higher development.

But if, as we have shown, it be in the natural course of things for women to take part in industrial pursuits, what is the meaning of the warning notes that attend their steps in that direction? We are told that women break down under the strain of college education; that their health gives way under the requirements of book-keeping, telegraphy, factory-work, every kind of business; that their work is poor and unreliable, and will command only starvation wages, etc., and these discouraging reports come not only from illiberal opponents, but from sincere friends and well-wishers. The most important of these objections is based upon the assumption that the physical constitution of women unfits them for safely bearing the strain of brain-work or business.

It is true that the health of women is not what it should be; but the cause of this lies neither in their peculiar organization nor in their efforts in new directions. It is to be found in the influences surrounding them from infancy, which prevent our girls from acquiring the physical vigor which should accompany maturity. This defective health is nowhere shown more conspicuously than in domestic life. Nowhere do women break down more frequently and completely than in the bearing and rearing of children, under the strain of maternity, and the wear and tear of domestic duty.

It is not only, nor chiefly, our college graduates and industrial workers who crowd the offices of specialists, and the same department in our charities. The girls who stay at home and are subjected to no educational strain, the wives and mothers who are pursuing the most natural of avocations, are quite as fully represented. We must believe that it is the physical education, not the organization, of women that is at fault, unless we accept the conclusion that the special constitution that is supposed to disqualify them for other work disqualifies them also for its own ends.

It is generally assumed that the women who have broken down in outside work would not have done so in married life, but it is precisely the feeble health that fails in one that fails in the other also. There is a general inclination to compare the results of work under unfavorable conditions with those of married life under favorable ones. If we compare the health of the same class of women, under equally favorable or unfavorable conditions of work or of married life, it is extremely doubtful if the result would be as much in favor of the latter as the opponents of non-domestic work for women take for granted.

Many of the difficulties which now embarrass women in work are such as belong to a transition state. They will disappear as the presence of women in these new fields is accepted and provided for. The fewness of the occupations open to women and their consequent overcrowding; the difficulty, often the impossibility, of acquiring special education for occupations in which special skill is required; the opposition of the workers already in the field—these are only a few of the obstacles which are due to the novelty of the effort. Business has been arranged to suit men; and women, upon entering any new branch of labor, are required to accept its existing conditions. There are many kinds of work which women could do perfectly well if they could modify these conditions. But if, without this, they fail to do it as well as men, or suffer more in doing it, it is taken for granted that the work is unfit for them, that the remedy is to exclude them from it, not to adopt the mode of doing it to their requirements.

As an illustration of the different effect of the same work according to the circumstances under which it is done, take agricultural labor. Nothing is more frequently quoted as an exemplification of the brutalizing effect of masculine work upon women, than the results of field-labor as it is carried on by them in some parts of Germany and other places, where women are considered, and treated, as mere drudges. Contrast with these reports the following statements in regard to the effect of field-work upon women in the north of England, extracted from the "First Report of the Commissioners on the Employment of Children, Young Persons, and Women in Agriculture," presented to Parliament in 1868. In it Mr. Henley states that the women who work in the fields of Northumberland are "physically a splendid race." The same witness says: "There are many who consider field-work degrading; I should be glad if they would visit these women in their own homes, after they have become wives and mothers. They would be received with a natural courtesy and good manners that would astonish them. . . . The visitor will leave the cottage with the conviction that field-work has no degrading effect, but that he has been in the presence of a thoughtful, contented, unselfish woman. . . . The very appearance of the habitual workers is sufficient to prove the healthiness of their mode of life; and the medical testimony is overwhelming as to the absence of disease and the usual complaints attendant on debility."

Mr. John Grey testifies of the same women: "The healthful and cheerful appearance of the girls in the hay or turnip fields of the north, and their substantial dress, would compare favorably with those of any class of female operatives in the kingdom," etc. Here we have the same kind of work, destructive in one case, beneficial in the other. And this is due to the different conditions under which it is done. So in other work, it is not necessary that women should do every part of it precisely as men do it. The question is, Is there not in most kinds of work a place which women can fill to advantage under suitable conditions?

Women are much more fettered than men by conventional requirements and prohibitions. They come to any new occupation hampered by the restraints and burdens so imposed. Their dress is modeled upon fashions adopted by women in society, to whom dress is a profession, occupying a great part of their time, strength, and intelligence; yet custom forbids any material modification of it to suit the requirements of work. Equally liable to misrepresentation is any assumption of unconventional freedom in going about, ways of living, etc. Women are hindered at every turn by endless restraint in endless minor details of habit, custom, etc., which, often trivial in themselves, by their number and perpetual action often trammel them as effectually as the threads of his Lilliputian adversaries did Gulliver. In these respects we might apply to men and women the common French saying in respect to English and French law, viz., that "to one everything is permitted that is not expressly forbidden, to the other everything is forbidden which is not expressly allowed." Most women who have been engaged in any new departure would testify that the difficulties of the undertaking lay far more in these artificial hindrances and burdens than in their own health, or in the nature of the work itself.

Finally, is not much of the objection that work is destructive to the workers applicable to all work and all workers—to men as well as to women—to domestic as well as non-domestic work? Do we not hear on all sides the complaint that, from the highest forms of brain-work to the lowest forms of hand-work, the strain requisite for success breaks down prematurely those who follow them? Is not the choice, too often, virtually between immediate death from want, or a more gradual and protracted death from overwork, or the unhealthy conditions of work?

Our organization of labor is exceedingly one-sided and imperfect. It is directed almost exclusively to the advancement of the work, without any reference to the welfare of the worker. We have a long way to go before we can be rid of the most crying evils of our present state.

It is only too evident that we have not yet solved the most fundamental problems in regard to labor, when we see such glaring contradictions as produce spoiling in the fields because there is no market for it, and mills stopping work because the market is over-supplied, when at the same time thousands are suffering from want of food and clothes. So long as the relations between workers and work are so imperfect, the hardships thus entailed must fall upon women as well as upon men.

One of the first requisites for improvement is to know the direction in which effort should be made. We must learn to distinguish the movement of the tide from the eddy caused by resistance to its advance. One of the greatest difficulties in the way of freedom of work for women will be removed when once it is recognized that in this direction is the onward movement of the current, however turbid it may be from the obstacles that disturb its course.

AFRICAN PSYCHOLOGY.

By MAX BUCHNER.

ALL of those parts of South Africa which are under the dominion of the Bantu race are ethnographically so homogeneous that the essential facts that may be stated of one tribe apply almost exactly to all, and the differences in dress, stature, color of the skin, utensils and weapons, ornaments, customs, and ideas, which are produced by external and different temporary, not local, changes only, are limited in every case by the same lines. Many of the photographs brought by my friend and colleague Buchta from the Egyptian Soodan might as well have come from the territory I explored, diagonally opposite to it. The language of King Mtesa's Waganda has the same grammatical structure as that of the Angolese, and the vocabularies of both people have numerous similar words.

The negro in his native condition is not apparently of a lower grade of natural intelligence than the European of the common class. He probably excels the European in a kind of selfish cunning, while the restraint of moral scruples and of the finer feelings operates less strongly upon him. Yet he is not destitute of a sort of moral instinct, of a kind of taboo-conscience, that causes him to hesitate to do wrong. If he can not resist the temptation, he resorts to sophistics to give himself an apparent justification. This is a remarkably well-developed trait in his character. For this reason the negro is never an open thief, but will always seek or make an excuse, under the operation of which his robbery may be caused to appear in the light of a reparation made to him. Of such character are the numerous *milongas* which play so great a part in the life of the traveling trader, the name of which, a much-used word of unpleasant sound, combines in itself various equivocal ideas of criminal process, liability to penalties, oppression, and a great clamor. As an example of the *milonga*, we may notice a favorite trick among several of the tribes of sending their women into the camps of passing traders to tempt their members by coquettish behavior. On the slightest occasion, the men, who have been watching, rush in in a threatening way, and demand a quantity of goods as a recompense for the affront that has been offered them. The trader has to satisfy them, for he has not force enough to resist them. Another trick is to leave manioc-roots or baskets of grain in the road, where the hungry travelers may be prompted to take them up, when a similar scene of surprise and extortion will be enacted.

The negro is above everything positivist, practical, and materialist, and is inaccessible to intangible considerations. He is not, it is true, destitute of a sense of beauty, and has a word for the idea. But although, other conditions being the same, he will prefer a handsome woman to an ugly one, he is always moved by practical views in his choice. With this practicality is associated the persistent propensity toward falsehood that makes the traveler's way so hard. Hunger and thirst, heat and cold, fever and privation have, I confess, often proved less wearing upon me than the impossibility of ascertaining a fact by means of direct questioning; and I have frequently, in my vain struggles after clear information, been tempted to anathematize language as a tool of error. In indifferent matters the negro will say the first thing that occurs to him, because that is the easiest; in matters that touch his interest, such as the value of anything he may have for sale, no reply will suit him better than a false one. To these two incentives to lying—indifference and cunning—is added a third, the sense of the comic which much questioning arouses within him. Some traders are able to enjoy the stories the blacks tell under such circumstances; and they are perhaps harmless, unless the traveler puts them into his note-book and prints them for truth. The negro's moods are cheerful and wanton, superficial and changeable. Passion and hysterical anger are not uncommon, but they pass away as suddenly as they come on. Lasting friendships are not known. Relations apparently the closest are suddenly broken up or changed into enmity by the most insignificant causes.

Melancholy tones can hardly be attributed to the negro spirit, and I would have averred that suicide was inconceivable among them, had I not learned from trustworthy sources that instances of it had occurred. These were, however, only among more nearly civilized individuals. The ruling passions of the race concern the gratification of pleasure and greed for property. The most serious troubles originate in these spheres. The theft of a goat will afford a chief a more ready provocation for war than a box on the ear. The ideas of honor and manliness are almost wholly wanting, at least among the common men. Blows are unpleasant to them only in so far as they cause pain. They will bear the cuffs of their lord with resignation and as matters of course, as a part of the contract, while they will most likely toward strangers put themselves timidly and passively in an attitude of defense.

The question, "Has the negro a religion?" can not be answered at once either affirmatively or negatively. It must first be made clear what is to be understood by religion. If it be defined as a system of conceptions, aspirations, hopes, and apprehensions, and the moral precepts suggested by their operation, then the negro has no religion. If we call a confused mixture of vague wants and superstitious impulses a religion, then he has one. We might, perhaps, say more correctly that the common human weaknesses which are among ordinary motives of religion—feelings of anxiety, longings, illusions, fancies, and the corresponding efforts to get light—are not wanting in the negro, but he lacks the deep reflective power to build up a symmetrical structure out of his theological raw material. As the negro is in the habit of dreaming of his dead relatives, and is very apt to imagine that this or that dead person allows him no rest in the night, and must be silenced by propitiatory offerings, he is not very far from believing in the immortality of the soul. I have frequently inquired of the most intelligent blacks under my command, of those who had been baptized and considered themselves Christians, what they thought of their future after death, and have never received any other answer than that "then life will be at an end, and we shall be buried in the ground and eaten by worms."

They have a word, *nsambi*, which might be translated by "God." The following are examples of the way it is used: *Diulec dia nsambi*, God's sky; *Kalunga ka nsambi*, God's sea; *dikembi dia nsambi*, God's sun; *dikua dia nsambi*, God's axe—the name of a grass that cuts very badly; the name *nsambi* is also applied to the *mantis*, or praying insect. Personally and practically however, this *nsambi*, as my Augustus once told me, is of no interest to the negroes. He does them neither good nor harm, and troubles himself only about the whites, who owe their skill and wealth to him.

The woods and fields, however, are supposed to be inhabited by numerous sprites which go out to trouble and vex the blacks, never doing them any good, but are at their best when they are satisfied to be harmless. The dead are regarded as in the same position as toward the living. A third, still more dangerous class of hostile powers, consists of the wicked enchanters among the black's own neighbors, with whom he is in daily intercourse. The magicians are also capable of doing harm to the whites, while the genii and spirits of the dead are not. All sickness, all loss in business, every misfortune, even strokes of lightning, are referred to one or another of these evil influences. The religious aspirations and ritual of the Bantu relate chiefly to provisions against these three negative principles. Among the defenses against evil are oracles, medicine-men, and prayer. The technic of the oracle, the duties relating to which are generally performed by some person who has gained a repute for skill in the art, is extremely childish and ridiculous, and depends upon the crudest and most palpable deception. A favorite method of managing it is to take a piece of board with a smooth groove cut upon it. The oracle-priest rubs a stick back and forth in the groove, all the time asking, if, for instance, the object is to discover who has been guilty of some trespass or witchery: "Was it the Shamuhongo?" "Was it Joao?" and so on. All at once the stick will stop and refuse to slide any more in the groove. The person whose name has just been pronounced when this happens is the guilty individual. None of the by-standers will have any doubt on the subject; for, it is fair to remark, the priest has generally previously taken care to inform himself of the state of public opinion in the matter. Men's lives are frequently risked by these experiments; for the person who is accused in them has afterward to undergo the ordeal of poison. Another method is for the oracle-priest and the person consulting the oracle to take a position in the open air and both grasp with their right hands the handle of an axe which has been placed upright on the ground, the questioner's hand uppermost. The questioner tries with all his might to hold the axe fast to the ground, the oracle-man exerts his strength to lift it up. The answer is given when the axe sticks so fast to the ground that it can not be moved at all. The fear which prevails and is generally quite strong, of being accused by some of the oracles, has a beneficial effect in restraining malicious mischief and promoting peaceableness.

Of the two chief motives of European prayer—the fervor of devotion and the strength of desire—the negro is acquainted only with the latter, or selfish one. He has a kind of instinctive, unconscious idea that he may attain his wish by giving it constant utterance, and every other higher blossoming of religious wants is strange to him. Prayer is made with a sort of litany, in which the praying-master, swinging a kind of a rattle, utters some appropriate sentence, while the petitioner repeats it in unison with him. Particularly well-trained praying-masters deliver themselves of the prayer in a high falsetto, which appears to them to have a more insinuating, and therefore more effective, sound. There is no real priest class. There are negroes accustomed to daily religious exercises, like devotees among us ; but of earnestness and devotion, in the sense in which we understand those terms, not a trace can be observed. The cheerfulness of the negro temperament is never suppressed. If a person happens to come upon any of their religious exercises, and betrays an expression of amusement, the whole company of worshipers will break out into laughter, and be glad that their demeanor has been found so pleasing. Aside from the fear of wicked fetiches, which is a great source of trouble, and from the pleasure of trading, which occasionally carries him hither and thither, the life of the negro passes with a uniform freedom from care. He is born, brought up, takes a wife, begets offspring, grows old, and dies, without having undergone any training, gone to school, had to choose a calling, or been subject to any other kind of anxiety. He has no regularly recurring festivals ; but the revelries on the occasion of a death in the connection or in the circle of neighbors and friends are often protracted through many days or even weeks. How many years old he is he neither knows nor cares.

A system for computing time can hardly be predicated of such a people ; but they have a kind of superficial calendar of the months, which they make to help regulate their agricultural operations. The Angola negroes count the moons during the period of cultivation, and indicate them by numbers from one to ten. During the dry season, when agriculture is dormant, the calendar also is asleep. In August, when the distant lightning announces the approach of the rainy season, the women start out to clear the fields for the crops ; and, as soon as the ground has been wet by the first rains, they plant their ground-nuts. The moon in which this is done is the first. The divisions of the day are measured off according to the place of the sun in the sky.

The often asked and variously answered question of the capacity of the negro for civilization applies in an equal degree to him and to all other savage people. It arises more frequently with respect to the negro, only because the attention of philanthropic men has been more prominently directed to him. It must be answered in his favor. The negro undoubtedly possesses all the capacity for education and civilization to at least as great an extent as our primitive ancestors had it. But, just as our ancestors could not at once and immediately emerge from barbarism into our present conditions of many-sided development and refinement, so we have no reason to expect that the African savages can, in one or two generations, reach the standard of modern

Europeans. The fact that the psychical and intellectual, as well as the physical, differences between particular races of men are really insignificant, is destined to be made more plain the more the subject is impartially studied, and the efforts of certain men, learned in distinctions of types, to set up fixed marks of separation between them, will not succeed.—*Translated for the Popular Science Monthly from "Das Ausland."*

SKETCH OF DR. WILLIAM FARR.

DR. WILLIAM FARR, who died on the 14th of April last, aged seventy-six, was the founder of the English system of vital statistics, and was chiefly instrumental in bringing it to its present state of perfection; and, in the measure that the study of the statistical tables has furnished facts for the guidance of sanitary officers, he may be said to have contributed directly and very greatly to the improvement that took place in the public health conditions of Great Britain during his career.

Dr. Farr was born at Kenley, Shropshire, England, in 1807. He went to school at Dorrington and Shrewsbury, then entered upon a university course in Paris, and concluded his studies in the University of London, in 1831. He served for six months as house-surgeon of Shrewsbury Infirmary, subsequently began the practice and teaching of medicine in London, and afterward edited for some time the "Medical Annual" and the "British Annals of Medicine." In this work he exhibited a power of statistical analysis that attracted the attention of the proprietor of the "Lancet," and he became a constant and valued contributor to that journal, of articles dealing chiefly with vital and medical statistics. He thus acquired a reputation in this line of work, which induced his selection by the Government, in 1838, as compiler of abstracts in the newly-created office of the Registrar-General of Births, Deaths, and Marriages. An act of Parliament was passed directing that a statement of the cause of death should be inserted in connection with the registry of the fact, and Dr. Farr was assigned this work specifically on account of his known capacity for statistically analyzing the materials that would come under his eye; the registrar-general stating in his first report that the assignment had been made to him as "a gentleman of the medical profession, whose scientific knowledge and intimate acquaintance with statistical inquiries were ample pledges of his peculiar fitness." For forty years in succession Dr. Farr's reports of his analyses were presented to the registrar-general to form one of the most important parts of his reports, and were the medium for contributing facts, the practical applicability and permanent value of which became every year more evident. Of these reports, as a whole, the registrar-general says in his report for 1879: "To his scientific researches and reports I attribute any reputation that may have accrued to the General Register Office of England and Wales from the time he accepted office in this department." Besides these letters, many special and supplementary reports were contributed by Dr. Farr to the publications issued by the registrar-general. Among them were the "English Life Tables," the first, for 1841, based upon the deaths in all of England and Wales for that year; and the second, for 1844, on the mortality of the seven preceding years; while the third, for 1854, on the seventeen preceding years, was published as a distinct work, prepared by direction of the Government for use as the basis of the post-office insurance system. In 1852 he published a report on the cholera epidemic of 1848–'49; and, in connection with the twenty-ninth annual report of his chief, a report on the cholera epidemic of 1866. Of special value also were his decennial reports on the English mortality statistics of the three decades, 1841–'50, 1851–'60, and 1861–'70, the last of which, says the "Lancet," "especially is a mine of statistical wealth, not only as a treasury of well-arranged and analyzed facts, but as suggestive of fruitful fields for future investigation."

Dr. Farr was appointed an assistant commissioner under the direction of the registrar-general for taking the censuses of 1851, 1861, and 1871; did valuable service in statistically organizing and superintending each of the enumerations, and wrote the greater part of each of the three reports. He was one of the earliest members of the Statistical Society, and was for forty-two years a member of its council, its treasurer for twelve years, and its president in 1871 and 1872. His papers to this society have been pronounced by Mr. Leoni Levi, also an eminent statistician, "replete with facts, rich with mathematical lore, and remarkable for close reasoning," but never dry; and his work was invariably marked by a distinct and due regard to practical results. He was an early and valued supporter of the British Association, the British Medical Association, and the Social Science Association, in the proceedings of all of which bodies papers by him may be found, and was largely instrumental in the formation of the Section of Statistics and Economical Science in the British Association.

Dr. Farr served the state on a large number of royal commissions and parliamentary committees on sanitary and other subjects, in the work of which his special attainments, his familiarity with statistics relating to them, and his mathematical skill, made his assistance desirable, and sometimes indispensable. Among the special subjects with which he was thus at one time or another engaged, were army medical statistics, the health of the army in India, the condition of mines in Great Britain, water-supply, public health, and police superannuation. On all these matters, when called upon, he gave his services cheerfully, and did thorough work. He was present as a representative of Great Britain at the several statistical congresses which have been held at intervals in the various capitals of Europe since the custom was begun, in 1851. At the Statistical Congress held at the Hague in 1869, he made a report upon coinage and metric weights and measures, in which was embodied a recommendation for an international system of metric coinage, with a strong argument in its favor.

"The forty years of Dr. Farr's life preceding his retirement from the public service in 1879," says the "Lancet," "were spent in unremitting statistical labor. It is impossible to doubt either the value of his work, or of its influence upon public opinion in health matters, preparing the way for and making possible the sanitary legislation of 1872 and 1875, which is already so favorably influencing the health and longevity of the English people. We know, however, of no complete list of his contributions to statistical literature." Besides the papers already mentioned in this sketch, we find, referred to in articles of which he is the subject, a paper in the "Lancet" "On Benevolent Funds and Life Assurance in Health and Sickness"; a pamphlet describing a system of Government life assurance; a paper in the "Transactions of the Royal Society" on the "Construction of Life Tables"; the article on "Vital Statistics" in McCulloch's "Statistics of the British Empire"; and papers on the "Finance of Life Insurance," the "Income Tax," the "Valuation of Railways," and the "Valuation of Railways, Telegraphs, Water Companies, Canals, and other Commercial Concerns, with Prospective, Deferred, Increasing, Decreasing, or Terminary Profits." The language of his papers was always characterized by lucidity, simplicity, and common sense, and, notwithstanding the supposed aridity of the subjects, often rose into eloquence and impressive presentation; and his influence on public opinion in health matters is believed by the "Lancet" to have been "in great measure due to his picturesque style of writing, which invested dry facts with popular interest, although it laid him open at times to depreciatory criticism from those who believe that the style of statistical literature and reports should be characterized by the soberest dryness."

In 1879 Major Graham, the registrar-general, Dr. Farr's superior, resigned his office. Public opinion indicated Dr. Farr as his legitimate and only fitting successor; but the Government overlooked the principle of civil-service selection and appointed another person, who was not known to have any special qualifications for the trust. Dr. Farr therefore wrote to Major Graham a letter of resignation of his own position, saying: "Having learned from you that Sir Brydges Henniker is to be the new registrar-general, and thus having lost all chance of being your successor, I shall be glad if the Lords of her Majesty's Treasury will allow me to resign my appointment, and will grant me superannuation allowance to the extent of my full pay. I have served under you nearly forty years, I have taken with you three censuses and I feel confident that I can leave my case in your hands."

Dr. Farr's health failed so rapidly after his retirement that he was soon practically lost to the field of scientific labor in which he had been so long engaged, "and which he had graced," says an English journal, "not only with exceptional intellectual power, but with a genial modesty which charmed all with whom he was brought into contact." His scientific friends, who always regretted that the value of his services had not been recognized and better appreciated by the Government, took measures to raise a testimonial fund for him. Subscriptions were obtained to the amount of nearly a thousand pounds sterling, and this sum was invested at his request, and allowed to accumulate for the benefit of his daughters. An effort is now to be made to obtain a grant from the civil list to his daughters, in connection with which it has been remarked that the value of his work has been more unreservedly acknowledged on the Continent and in America than in his own country, where it has not yet received the recognition it is entitled to at the hands of the nation and its Government.

Dr. Farr's admirable personal and social qualities were well known and esteemed by all who had the privilege of meeting him and being associated with him at scientific assemblies. He was modest, kindly, genial, and bright in his manner, and had a generous appreciation of the services of others. "He was deservedly popular," writes one of his biographers, "in the best sense of that word, and, while the friends who mourn his loss on public and private grounds are innumerable, it seems impossible, to those who knew him, to believe in his having a single enemy."

"As a vital statistician," says an English professional writer, in noticing his death, "Dr. Farr's name and work are inseparably bound up with the rise and progress of a science which he had made peculiarly his own. . . . It was the national faith in Dr. Farr, personally, as a vital statistician that invested with so much confidence the registrar-general's statistics, which shed so clear a light upon the black figures of our urban mortality statistics, and thus strengthened the hands of other workers in the field of sanitary reform."

CORRESPONDENCE.

SEWAGE AT THE SEA-SIDE.

Messrs. Editors:

A LETTER in the "Christian Advocate" for March 22d denies the charges made in my article in the "Monthly" for March, as to the unhygienic condition of Ocean Grove during the crowded periods of past seasons. An editorial in the same number of the "Advocate" and another two weeks later call attention to this letter, and challenge "The Popular Science Monthly" "either to prove or retract" these charges. The editor, who says that he is "without personal knowledge" of the conditions of the place, assumes that Ocean Grove has been slandered from anti-religious motives, and avers "that the determining reason which animated the singling out of Ocean Grove for special mention as a sinner above all others in sanitary matters was, . . . because it was, as the writer phrases it, a religious resort."

Now, the writer indignantly disclaims the charge that the question of religion presented itself to her mind. It would, indeed, be a strange association of ideas that could make her attack on bad sewage an assault upon religion. Moreover, it is evident that this editor was not only "without personal knowledge" of the place he champions, but that he was also without personal knowledge of the article which he criticises. Otherwise he presumably would not apply the masculine gender to a writer giving a name purely feminine, nor complain of the "singling out of Ocean Grove," when it was one of six places mentioned, and only twelve lines were given to it. That I was not alone in my criticism is naïvely acknowledged by the editor in characterizing it as "one of various unwarranted attacks," and in his saying that "Ocean Grove has not been excepted from the unfavorable comments" that have been made on various sea-side resorts, and that "the intimations have continued and become rumors detrimental to the character of the place as a health resort."

The letter above referred to is from the Rev. E. H. Stokes, President of the Ocean Grove Camp-Meeting Association. Mr. Stokes says: "*All* our large hotels, and many of our larger cottages, eighty in number, have sewer connections . . . The sewer runs up into the camp-ground occupied by tents, and takes off all the deposits, both of privy and cesspool from there. The grounds on which the tents are located are thoroughly raked over every morning, and the air is pure." From the writer's personal observation extending over a period of three summers, she denies that the sanitation of Ocean Grove was then even tolerably good. Her account, written in August, 1882, on the spot, and sent to the "Monthly" in September, did not overestimate the crowding, nor the effects of the imperfect means which existed for removing fecal accumulations. This was matter of common repute; everybody could smell the vile odors, and many physicians denounced the unsanitary condition of the place. Both the State and the National Boards of Health took notice of these things in their reports for 1882. The former states that in Ocean Grove "the system of water-closet disposal is varied, and depends too much upon the will of each family. The town should ultimately adopt either a public system of weekly dry removal, or connect all closets, both in-doors and out, with a sewer system." It is further advised because Ocean Grove is "so much of a camping-place for the summer, that to the parts thus occupied the strict rules of military sanitary police should be applied and executed by an inspector constantly on duty." "The Sanitarian" for April 5, 1883, published an abstract of a "Report on the Atlantic Coast Resorts," made by E. W. Bowditch, C. E., to the National Board of Health, in which is this statement: "The watering-places on the Atlantic coast of New Jersey are all more or less in a transition state; few have adequate water-supplies, and none are supplied with sewers." Dr. Bowditch thus practically ignored the attempts at sewerage made by the authorities of Atlantic City and Asbury Park, as well as of Ocean Grove.

These authorities, and the statement of the writer's own experience, will perhaps refute the "Advocate" editor's assertion that, "without knowledge of any facts, the reckless charges were penned," and the still more vigorous language of the Rev. Mr. Stokes, who arrogates a thorough knowledge of the five other places criticised, when he writes, "I pronounce the whole article false"! A virtual confession of the truth of the charges is made by the activity displayed during the winter in remedying the causes of complaint. Faults in construction of the Asbury Park sewers have been remedied, and some eighteen thousand feet of sewer-pipe have been laid in Ocean Grove. Fletcher Lake, which last summer was filled with muck, has been cleaned out and transformed into a respectable body of water. These and other hygienic improvements which have followed in the wake of the fault-finder will doubtless render Ocean Grove and its close neighbor, Asbury Park, satisfactory places for visitors during the season of 1883. That the past winter's work is likely to prove efficient may be gathered from Mr. Stokes's letter, in which he says, "The State Board of Health reports that the sanitary matters of the Grove progress satisfactorily."

It is hoped that the pleasure with which this account is given of a better sanitary prospect for the present summer over that of former years will prove previous charges of improper drainage to have been made only in that spirit which sounds an alarm to prevent danger.

ALICE HYNEMAN RHINE.

COST OF LIFE.

Messrs. Editors:

IN an article in the June number of your magazine, entitled "Cost of Life," there are some mathematical calculations, or rather blunders, that make one wonder how they could have been put forth in any journal, though making less claims to science than your valuable magazine. It is gravely stated that a man weighing 150 pounds upon the earth would, upon the planet Jupiter (having 300 times the earth's mass), weigh 45,000 pounds = 22½ tons. The relative mass of Mars is said to be $\frac{1}{60}$ that of the earth, and, therefore, the man spoken of above would weigh only 2½ pounds upon Mars. Now, if the law of attraction as first announced by Newton, and now taught to every schoolboy, is correct, the weight of the above man upon Jupiter would be 2·55 (two and $\frac{55}{100}$) times his weight upon the earth = 382½ pounds—enough to make him decidedly uncomfortable, but still not quite 22½ tons. In regard to Mars there are two errors: first, his mass is $\frac{11}{100}$ that of the earth, not $\frac{1}{60}$ as stated; second, if it were $\frac{1}{60}$, it would not be right to divide 150 by 60, for that would disregard a very essential part of the great law or laws of gravitation. If the radius of Mars is ·52 that of the earth, would not the supposed man weigh, if placed upon his surface, 61 pounds?

There may be some errors in these corrections, but I think they are trifling compared with those in Mr. Pratt's article.

R. S. BOSWORTH.

WATERTOWN, NEW YORK, *May* 21, 1883.

Messrs. Editors:

ALLOW me to call attention to certain assertions in the article headed "Cost of Life" in the June number of your journal. The points I speak of relate to gravity on the planets, and the statements made in regard thereto. It is declared that a man of 150 pounds weight would on Jupiter weigh about 45,000 pounds. It is an elementary truth in physics that gravity decreases as the square of the distance increases; wherefore, although Jupiter is more than 300 times as heavy as the earth, its diameter is more than *eleven* times that of the earth, and the relative weight must be divided by the *square* of the ratio. In this case the divisor is more than 121. The best determinations of the force of gravity on Jupiter give it at a little less than *two and three fourths* that on the earth. So the man of 150 pounds would, on Jupiter, weigh about 400 pounds, not that enormous figure quoted above.

So, gravity on Mars is more than half that on the earth, and our man would weigh 80 pounds, not 2½, as given in the article. Every similar statement in the whole course of the discussion is as badly in error as these here noticed.

It is well known that the destructive effect of a bullet fired by an explosive depends not on the power of gravity, but on that of the powder; and the philosophers who, on Mars, should attempt to catch bullets in their hands, might rue their philosophy. As *science*, the article harmonizes well with the kind in which Jules Verne is accustomed to indulge.

R. W. MCFARLAND.

OHIO STATE UNIVERSITY,
COLUMBUS, *May* 23, 1883.

EDITOR'S TABLE.

THE BACK-DOWN OF DR. DIX.

OUR friend Dr. Dix has deserted us. We have received divers sarcastic congratulations upon our new ecclesiastical alliance, implying that we had made no great acquisition, but we could not anticipate that we should be left in the lurch so soon. We were taken with the impressive declamation about the supremacy of the home sphere in the life of woman, and when Dr. Dix said, "These considerations give the turn to every thought of ours about woman's work"—and of course the preparation for it, we supposed that this was a living and stable conviction to be consistently carried into practice whenever opportunity arose. But, if we rightly interpret subsequent developments, our confidence was sadly misplaced.

For no sooner had Dr. Dix made proclamation of his views on the woman question, than a rare opportunity was afforded him to reduce them to application in a large and influential way. The Association for the Promotion of the Higher Education of Woman, in New York, had petitioned the authorities of Columbia College to admit women to their institution that they might obtain this "higher education." The petition was referred to a committee, of which Dr. Dix was chairman, and he is declared to be the author of the report that was made upon the subject. It was decided not to admit women to co-education, and it was further declared that Columbia was not able to establish an adjunct institution for the use of female students; but it was offered that, if the women or their friends would provide their own separate accommodations, Columbia College would take charge of the teaching; and, in anticipation of this possible event, the committee prepared such a scheme of studies as it deemed suitable for the purpose in view, viz., to afford woman the facilities for a "higher education" than is now assumed to be available.

Dr. Dix, as we have intimated, drew up this report and framed the curriculum approved by the committee. The situation was thus in every respect most favorable for putting female education upon a higher and more rational basis, and conforming it to the requirements of the feminine character as a preparation for woman's practical life. There were no trammels, the institution was to be newly constituted, and there was no reason for not appealing to first principles in shaping the scheme of studies and embodying all that has been gained in the progress of education. Moreover, there were abundant precedents for shaping the course of studies to the highest ends of practical usefulness. Columbia College has already appended to it a group of colleges devoted to applied knowledge—a mining school, a medical school, a law school, a school of arts, and a school of political science. There was therefore full freedom to construct a new curriculum for female students designed to do whatever a "higher education" can accomplish for the improvement and elevation of woman.

It might have been thought most fortunate that the subject was mainly in the hands of a man who had given special and earnest attention to the question, and avowed fundamental convictions which had a potent and salutary bearing upon the result to be attained. Dr. Dix had said: "The place and work of woman in this world are a place and work in social life; and her place and work are not those of the man." He had said: "Whatever it be in thought, deed, or will that works among us now to break up the home, to make the home idea mean and contemptible in the eyes of woman, or to unfit her for domestic duties, and disgust her with her proper work, whatever now acts on her high-wrought nature, her ambition, her self-love, to turn her steps away from the home-life, and inflate her with visions of a career in the public places outside—this, whatever it be, is working against the best interests, the hope, the happiness of the human race." Could it be imagined that one who had so vivid a conception of womanly nature and destiny, such an appreciation of the higher sphere of her legitimate activities, and so earnest a conviction of the perverting influences to which she is exposed, would frame a working scheme explicitly designed to mold the feminine character in which these guiding ideas are wholly ignored? Yet this is the anomalous fact. Drawing up a plan of culture specifically for a sex, nay, for "the sex," the all-controlling element of sex and its vital implications are passed by as if they had no existence. Dr. Dix has prepared a programme of feminine collegiate study in which there is no more recognition of the claims of the home as an object of cultivated thought than there is in the curriculums of colleges exclusively for men. He proposes a course of training which will preoccupy woman for at least a dozen of her most impressible years with a range of acquisitions that have no definite or distinct relation to home interests, and in which the "certificated" young lady can come out as proficiently ignorant of all these matters as the "graduated" young gentleman. His programme, which embraces nine groups of subjects* to occupy four college years, and involves an elaborate preparation for entrance, has not even a corner for physiology, not to speak of other subjects which should be fundamental in any rational system of higher female education.

The satirical writer on education must have had Dr. Dix's plan in view in penning the following well-known passage: "If by some strange chance not a vestige of us descended to the remote future save a pile of our school-books or some college examination-papers, we may imagine how puzzled an antiquary of the period would be in finding in them no indication that the learners were ever likely to be parents. 'This must have been the curriculum for their celibates,' we may fancy him concluding. 'I perceive here an elaborate preparation for many things, especially for reading the books of extinct nations and of co-existing nations (from which, indeed, it seems clear that these people had very little worth reading in their own tongue); but I find no reference whatever to the bringing up of children. They could not have been so absurd as to omit all training for this gravest of responsibilities. Evidently, then, this was the school course of one of their monastic orders.'"

* Dr. Dix's college course for women: 1. The English language and literature. 2. Modern languages and foreign literature. 3. The Latin language and literature. 4. Greek language and literature. 5. History and political science. 6. Moral and intellectual philosophy. 7. Mathematics. 8. Physics, chemistry, and hygiene. 9. Natural history, geology, paleontology, botany' and zoölogy.

OPENING DAY OF THE SUSPENDED HIGHWAY.

Although all the world has been abundantly apprised of the fact, yet there is pleasure in still repeating that the opening of the new and splendid bridge over the East River, connecting the cities of Brooklyn and New York, on the 24th of May, was a most successful affair. The grand structure, a monument alike of the marvelous progress of science and art, of constructive genius, and of business enterprise, was recognized by all as a credit to the generation, and the impulse was spontaneous and universal to join in the tributes of honor to the founders and promoters of the enterprise, living and dead, on the occasion of the completion of the work. Business was therefore widely suspended in the two cities; the day of opening became a holiday, and countless thousands of the people gathered to witness the impressive ceremonies, and to express the enthusiastic gratification that filled all minds at the triumphant event. The ceremonies were appropriate and imposing. Parades and salutes, festivities and fire-works, and all the demonstrative accompaniments of high satisfaction, made the day and night memorable among popular celebrations. The oratorical garnishing was, of course, profuse, varied, and excellent, for the theme was well calculated to bring out eloquence of utterance. But the address of Hon. A. S. Hewitt was perhaps the most felicitous feature of the day. It was simple, pertinent, instructive, and timely, in the considerations suggested by the completed undertaking. It is not often the happy fortune of a man to put the trimmings on a great occasion with such fine propriety as did the oratorical representative of New York in consummating its closer alliance with Brooklyn. We print this speech, and also a brief article on the statistics of the bridge, which, however, can not be authoritative and complete till the issue of the final official report.

THE TYNDALL SCHOLARSHIPS.

Dr. Lucien J. Blake returns to this country at the present vacation from Berlin, where he has been studying physics in the university laboratory of Professor Helmholtz, as a Tyndall Scholar, for the past two years. He has distinguished himself in original work, and will be prepared to take an honorable position as professor in an American college. With the resignation of Dr. Blake there will be two vacant scholarships of the Tyndall Trust Fund, the revenue of which is devoted to the aid of American students of promise who desire to obtain Continental facilities for training in physical investigation. It will be remembered that Professor Tyndall consecrated the total profits of his American lectures ten years ago to this noble object. The proceeds of those lectures, beyond the payment of necessary expenses, he refused to regard as belonging to himself, but left them as a fund in the hands of trustees to be used for the benefit of American young men of capacity and ambition, to prepare themselves for a life of original experimental work in physical science. The provision was wise as it was generous, for while, on one hand, the students of pure science are without the strong incitements of pecuniary reward for their labors, on the other hand, the encouragements to scientific study are too often in the direction of its immediate utilities. Aware of the strong temptation in these times to cultivate science from the lower motives, Professor Tyndall has lent the influence of his example, his teachings, and his substantial earnings to stimulate and sustain those youthful devotees of scientific truth who would pursue the work of research from the simple and elevated motive of a desire for the extension of valuable knowledge. Those wishing to obtain the benefits of the Tyndall Fund should apply to its trustees, Professor Joseph Lovering, of Harvard College, Cambridge, Massachusetts; President F. A. P. Barnard, of Columbia College, New York; and the senior editor of this periodical.

PROGRESS AND THE HOME.

Dr. Emily Blackwell discusses the industrial position of woman in a way that appears to us especially significant at the present time. We said not long ago, "If there is one thing that pervades and characterizes what is called the 'woman's movement' it is the spirit of revolt against the home, and the determination to escape from it into the outer spheres of activity that will bring her into direct and open competition with men." This statement has been criticised as unjust; but we certainly did not mean to intimate that there may not be many women thoroughly enlisted in the "woman's movement," and who, nevertheless, retain a strong home interest. Our statement was general, and simply affirmed a widespread tendency, the unmistakable drift of which, we think, the article on "The Industrial Position of Woman" decisively illustrates.

It will be seen that Dr. Blackwell writes as a student of social tendencies. She appeals to the primitive condition of society, falls back upon the law of progress, and forecasts the results of its future working upon domestic life. The industrial progress of mankind, as is well known, has been carried forward by the division of labor, in which, through greater proficiency of specialized work, improved machinery, and efficient organization, the productive capacities of society have been much diversified and augmented. Dr. Blackwell's argument is that this great social tendency has taken effect upon the domestic sphere, and must take much further effect by removing those forms of domestic labor with which women have been so long burdened, to the outside sphere of business organization. She maintains that woman must follow out these industries into the outer field of competition, or be left without the means of subsistence; while, by thus getting rid of all work hitherto called domestic, she will achieve her liberation from that home bondage of which she has so long been the victim. The social movement here referred to has two effects—the enlargement of external competition for woman, and a corresponding diminution of the internal sphere of home occupation. We must very briefly object to Dr. Blackwell's views upon both points.

As to the industrial tendencies of social evolution invoked by Dr. Blackwell, she seems to have left out the most important, and, indeed, in this case, an all-determining consideration. While the common differentiations of industry are a result of progress, that between the sexes is not a result of progress. The division of labor between the sexes is primordial—older and deeper than all social development, and a fundamental condition to it. Any one who will consult the comprehensive "Cyclopædia of Descriptive Sociology," by Herbert Spencer, and refer to the operative division of his tabular summaries, will find superabundant proofs that in the very lowest stages of all savage societies there was a fundamental and universal separation in the active spheres of the sexes, so that "no division of labor except that between the sexes" becomes almost a stereotyped formula. Men devoted themselves to hunting, fishing, and war, for the maintenance of the life of the tribe, while women cooked the food, made the clothes, took care of the children, and occupied themselves chiefly with the drudgeries of the rude home. Thus, before industries began to take any separate shape, there was already a division of occupations so broad and clear as to be evidently grounded in the nature of things, and all the subsequent progress of mankind has been achieved in subordination to it. The first great specialization of human activities is, therefore, not a product of social evolution. We have here to do with a fact of exceptional import, deeply grounded in the constitution of things, and not to be studied as an effect of social progress. And in its essential quality, moreover, this separation of the spheres of action of men and women is totally different from the ordinary differentiations of industry. The historic relation of the sexes, in regard to their distinctive spheres of action, is a non-competitive relation. The family arose not merely by a union of the sexes in marriage, but by a union of interests which made their respective spheres of occupation supplementary to each other. There is here no industrial rivalry, but the common ambition centers in the prosperity of the home. This is the fixed order observed equally in all stages of progress. As men fished, hunted, and fought in the pre-industrial stages of society, while women were occupied with the domestic cares, so the men still labor without, struggling with their fellows in the arena of business, and earning wealth which it is their pleasure and pride to expend upon the home and for the advantage of the family, while wives and mothers co-operate in the household sphere, contributing their indispensable and co-equal share to the common domestic welfare. But the relation of woman throughout has not only been non-competitive, but the fundamental fact in the case is that it has been a relation of protection. Not more in the predatory life of the savage than in the highest civilized life, woman has been the protected sex. Her security, and through it the maintenance of the social order, and the progress that has resulted, have not arisen from the independent competitive struggles of woman, but from the identification of her interests with those of man, through the division of their spheres of action. We await the reasons which are to convince us that these deeply-grounded relations must not continue throughout the future of humanity. The precipitation of woman into the outer world of conflicts, where the strongest have their way, would involve a dissolution of human society, and is not even possible as an experiment. Granting that the protection of woman has always been, and is still, very imperfect, progress must consist in making it more perfect, and not in subverting the order of which it is a natural and necessary part.

And now let us note the correlative effect upon the home of Dr. Blackwell's thorough-going social reform, and point out its radical error. She says: "There is no reason why what is now done by domestic service should always continue to be so done. As weaving and tailoring have gone, so the making of women's and children's clothing is now going. There is no reason inherent in the nature of things why washing, cooking, mending, etc., should not go also, and be done by business organizations from outside, instead of by domestic service. Thus domestic work will be reduced to the minimum, to that part most intimately connected with the personal life of the family. The need of domestic service will diminish in the same proportion, and the problem it presents will be solved by its diminution or gradual disappearance." But this process of the "gradual disappearance" of domestic activities and their relegation to outside organization is to be carried still further, so as to remove from the home the nurture of even "very young children." "There is nothing which would seem more absolutely dependent upon the mother than the care and training of very young children. Yet the careful study of the best modes of training these early years, which has come in with the Kindergarten, shows how far the nursery alone is from meeting their needs; how early and how much skilled teachers, other children, a variety of apparatus—that is, outside help—are desirable for the best interests of the child, as well as for the assistance of the mother."

It is not surprising that Dr. Blackwell should anticipate the very natural objection "that so radical a change in the conditions of household work must imply the destruction of the home as we at present understand it." She intimates that the dread is illusive, but she by no means replies to the objection. And that the logic of her position leads inevitably to this result is undeniable. For, when the process of removing all that can be removed from the domestic sphere, and handing it over to outside organization, is completed, not a remnant of family life "as we at present understand it" can remain. As spinning and weaving, brewing and drying fruits, tailoring and knitting, butter and cheese making, have gone, so washing, mending, sewing, and cooking can go also in the same way, and the sick can be sent out to the hospitals. And when the Kindergarten becomes a state institution, and "compulsory education" takes away the "very young children" to be cared for by outside arrangements, and all kinds of domestic occupation are thus eliminated, it might appear that the home has been reduced to its minimum as a place for the bare organic processes of gestation and lactation. But will progress, under such heroic interpretation, leave even this shred of a domestic sphere? Is not the stirpiculturist abroad with his lamentations over the evils of the unregulated multiplication of human beings, and is he not predicting the time when human perfection shall be attained through the total disappearance of present domestic relations, and their better discharge under the control of outside organization? Dr. Blackwell declares that the personal relations in the family are "a fixed and constant element"; what is her warrant for the declaration in the light of the slow-working progress she invokes.

Dr. Blackwell's argument rigidly carried out would sweep the family and the home out of existence, and merge it in the outside life of society, where all regulation falls within the province of the state. Her reasoning goes to the most chimerical lengths through a failure to recognize that there is a permanent sphere of legitimate distinctive womanly work. Her affirmations that "there is no one kind of work which absolutely belongs to domestic life," and that "there is no necessary connection between domestic life and domestic work" can not for a moment be accepted as true. They are no more true than would be the proposition that there is no necessary connection between life and work at all. There are plenty of people who live and never work, but it remains true that human life is inexorably conditioned upon work. There are women who never do domestic work, who abandon the home, and live in hotels; but it is still true that domestic work is a condition and necessity of home-life—so true that, if domestic work disappears, the home is impossible. If there is a house, there must be housekeeping; if there are children, they must be cared for; if there are invalids, they must be nursed; if there is food, it must be prepared, and all these things involve work as a simple practical necessity. Because there has been a great deal of foreign and unfeminine work carried on in the household is no reason for asserting that there is no such thing as proper feminine domestic work. The home has, of course, been burdened by these industries, and women made drudges to them, and we all bid Godspeed to their exodus. But for what reason? That woman may be released from exhausting, unfeminine occupations, to give more strength to the proper performance of her legitimate duties as wife, mother, and household administrator. Weaving, cheese-making, and domestic manufactures stand in no relation to the essential nature and characteristic duties of woman. Such occupations have robbed her of leisure for self-improvement, and want of suitable culture has hitherto prevented the mass of women from properly performing the duties which lie in the very heart of home. Every step of progress from the primitive state to the present has been in the direction of woman's emancipation from the hardships of physical labor, and coincident with this relief there has been an improvement in her nature, the gentler virtues appear and the finer qualities of the feminine mind are developed. But the ideal of womanhood toward which such considerable progress has been made is not the fine lady, idle of hand and brain, the gadding and gossiping woman of leisure and society, who evades or discharges with wretched incompetence the cares and responsibilities of domestic life. Womanly talent and cultivation are demanded in the line of strictly feminine occupations, that the home shall become more and more instead of less and less in the social life of the future.

We have no space here even to enumerate the varied forms of womanly activity involved in the home, when all its extrinsic burdens are removed. That which progress must bring us is not exemption from them, but their more intelligent and congenial performance. The adequate education of woman for the home sphere we have never had, and it is now resisted with all the power of traditional habit and all the influence of the old educational ideals and the organized systems of study. Men are educated by the newer colleges for their special work in life; women never! The prejudice against studying things domestic, although the problems opened are many and of the deepest intellectual interest, abides with a strange inveteracy. Dr. Blackwell recognizes no amelioration of the home through intelligent preparation for it. Though education is now the standard solvent of all the difficulties in our civilization, she concedes to it no potency in renovating and developing home-life. She asserts, indeed, that women must have technical training for the sphere of outside competition, but nothing is said of its need as a preparation for domestic activities. As long as the home endures, it is to continue the stronghold of servility and degradation. Progress is to do wonders, but the home must remain the asphyxiating Black-Hole of menial ignorance and stupidity as lasting as may be the vestige of the institution. There are perhaps not many who will go to this visionary extreme, but in so far as the "woman's movement" exemplifies the feeling it merits unsparing condemnation.

LITERARY NOTICES.

Conflict in Nature and Life: A Study of Antagonism in the Constitution of Things. For the Elucidation of the Problem of Good and Evil, and the Reconciliation of Optimism and Pessimism. New York: D. Appleton & Co. Pp. 488. Price, $2.

This anonymous work is in the most comprehensive sense an ethical essay upon human life in connection with the order of nature. It is a philosophical inquiry into the constitution of natural things, as it bears on the fundamental problems of good and evil, which, as the writer thinks, have been prematurely resolved in the theological stages of thought, before science had furnished the conditioning data for dealing with the morality of nature and the ethical possibilities of mankind. With legendary ideals of golden ages and paradisiacal states, at the opening of man's career, and the hopes and prophecies of millennial felicity to be finally attained, and with numerous intervening revelations, evolutions, and reforms, as means of regaining the lost paradise and reaching a condition of ultimate perfection and supreme happiness—as exemplified by all this, the author thinks that we have been dominated by a chaotic and groundless philosophy, only to be escaped through a better understanding of the existing order of things, and the way it must operate until replaced with quite another order. Is the optimist justified in blessing the world? is the pessimist justified in cursing it? or is it a mixed affair, that must be systematically comprehended before it can be morally estimated?

It appears that, long ago, while the author was hoping for harmony and happiness on the basis of an optimistic constitution of nature, he began to perceive that, at every point gained in the direction of freedom and intelligence to secure greater harmony and perfection in life, some new element of discord and danger would arise to vitiate the result—such element being not incidental but necessary, and bound up with the scheme of things. Thus, in order to avoid the evils of ignorance, we must promote education, which increases the sensibilities for keener enjoyment, but which at the same time whets them equally for intenser suffering. Civilized people enjoy more than savages, but they also suffer more; and, while the higher classes enjoy more exquisitely than the lower, they have their own characteristic troubles to deal with. Further, personal sovereignty has a good side, but also an evil side; and there is no such thing as absolute or perfect freedom. Freedom is self-limiting, and hedged about by barriers which are necessarily impassable, except at the expense of freedom itself. Again, political centralization has advantages which no great people can afford to dispense with, but it must be carefully guarded or it will result in despotism. So, also, local self-government has peculiar benefits which no free and intelligent people should ever forego; but local autonomy involves political weakness, which is not to be neglected. And so in attempting to get away from the evils of indissoluble marriage by opening a way of escape, we find ourselves at once in the presence of new evils, and the proper balance of stringency and liberality is by no means clearly seen and ready of attainment.

It was this conception of life, as involving in all its aspects a choice of evils, that led the author on to the study of the *necessary antagonisms* in the constitution of nature, and which he found to be equally displayed in the lower orders of life, and to be rooted in the actions and reactions of the physical forces themselves. His book is an attempt to trace out this principle of conflict in the order of natural things, from its simplest to its most complicated manifestations.

Part I is intended to show the past prevalence of optimism and the fragmentary and fruitless conceptions of antagonism exemplified in the views of eminent representative men by summaries and brief quotations from their writings. Part II deals with the fundamental conceptions of existence, and speculations concerning the primary forces into which the conception of conflict has entered as an undefined principle of the philosophy of science. Its illustrations are traced through a series of the principal branches of science, physics, chemistry, biology, mind, morals, etc. The last chapter deals with morality in accordance with the ethical systems that have grown out of utilitarian experience, on the hypothesis that the moral instincts become fixed by association and habit, and in which the higher faculties or the later organized or more complex feelings overrule the lower or earlier developed feelings in determining ethical action. This chapter insists on the struggle in life through which morality has taken form as conduct in the direction of least social conflict. The author maintains that the prevalence of moral order has been determined and is maintained through conflict as really and to quite as great a degree as the struggle for existence has produced the local forms among plants and animals. The writer observes that Mr. Spencer recognizes antagonism in the origin and development of moral systems, but also indulges in optimistic anticipations which are without warrant in "the constitution of things." He interprets Spencer as maintaining that industrialism is to supersede militancy in such a manner that antagonism will be done away with. But the author insists that any possible industrialism only complicates antagonism and changes its forms. Part III illustrates the subject from a survey of history, and Part IV deals with it in connection with the theory of evolution. The doctrine is, of course, accepted, and the exposition of it given in Spencer's "First Principles" is taken as authoritative; but the writer is of opinion that the principle of antagonism is not accorded its due weight, and various exceptions are taken to the Spencerian argument. Part V is chiefly devoted to the discussion from the point of view of geology and meteorology, showing that the necessary conditions of physical life and enjoyment necessarily involve discord and pain. Part VI illustrates the subject in relation to practical life, and aims to show that, whatever schemes of improvement may be adopted, there are always drawbacks, accompanying evils, which stand in the way of perfection in results. The chapter on "Relative Prolificacy" deals with this agency not only as a permanent and perpetual social element, but in its immediate bearing upon the various grades and classes of society, and it involves a criticism of the tendency to overrate the optimistic side of evolution.

It will appear, from what we have said, that this work on conflict is offered as a contribution to the philosophy of life, or as deepening the foundations for such a philosophy. The claims in this direction are brought out in a general way in the final chapter. Its conclusions are broadly practical. The philosophy of conflict inculcates moderate expectations. Avoiding the extremes of optimism and pessimism, of conservatism and radicalism, it aims to do work only where work will be effectual—work that will make things better, and work which prevents them from becoming worse.

We have here endeavored simply to state the general object of the book before us, and briefly to outline the course of its argument; but our sketch gives no adequate idea of the number and importance of the specific topics that are treated in the course of the exposition. Many of the larger and more urgent questions of the time are taken up, and, while considered in relation to the fundamental principle which it is the object of the work to develop, they are handled in a way that is full of suggestiveness and valuable instruction.

Our Home Physician: A Popular Guide to the Art of preserving Health and treating Disease. By George M. Beard, M. D., assisted by Eminent Medical Authorities. New York: E. B. Treat. Pp. 1,506, with Plates. Price, $6.

This work is designed to present, in a form intelligible to ordinary readers, a review of the whole field of medical science, so far as it is of practical application and popular acquaintance with it is desirable. It includes within its scope anatomy, physiology, hygiene, and the employment of simple treatment and remedies. It gives information concerning the structure of the human body and the functions of its organs; on diet, stimulants, narcotics, air, sunlight, exercise, and bathing; on the care of the sick-room, the management of infants and children; on the general laws and history of disease; and on the treatment of accidents and emergencies, with descriptions of familiar remedies, for all persons and every household; together with suggestions concerning the special care and treatment of obscure and grave diseases and the application of powerful remedies, for persons who, like planters, miners, sailors, travelers, and dwellers in remote districts, are beyond the reach of skillful medical aid, and must be either treated by themselves or by their friends, or left to suffer. The great advance that has been made in the science of medicine during the last quarter of a century is duly recognized; and prominence is given to the view that the types, phases, and names of diseases have wonderfully changed during that period, and that a greater revolution has been wrought in the method of treatment and the selection of remedies. Hence, physicians are more successful in the treatment of disease now than formerally; and the fact is enforced that a large number of maladies formerly regarded as incurable have been found susceptible of relief and cure, and that the accession of a considerable proportion of diseases may be prevented by timely and suitable precautions. On the subject of medical schools and systems, the broad principle is assumed that "the wise physician of our time uses for his patients all things that have been proved to be beneficial." The author has been aided by authorities and physicians of recognized standing in the preparation of the several departments of his work. His aim has been, in his own words, "to prepare a comprehensive, popular treatise, . . . that shall say just enough to instruct and not so much as to bewilder; that shall fairly represent the various departments in language both clear and attractive, as well as accurate and instructive; that shall make broad and plain the boundaries between those subjects which the people can and should know and those which they should not attempt to know; and that shall treat all this large variety of themes in such a manner as not to offend the taste of the best-ordered household." The work is illustrated by fifteen chromolithographic plates and numerous woodcuts.

The Correspondence of Thomas Carlyle and Ralph Waldo Emerson, 1834–'72. Boston: James R. Osgood & Co. Vol. I, pp. 368; Vol. II, pp. 383. Price, $4.

This work, edited by Charles Elliot Norton, is one of remarkable interest, and is unique in literature. It covers a period of thirty-eight years in the intellectual life of two gifted and remarkable men belonging to different nationalities, and who were early drawn together by a sympathy of ideas and a mutual appreciation of genius before either had conquered a position in the world of public letters. The work has all the interest of personality, and is a sort of compound autobiography or revelation of the inside life of the distinguished men whose intimate and prolonged correspondence makes up the volumes. The characters of Carlyle and Emerson were, of course, both formed before they came into this relation of close correspondence; but the epistolary record covers the period of their mental development, and brings it to the maturity of advanced age, when it ceased, through the decline of literary enthusiasm, and perhaps through a divergency of views which became settled in the later period of life. Both men went through important transitional stages in their mental experience, Emerson escaping from the transcendentalism of which he was the early apostle, and is said to have been the inventor, in New England; and Carlyle escaping from the intense radicalism of his opening career into the pessimistic conservatism of his maturer years. The work, therefore, has abundant interest as a study of character through the free disclosures of a copious and varied private correspondence. In the first place they were both men of unrivaled powers of expression, and the highest capacity of analyzing their own mental conditions, and presenting them with vividness and original force. It is, perhaps, not to be supposed that they were unconscious that what they said would ultimately be given to the world; but this consideration operated as but a partial restraint upon the freedom of their communications. They were both men of opinions—thinkers, *doctrinaires*, students of men and society—and therefore had much to say pertaining to contemporary events, especially in the field of current speculation, and in relation to the literary phenomena of their period. They spoke with a liberty about contemporary men in the world of authorship which gives a pungent interest to the letters, and which was sometimes carried so far that the editor is constrained to disguise the names of parties implicated. But the strictures made were generally within such proper limits that no such editorial intervention was necessary. The two men are here pictured by themselves in their full individualities. These, of course, are shown in their respective writings, and it can hardly be said that there are any new disclosures in the correspondence that can much revise or affect the judgment of those who are already familiar with their books; but the result of a perusal of their letters is like turning on the gas which brings everything out into greater distinctness. It is unnecessary, of course, to commend these volumes to the attention of readers. All those who are familiar with the thought and the history of these men as authors, displayed in their successive publications, are certain to procure and peruse this correspondence. But Carlyle and Emerson now belong to the past, and the new generation of readers can be but partially familiar with those stages of mental development through which they passed many years since, and which were eagerly observed by their contemporaries as they went forward with the issue of their books. For those younger readers, therefore, to whom these authors are historic, the volumes before us may be recommended as full of special instructiveness in interpreting the character and position of these men whose eminent position will be permanent in the literature of the future.

The Examination of Medicinal Chemicals: A Guide for the Determination of their Identity and Quality. Illustrated; third edition, revised and enlarged. By Frederick Hoffmann, A. M., Ph. D., Public Analyst to the State of New York, etc., and Frederick B. Power, Ph. D., Professor of Analytical Chemistry in the Philadelphia College of Pharmacy. Philadelphia: Henry C. Lea's Son & Co. Pp. 624. Price, $4.25.

The present edition of this valuable work contains a large amount of new matter, and has been adapted to the recent editions of the United States and German Pharmacopœias. Part I describes the operations and reagents necessary for analytical work, gives a system of qualitative analysis, directions for volumetric analysis, and for detecting the most important alkaloids. Part II describes the various substances that are used medicinally, giving their physical and chemical properties, the impurities that are to be looked for in each, and the way to detect them, and, whenever desirable, a method of assay. Under their appropriate heads are given directions for testing for the important poisons in forensic investigations, processes for the determination of glycerine in wine and beer, of the alkaloids in cinchona-barks, etc., and rules for the dilution of the important acids, etc., together with tables of the strength of solutions.

The authors have aimed to make each article complete in itself, preferring to repeat text and illustrations rather than send the reader to several cross-references. The volume is well supplied with illustrations of apparatus and forms of crystals, and contains unusually detailed tables of equivalent weights, measures, and temperature, in the decimal and the old system. It has been brought up to the latest established results in its department, and can not fail to be a valuable possession to every one whose business it is to prepare, prescribe, or dispense medicines.

The Possibility of not Dying: a Speculation. By Hyland C. Kirk. New York: G. P. Putnam's Sons. Pp. 112. Price, 75 cents.

The author of this speculation says: "The proposition 'all men are mortal' is an unsound assumption—unsound because not based on actual knowledge. Men subjected to certain conditions are mortal. This is a true proposition. That men subjected to certain other conditions may be immortal, we can not deny. As knowledge is, our subject involves merely a matter of uncertainty, unless data can be procured such as shall afford means of determining the truth."

The author then goes back, as usual, to Columbus and Galileo, to show that both in the realms of discovery and invention suppositions generally regarded as absurd have proved to be correct. And as the doctrine of the sphericity of the earth was once held to be absurd, but is now proved to be true, he maintains that the theory of physical immortality, though now regarded as absurd, may yet be found true.

Moreover, it is a great time now for progress of all sorts, and after the telegraph and phonograph and telephone, who shall assume to say what may come next? The secret of earthly immortality has been dreamed about a great deal, and patentable arts of prolonging life indefinitely are no novelty. Paracelsus announced that he had found the elixir of life by which men might be enabled to live forever, but, as he died himself in middle age, the announcement seems to have been premature, the invention, like that of perpetual motion, having been probably not quite perfected. Mr. Kirk offers no contrivance by which death may be escaped, but he is full of ingenious reasonings to show the theoretic possibility that, by a system of right living, earthly life could be made to last forever.

Mr. Kirk argues that the end he proposes is desirable, which is far from certain. The question is very seriously mooted nowadays whether, even in its brevity, "life is worth living" at all; but it is pretty clear, at any rate, that it is only tolerable through its brevity. The experiment of trying life for a time is certainly interesting; but the most beneficent part of the arrangement is, that its eternal continuance can be escaped, at least in this state of being. Mr. Kirk considers the matter from the point of view of evolution, which, as it raises humanity to a plane of higher possibilities, may find everlasting life among them. But evolution seems to be made possible only through death—by constantly getting rid of the less perfect to make room for the more perfect. Shortening life multiplies lives, so that while the vital stream is continuous, in an immortal progress, individuals are replaced in the succession by better ones, and, if there be the slightest advantage in living, it is increased by the indefinite multiplication of separate lives. If any one set could find a way of holding on, would there not be an end of evolution? We are much inclined to think that it would be hard to conceive anything more calamitous than to have Mr. Kirk's reform practically carried out. Even now the "Old Hunker" element in human affairs defies everything but death, but what kind of a world would this be if the Civil-Service Commission could confer upon office-holders an immortal tenure?

Bulletin of the United States Fish Commission. Vol. I, for 1881. Washington: Government Printing-Office. Pp. 466, with Twenty-one Plates.

To secure a more speedy dissemination of the information collected by the Fish Commission, it has been authorized to publish an annual "Bulletin," of the edition of which a part is to be distributed signature by signature (in the sheets as they are printed), and the rest in bound volumes. The present is the first of the series of volumes. It contains a large number of papers of varied importance on the different aspects of fish-culture and fishing, with a table of contents arranged alphabetically by authors, and an admirable index. Among the papers of more general interest are those on "Recent Contributions to Pond Cultivation," "Treatment of Fish-Eggs at Sea," "The Dry Transmission of Fish-Eggs," "The Destruction of

Young Fish by Unsuitable Fishing Implements," "The Winter Haddock-Fishery of New England," "The Influence on the Coast Fisheries of the Steamers used in the Menhaden Fishery," "Artificial Culture of Medicinal Leeches and of Species of Helix," and "Changes in the Fisheries of the Great Lakes during the Decade 1870–1880."

Electro-Magnets: The Determination of the Elements of their Construction. By Th. Du Moncel. New York: D. Van Nostrand. Pp. 122. Price, 50 cents.

The author's purpose is to give a plain, practical essay on the subject, adapted to the use of amateurs, experimenters, and working artisans, as well as of students. Though the laws on which the formulas are based have not been fully verified, yet results have been obtained so nearly approaching verification as to make it safe to admit them as guides in the construction of electro-magnets.

A Perpetual Calendar. By President F. A. P. Barnard. Price, 40 cents.

The calendar, though having a rather complicated appearance at first sight, becomes simple and easy of operation when its theory is once explained. It consists of a sheet of stiff pasteboard, to the top of which is attached a revolving disk bearing the names of the months and the numbers from 1 to 99, while the main sheet contains seven parallel columns of the days of the month. The disk should be properly set to the columns at the beginning of each year; then the day of the month can be found on looking for it.

Pocket Logarithms, to Four Places of Decimals. New York: D. Van Nostrand. Pp. 139. Price, 50 cents.

Surveyors and other persons engaged in field-work often find themselves in need of tables of logarithms in a form which they can conveniently carry with them. The present volume is for the use of such persons. Its four-place tables give as close an accuracy as is likely to be required in field-work. They include the logarithms of numbers, and logarithmic sines and tangents to single minutes, with a table of natural sines, tangents, and co-tangents.

First Annual Report of the Bureau of Ethnology to the Secretary of the Smithsonian Institution, 1879–'80. By J. W. Powell, Director. Illustrated. Washington: Government Printing-Office. Pp. 603.

The act of Congress of March 3, 1879, which established the United States Geological Survey, made provision for continuing, under the direction of the Smithsonian Institution, the anthropologic work that had been carried on by the earlier surveys. The methods of the new bureau have been, "first, the prosecution of research by the direct employment of scholars and specialists; and, second, by inciting and guiding research immediately conducted by collaborators at work throughout the country." The latter division of the work has been furthered by distributing manuals upon various branches of the study, designed to make the investigations of independent workers systematic and thorough. Being convinced that the social institutions of the Indians can not be understood without a knowledge of the means adapted to express accurately the ideas embodied in those institutions, Major Powell has directed a large share of attention to language, and about two thirds of the present volume is occupied by papers on that subject. The longest of these is one by Lieutenant-Colonel Garrick Mallery on "Sign Language among North American Indians compared with that among other Peoples and Deaf-Mutes." This is drawn up merely as a report of progress, and consists of a part of the data on this subject that have been obtained by the bureau. A large number of Indian signs are herein graphically described and fully illustrated, though perhaps more space is given to describing the signs of other peoples than is absolutely necessary for purposes of comparison. A paper by the director describes quite a complete system of government that exists among the Wyandots; and another, also by Major Powell, is an interesting and thoughtful sketch of "Indian Mythology." The contribution of greatest popular interest is a second paper by Dr. H. C. Yarrow on mortuary customs, which embodies many communications from recent investigators, together with a large number of extracts from writers who have touched upon this subject within the last two hundred years.

While earth-burial, either with or without embalmment or partial cremation, seems to have been the general custom among North American Indians, other methods of disposing of bodies are also known: as aërial sepulture, or leaving the body in a box or canoe, which is supported on a scaffold or tree; and aquatic burial, which consists in sinking the body in a stream, or setting it afloat in a canoe. Violent expressions of grief are expected from the friends of the dead, and especially from widows. Some of these are, blackening the face, shaving the head, and cutting the flesh—all being accompanied by mournful cries, and sometimes hired mourners being employed. In some tribes, the widow observes a long period of mourning, involving many discomforts, and in others she submits to being put to death at the grave. This volume does not include all the material collected before its date, nor does it mark the end of the bureau's labors; all investigators of American ethnology are earnestly requested to co-operate in the further work of the bureau, and cordial thanks are offered to those who have already contributed their observations.

American Humorists. By the Rev. H. R. Haweis, M. A. New York: Funk & Wagnalls. Pp. 180. Price, 75 cents.

This is a reprint of a course of lectures which were delivered at the Royal Institution in London, on six of those whom the English regard as our most characteristic and typical humorous writers, viz., Washington Irving, Dr. Holmes, Mr. Lowell, Artemus Ward, Mark Twain, and Bret Harte. The pervading quality of the wit of each of these authors is analyzed, and is illustrated by liberal citations from the most characteristic of their writings. The work is not satisfactory to all the critics, but this arises probably as much from the fact that the flavor of humor can not be conveyed, as from any deficiencies of the author.

Jesus, his Opinions and Character: The New Testament Studies of a Layman. Boston: George H. Ellis. Pp. 471. Price, $1.50.

Taking a judicial and critical rather than a partisan attitude, the author has collected and arranged systematically what Jesus seems to have thought about the various subjects upon which his followers represent him as teaching. The author's data are taken from the first three gospels, while the fourth is regarded as a genuine early commentary, and as such is referred to by way of illustration. "Every great historical personage," our anonymous author writes, "to be understood, must be studied in connection with his dominant idea." This dominant idea in the case of Jesus he finds to be the "doctrine of the kingdom of heaven," and insists that this doctrine be kept clearly in view, as the central idea "around which was grouped all that he said and taught." Successive chapters take up the political, ethical, philosophical, and religious ideas of Jesus, his ideas of a future life, the miracles attributed to him, his arrest, trial, and death, his personal pretensions and character, and the legend of the resurrection, the last chapter being devoted to the "Influence on Historic Christianity of Paul and John."

An Introduction to the Study of Organic Chemistry. By Adolph Pinner, Ph. D. Translated and revised from the sixth German edition, by Peter T. Austen, Ph. D., F. C. S., Professor of Chemistry in Rutgers College and the New Jersey State Scientific School. New York: John Wiley & Sons. Pp. 382. Price, $2.55.

English-speaking students of organic chemistry have suffered from a dearth of suitable elementary text-books in their own language; hence this translation of Pinner's standard work is to be heartily welcomed. The book is too well appreciated in the original to need comment here; the translation follows the easy lecture-style of the original, and contains additional matter describing the most important recent discoveries.

Entomological Papers from the Transactions of the Iowa State Horticultural Society, for the Year 1882. Des Moines, Iowa: F. M. Mills, State Printer. Pp. 42.

The papers include one on the injury done by insects in orchards, by the Hon. J. N. Dixon; notes on the "Injurious Insects of 1882," by Miss Alice B. Walton; and "Entomological Notes," for the year, by Professor Herbert Osborn, all of which have a practical bearing.

Manual of Assaying Gold, Silver, Copper, and Lead Ores. By Walter Lee Brown, B. Sc. Chicago: Jansen, McClurg & Co. Pp. 318. With Illustrations. Price, $1.75.

The author of this manual has aimed to produce a guide for those who, having had no previous training in chemical work, wish to learn assaying. Hence, he gives first full descriptions of the apparatus required, generally with illustrations, names of makers, and prices. The reagents are as fully described, and, wherever necessary, methods of preparing and testing them are given. The processes of assaying are detailed with great clearness, from the crushing of the ore to the estimation of its value per ton, and in the appendix are given various special methods of assay, lists of minerals likely to contain gold, silver, copper, or lead, a list of books on assaying, various departments of chemistry, mineralogy, mining law, etc., and useful tables. The volume is got up in much better style than is usual with scientific and technical manuals.

Reports of Experiments, chiefly with Kerosene, upon the Insects injuriously affecting the Orange-Tree and the Cotton-Plant. Made under the Direction of the United States Entomologist. Washington: Government Printing-Office. Pp. 62.

The expediency of using kerosene has been disputed, chiefly on account of the danger of its injuring the plants. The objection is applicable to pure kerosene, and with greater force as regards some species than others. Professor Riley advises that kerosene be used with caution where its effects are not already known, and never be employed pure. With this reservation, his own experience and that of his assistants shows that neither lye nor whale-oil soap, the other substances recommended, "bears comparison with an effectual kerosene emulsion as an effectual destroyer of scale-insects and their eggs."

Shade-Trees, Indigenous Shrubs, and Vines. By J. T. Stewart, M. D. Second edition, revised and improved. Peoria, Ill.: Transcript Publishing Company. Pp. 37.

This paper was prepared with particular reference to the city of Peoria, and was read by request, in December last, before the Scientific Association of that place. It is the fruit of many years of observation and much careful study, and consists chiefly of notes on native species and their adaptability to the soil, climate, and situation of Peoria, with directions for their cultivation and care. Much of it is applicable to other places than Peoria.

Professional Papers of the Corps of Engineers, United States Army. No. 24. Report upon the Primary Triangulation of the United States Lake Survey. With 30 Plates. By Lieutenant-Colonel C. B. Comstock. Washington: Government Printing-Office. Pp. 922.

This is the final report of the survey, begun in 1841, of the Northern and Northwestern lakes. The work is described under the headings, "Standards of Length, Bases, and Base Apparatus." "Primary Triangulation," "Astronomical Determinations," and "Principal Results of the Geodetic Work." A short history of the survey is prefixed to the volume.

Astronomical Papers, prepared for the Use of the American Ephemeris and Nautical Almanac, under the Direction of Simon Newcomb, Ph. D., LL. D. Vol. I. Washington: Bureau of Navigation, Navy Department. Pp. 487.

In this volume is begun the publication of a series of papers whose objects are "a systematic determination of the constants of astronomy from the best existing data, a reinvestigation of the theories of the celestial motions, and the preparation of tables, formulæ, and precepts for the construction of ephemerides, and for other applications of the results." The present volume contains papers on the "Recurrence of Solar Eclipses," "Hansen's Lunar Theory," "A Determination of the Velocity of Light," "A Catalogue of 1,098 Standard Clock and Zodiacal Stars," on "Gauss's Method of computing Secular Perturbations," and a "Discussion of Transits of Mercury from 1677 to 1881."

The Bacteria. By T. J. Burrill, Ph. D. Springfield, Ill.: H. W. Rorker, State Printer. Pp. 65, with Illustrations.

Everybody wants to know all about the bacteria which have been found to play so important a part in the operations, whether useful or destructive, of life; but books in which satisfactory accounts of them are given are as yet rare, and hardly accessible. The author of the present paper, who is Professor of Botany and Horticulture in the Illinois Industrial University, has prepared it with the object of presenting, in language as far as possible freed from technical terms, the principal and most interesting facts now known about these active agents. He also gives references to other sources of information on the subject.

The Q. P. Index Annual for 1882. Bangor, Me.: Q. P. Index. Pp. 51.

A valuable, useful, and convenient publication. It contains a list of all the articles that appeared during the year in twenty-three different American and foreign publications, indicated by a notation simple and easily learned, so that, while reference is easy, the whole is compressed into a very small space.

PUBLICATIONS RECEIVED.

*** *Authors and others, sending papers and monographs for notice, will please specify, for general information, where they can be procured.*

Inundations in Louisiana: Their Influence on Health. By Stanford E. Chaillé, A. M., M. D. New Orleans. Pp. 27.

Eleventh Cincinnati Industrial Exhibition: Rules and Premium List. Cincinnati: Davis & Heineman. Pp. 76, with Plans.

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

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

Didactics in the State University of Iowa. By S. N. Fellows, Iowa City, Iowa. Pp. 24.

Cranial Nerves. By W. O. Thrailkill, San Francisco, Cal. Chart. One page. 56 cents.

Old Maryland Manors. By John Johnson, A. B. Baltimore: Johns Hopkins University. Pp. 38. 30 cents.

John Howard Payne Souvenir: Portrait and Autograph. Boston: L. Prang & Co. Pp. 4.

A Recent Find in the Trenton Gravels. By C. C. Abbott, M. D. Trenton, N. J. Pp. 10.

Reports of the Trustees of the Sanitary Improvement Bonds of the City of Jacksonville, Fla. Pp. 113.

Address of Vice-President A. H. Tuttle, Section of Histology and Microscopy, American Association. Salem, Mass.: Salem Press. Pp. 14.

How to make Photographs. New York: E. & H. T. Anthony & Co. Pp. 91, with Plates.

Handbook of Medical Electricity. By A. M. Rosebrugh, M. D. Toronto, Ont.: Dudley & Burns. Pp. 54.

Planting Trees in School-Grounds. Washington, D. C.: United States Bureau of Education. Pp. 8.

Normal Condition of Cellular Structure and Peach Yellows. By D. P. Penhallow (Houghton Farm Experiment Department). Mountainville, N. Y. Pp. 45, with Three Plates.

Zoölogical Society of Philadelphia, Eleventh Annual Report. Pp. 26.

Industrial Art in Schools. By Charles G. Leland. Washington, D. C.: United States Bureau of Education. Pp. 37.

The Impress of Nationalities upon the City of New York. By James W. Gerard. New York: Columbia Spectator Publishing Company. Pp. 32.

The Citizens' Law and Order League of the United States, Proceedings, etc. Chicago: Cowles & Dunkley. Pp. 81.

Worcester Free Institute, Statement. Worcester, Mass. Pp. 16.

Worcester Free Institute, Statistical Information. Worcester, Mass. Pp. 16.

Variations of Barometric Measurements of Altitude with the Season. By John Tatlock, Jr. Pp. 20.

The Library Journal, March–April, 1883. New York: F. Leypoldt. Pp. 68. $4 a year.

United States Bureau of Education: Its Work and History. By Charles Warren, M. D. Washington: Government Printing-Office. Pp. 29.

Clinical History and Localization of Perinephric Abscesses. By John B. Roberts, M. D., of Philadelphia. Pp. 19.

Heart-Puncture and Heart-Suture as Therapeutic Procedures. By John B. Roberts, M. D., of Philadelphia. Pp. 5.

Preliminary Report on the Venoms of Serpents. By S. Weir Mitchell, M. D., and Edward T. Reichert, M. D., of Philadelphia. Pp. 14.

Bulletin of the Buffalo Naturalists' Field Club, No. 3. Buffalo, N. Y.: Hicks & Beach. Pp. 24.

The Biographer. Illustrated. New York: 23 Park Row. Monthly. Pp. 64. 25 cents each number.

Bulletin of the Philosophical Society of Washington. Vol. IV, pp. 189; Vol. V, pp. 189.

Notes on Copper Implements from Mexico. By F. W. Putnam. Cambridge, Mass. Pp. 12.

The Philippine Islands. By Samuel Kneeland, M. D. New York. Pp. 28.

The Magazine of American History. With Notes and Queries. April, 1883. New York: A. S. Barnes & Co. Pp. 80, with Map.

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

Deep Breathing. By Sophia Marquise A. Ciccolina. New York: M. L. Holbrook & Co. Pp. 48.

A Visit to Ceylon. By Ernst Haeckel. Translated by Clara Bell. Boston: S. E. Cassino & Co. Pp. 337. $2.50.

A Book about Roses. By S. Reynolds Hale. New York: William S. Gottsberger. Pp. 326.

Golden Sands: A Collection of Little Counsels for the Sanctification and Happiness of Daily Life. Translated from the French. New York: G. P. Putnam's Sons. Pp. 101. $1.50.

Practical Carpentry. By Frederick T. Hodgson. New York: The Industrial Publication Company. Pp. 144, with Plates.

Chemistry, Inorganic and Organic, with Experiments. By Charles London Bloxam. Philadelphia: P. Blakiston, Son & Co. Pp. 680. $4.

Eve's Daughters; or, Common Sense for Maid, Wife, and Mother. By Marion Harland. New York: John R. Anderson and Henry S. Allen. Pp. 454. Sold by subscription.

Lectures on Medical Nursing. By J. Wallace Anderson, M. D. New York: Macmillan & Co. 1883. Pp. 224. $1.

POPULAR MISCELLANY.

Higher Professional Aims.—"The Higher Professional Life" was the subject of Dr. J. M. Da Costa's recent valedictory address to the graduating class of Jefferson Medical College, Philadelphia. The higher aim of the physician should be to add to knowledge and increase the resources of his profession. It may be sought in various ways: by making original inquiries in the way that Darwin and Pasteur have so brightly illuminated; by cultivating literary tastes, and thereby becoming quicker in perception and more skillful in disseminating truths once learned; by mixing in the great movements that are to benefit mankind, and becoming influential in them; and by becoming active for the advancement of sanitative and preventive medicine. "There are thus many ways in which the aspirations of a higher professional life may be realized in useful or in great work. Some of these can be followed only when success has brought comparative leisure; but all can be kept in mind; one or all can be aimed at throughout our careers, and according to our individual strength."

The Glacial Moraine in Pennsylvania.—We have already mentioned the fact that Professor H. Carvill Lewis has traced the great glacial terminal moraine along its whole course through Pennsylvania. An account of his investigations is given in a paper recently read by him before the Franklin Institute of Philadelphia. The moraine enters the State in Northampton County, at latitude 40° 49′, and may be followed in a northwesterly direction till it enters New York from Potter County, at a height of 2,580 feet. It afterward turns at right angles to its former course, and, trending to the southwest, re-enters Pennsylvania at Pine Grove township, Warren County, whence it may be traced till it crosses the State line into Ohio at Darlington township, Beaver County, latitude 40° 50′. It thus leaves Pennsylvania at almost precisely the latitude at which it entered it; and, if a straight line were drawn across the State between these two points, the line of the moraine would form with it a right-angled triangle, whose apex would be a hundred miles distant from its base. The moraine crosses the Delaware at an elevation of 250 feet, the Allegheny River at an elevation of 1,425 feet, and the Beaver at an elevation of 800 feet above the sea, or 225 feet above Lake Erie. Upon the highlands it rises a thousand feet or more higher. The distinction between the glaciated portion of the State and the region south of glacial action is very marked, and the moraine itself is so sharply defined that at one point, Buck Mountain in Luzerne County, Professor Lewis was able to stand with one foot upon the glaciated and the other upon the non-glaciated region. The moraine is very finely developed west of Bangor, in Northumberland County, where it forms a series of "hummocky" hills one or two hundred feet high. Its course in Monroe County, as it winds from the top of the Kittatinny Mountain down to Cherry Valley, and then up again on to the Pocono, is a complete vindication of the glacial hypothesis. It is in no sense a water-level, nor could it have been formed by floating ice or by any other cause than that of a great glacier. It is wonderfully shown upon the summit of Pocono Mountain, over 2,000 feet above the sea, where a great ridge of moraine hills, twelve miles long, one mile wide, and 100 feet or more high, composed of unstratified till, and bearing numerous bowlders of Adirondack gneisses and granites, rises out of the plateau. The "kames" of Cherry Valley, with their accompanying "kettle-holes," and the terraces near Stroudsburg are also interesting features. Immense as was the power of the slowly moving glacier, says Professor Lewis, "it had but slight effect upon the topography of the country. It is a mistake to suppose that glaciers can level down mountains or scoop out cañons. The glacier had merely 'sand-papered' the surface of the rocks."

Joseph Duncan Putnam.—Joseph Duncan Putnam, late President of the Davenport (Iowa) Academy of Natural Sciences, who died December 10, 1881, had accomplished a remarkable amount of scientific work during his short life of twenty-seven years. He was born in Jacksonville, Illinois, in 1855; began making a collection of insects when eleven years old, and attempted their scientific classification in his fourteenth year. At the same time he was interested in other branches of science and collections. In 1872 he spent three months in the mountains of Colorado with Dr. C. C. Parry; in 1873, five months as meteorologist to Captain Jones's Yellowstone expedition. The next year he spent chiefly in Colorado, completing a series of expeditions in which he collected altogether 25,000 specimens of insects, many of them very rare. From 1869 he was one of the most active and useful members of the Davenport Academy, and was in succession its recording secretary, corresponding secretary, and president; and he sustained a large share of the burden of the editorial supervision and publication of its "Proceedings." Mr. Putnam's scientific publications were not voluminous. With one or two exceptions his most important investigations were never fully elaborated, and were embodied only in notes, letters, and incomplete manuscripts. A list of twenty-one is given, of which the most valuable are papers on bark-lice, and on his investigations of the *Salpugidæ*, a group intermediate between the scorpions and the spiders. A paper by him on "Insects and Flowers of Colorado" was published in the tenth volume of "The Popular Science Monthly."

Getting Water in the Desert.—The supply of water always formed a principal question, and often a preponderant one, during the marches of the French troops in Algeria and Tunis. Rivers having a permanent supply of water are very rare in those countries, but *wadies*—beds of torrents, generally dry, but full after a shower—are numerous. The most ordinary supplies of water were *sedirs*, or puddles of rain-water held in natural basins of clay or stone, near which the camps were pitched whenever they were accessible. They are to be found in the beds of wadies, and sometimes in slight depressions of the plain, where they are frequently of considerable extent. When full they contain, notwithstanding they are so shallow, prodigious quantities of water, which is, however, exposed to an enormous evaporation, so that it does not last long. These natural reservoirs have been covered with sand in many places, where a permeable bed several feet high has been formed, with a dry surface corresponding with the general level of the surrounding land. It is only necessary to dig a hole, and wait a little while, for the water to rise to a certain level, forming a kind of extemporaneous well, which the Arabs call an *oglat*. These wells contain but little water, and are soon dried up when drawn from, but will become filled again in the course of a few hours. These resources, precarious at the best, are often wanting; but the country is full of ruins, attesting the former existence of a large population, and among them are many useful structures, including well-made cisterns still almost entire, and very deep. Water is got from them by going down steps to the surface, or by means of a device called the *guerber*, which is in general use. This is a leathern bottle, adjusted at the curb of the well by means of pulleys and ropes, which are worked in such a manner by a man and an ox that the vessel goes up and down, fills itself with water and empties itself, without any one having to handle it directly.

Symptomatic Anthrax and Disinfectants.—The Lyons "Médicale" publishes the results of some valuable experiments which have been made by MM. Arloing, Cornevin, and Thomas, on the influence of various disinfecting agents on the virus of symptomatic anthrax. If the contents of a tumor in this disease be allowed to dry slowly at a temperature of 35° Cent. (or 95° Fahr.), a residue is obtained in which the organisms of anthrax retain their full activity. Water, through which a little of the residue is diffused, has a virulence not inferior to that possessed by the fresh virus, and which continues for at least two years. It was found, in carrying on the experiments, that the resisting power of the dried virus is much greater than that of the fresh. Whatever destroys the dried is capable of destroying also the fresh virus, while the converse is not true. The following substances were found to have no effect even upon the fresh virus: alcohol saturated with camphor or carbolic acid, glycerine, ammonia, acetate and sulphate of ammonia and sulphate of ammonium, benzine, a saturated solution of chloride of sodium, quicklime and lime-water, polysulphide of calcium, a one-in-five solution of chloride of manganese, a one-in-five solution of sulphate of iron, a one-in-five solution of borate of soda, a one-in-five solution of tannic acid, a one-in-ten solution of sulphate of quinine, a one-half solution of hyposulphite of soda, essence of turpentine, and monobromide of camphor; of gases, ammonia, sulphurous acid, and chloroform. A saturated solution of oxalic acid, a one-in-twenty solution of permanganate of potash, a one-in-five solution of soda, vapor of chlorine, and sulphide of carbon, destroyed the fresh virus, but had no effect on that which had been dried, while the activity of the latter was destroyed only by solutions of carbolic acid (two per cent), salicylic acid (1 in 1,000), nitrate of silver (1 in 1,000), sulphate of copper (1 in 5), boric acid (1 in 5), saturated salicylic alcohol, corrosive sublimate (1 in 5,000), and bromine vapor. Thus many substances, unanimously regarded as antiseptic, were without effect upon the virus, even in the fresh state. This is the case with pure and camphorated alcohol, with which surgeons are accustomed to wash their instruments, quicklime, with which dead bodies are consumed, etc.

The Poisons in Tobacco-Smoke.—Herr Kissling, of Bremen, has published a useful paper on the poisonous constituents of tobacco-smoke, among which he specifies as strong in quality, carbonic oxide, sulphureted hydrogen, prussic acid, picoline bases, and nicotine. The first three substances, however, occur in such small proportions, and their volatility is so great, that their share in the action of tobacco-smoke on the system may be neglected. The picoline bases, too, are present in comparatively small quantity; so that the poisonous character of the smoke may be almost exclusively attributed to the large proportion of nicotine present. Only a small part of the nicotine in a cigar is destroyed by the process of smoking, and a relatively large proportion passes off with the smoke. The proportion of nicotine in the smoke depends, of course, essentially on the kind of tobacco; but the relative amount of nicotine which passes from a cigar into smoke depends chiefly on how far the cigar has been smoked, as the nicotine-content of the unsmoked part of a cigar is in inverse ratio to the size of this part—that is, more nicotine the shorter the part. Evidently, in a burning cigar, the slowly advancing zone of glow drives before it the distillable matters, so that in the yet unburned portion a constant accumulation of them takes place. More, relatively, of this substance passes into smoke in the case of cigars that are poor in nicotine than in the case of cigars with much of that substance. Nicotine, notwithstanding its high boiling-point, has remarkable volatility.

Fisheries of New York.—According to the reports of the Census Bureau, New York is fourth in the list of fish-producing States, the value of its products being $4,380,565, but it holds a still more prominent position in several special branches. Its menhaden-fisheries are more extensive than those of any other State, its yield of the products of that branch being more than half that of the whole country. The value of its oyster-products, $1,577,050, is greater than that of any of the other States, except Maryland, Virginia, and New Jersey. It returns the largest quantities of clams, both hard and soft; and it ranks third in respect to the shad-fisheries. Seven thousand two hundred and sixty-six of its inhabitants, and $2,629,585 of capital are engaged in the fishing industries.

Liquid Air and Solid Alcohol.—M. Cailletet, a French chemist, some time ago succeeded, by liquefying ethyline and causing it to boil, in producing a temperature of $-105°$ C. ($-157°$ Fahr.), at which he liquefied a few gases under strong pressure, and even caused oxygen to approach the liquid state. M. Wroblewski, of Cracow, one of his pupils, continuing the experiments, has, by boiling liquid ethyline in a vacuum, produced a temperature of $-136°$ C. ($212\frac{4}{5}°$ Fahr.), at which sulphuret of carbon and alcohol were congealed, and oxygen and nitrogen became liquid. The change in the form of oxygen was obtained on the 9th of April in three experiments in which the conditions of pressure ($22\frac{1}{2}$ to $26\frac{1}{2}$ atmospheres) and temperature were slightly but not essentially varied. Liquid oxygen is transparent and colorless, differing in this from ozone, which is deep blue. Liquid nitrogen has a similar appearance. Sulphuret of carbon is a white solid at −116° C., but becomes liquid when raised to −110° C. At −130° C., alcohol assumes the form of a white solid, which becomes viscous at −129°. Carbonic oxide was liquefied under similar conditions with nitrogen.

Ancient Cities in Guatemala.—Mr. A. P. Maudslay, at one of the recent meetings of the London Geographical Society, described some ruined cities in Guatemala which he had visited during parts of the winters of 1881 and 1882. At Quirigua, not a very great distance from Livingstone, the Atlantic port of the country, the ruins consist of raised terraces or mounds, usually faced with stone, and elaborately carved monoliths, representing human and animal figures, situated near them. The upright monoliths measure from three to five feet across the sides, stand from twelve to twenty-five feet out of the ground, and bear human figures, of which the heads are sculptured in high relief, and are usually surmounted by grotesque masks, whence spring elaborately carved head-dresses. The body and dress are covered with the most intricate and elaborate ornament, in which small human faces and grotesque forms frequently occur. Of the animal-shaped stones, some had curved claws and indications of armor like that of an armadillo, and held a human head, apparently the head of a woman, between their jaws. The largest of these stones, which was estimated to weigh about eighteen tons, represented a turtle, whose head was replaced by a huge grotesque human head, while in place of its tail was a life-sized figure of a woman sitting cross-legged, and holding in her hand a manikin scepter somewhat resembling the children's toy of a monkey on a stick. The whole surface of the stone was covered with a profusion of ornaments. All of the monuments bore hieroglyphics and carved tablets—probably symbolical—of curious character. At Tikal, in the extreme northern part of the state, all the houses were made of stone, and coated with plaster, with walls about three feet thick, and the roofs built in the form of gables, without any attempt at an arch. The most imposing buildings are the five temples raised on almost pyramidal foundations. Beams of sapota-wood were used in supporting the building, and many of them remain in various states of preservation, while all were elaborately carved. The ruins of Usumacinta, on the river of the same name, and on the border of the Mexican State of Chiapas, were visited for the first time. The houses are more spacious than those at Tikal, and the lintel-beams are of stone, and handsomely carved. One of the houses, which is described as a typical specimen, is built on a succession of terraces; the first terrace, seventy-three feet long by seventeen feet broad, has three doorways, each with a rather poorly carved stone lintel, and is finished off with a projecting cornice. Above it is a second course of eleven feet of stone-work, and over this is a hollow superstructure, looking like a pigeon-house with numerous pigeon-holes. The entire height of the building is about forty-two feet. The whole house has been covered with stucco, and painted in various colors. On the second story are three large and eight small panels, which once held human figures molded in plaster; and in the center of the "pigeon-hole" course is another panel, which once contained a figure of more than twice the size of life. Only parts of these figures now remain, but enough to indicate what they were. Inside the house is a great stone idol, twice the size of life, well carved and sitting cross-legged, with its hands on its knees, like the figures of Buddha; the remains of a canopy of ornamental plaster-work were found near it. Remains of circular stone altars were found in different parts of the ruins, and earthen pots, partly filled with some half-burned resinous substance. The Lacandone Indians, who live here, speak the Maya dialect of Yucatan, and were observed to be lighter colored than Mr. Maudslay's Indian workmen, and to have thick lips, a prominent nose, and an extraordinary receding forehead, nearly resembling the foreheads represented on the carved stones. Their only weapons, so far as Mr. Maudslay could see, were stone-tipped arrows. Their communities were often at war with each other, generally on account of the efforts of one or the other to carry off women. The pots of half-burned incense found in the ruins and near the idol, some of which were comparatively fresh, are supposed to have been made and brought by them; and the suggestion is offered that it is the fact of these Indians still holding in reverence the temples built by their ancestors and offering incense in them that has led to the current Central American belief in the existence of one of the ancient cities still existing hidden somewhere in the forest. The mythic city has been gradually driven farther back, and this river, the Usumacinta, now marks about the last place where it could be looked for.

Lightning-Rods.—A committee, representing several societies interested in the subject, which was appointed some time ago to inquire into the best method of constructing and adjusting lightning-rods, has recently made a most valuable report, based upon all the information it was possible to procure. Inasmuch as sharp points, even if made of platinum, are liable to be melted and blunted, the report recommends that the rod should preserve its full diameter nearly to the extremity, and be merely beveled off. To preserve the sharp points for drawing off the silent discharges of electricity, the attachment of a copper ring, bearing three or four needles of suitable size, at a distance of about a foot below the extreme top of the rod, is suggested. Vanes, finials, and other ornamental iron-work on the upper part of a building, must be metallically connected with the conductor. A coronal, consisting of a copper band, with stout copper points, each a foot long, at intervals of two or three feet on its circumference, is recommended for the chimneys of factories. Copper is preferred to iron as the material for rods, chiefly because it is less liable to be injured and rendered inefficient by rust. The diameter should be three eighths of an inch for copper rods, half an inch for copper rope, and nine tenths of an inch for iron rods. The rods should not be insulated from the building, but should be attached to it by fastenings of the same metal as the rod itself. A good earth-connection is specially important. In towns, connection with the iron water and gas mains is recommended, but not with lead pipes, because they are too liable to be melted. As a general rule, the lower end of the conductor should be soldered to a plate of the same metal as itself, having an area of not less than a square yard, while the hole in which this plate is sunk must be so deep that the earth surrounding the plate shall be moist even in the driest weather. Drains and water-courses may be utilized for keeping the plate in connection with a large extent of moist earth. It is recommended that the height of the rod be such that a cone having its vertex at the upper terminal, and its sides sloping at forty-five degrees, shall inclose the whole building, or as much of it as this particular rod is required to protect.

Too Long School-Sessions.—A governmental commission in Alsace-Lorraine for the investigation of the sanitary conditions of school-life has made a report in which, besides noticing the unfavorable conditions that usually receive attention in such documents, stress is laid upon the fact that the principles of mental education have not partaken during late years of the progressive improvement which has characterized most branches of knowledge. Thus, the greater variety in the instruction which is imparted by modern education fails in many cases to accomplish its purpose, and is of advantage only to pupils of more than average capacity. Much evil is believed to arise from school-children remaining too long in a cramped or otherwise restrained position, and from the excessive and premature strain to which the youthful brain is often subjected, while the dangers of moral and physical infection are always present. Improvements in the ventilation and sanitary arrangements of schools, however important in themselves, are, it is urged, of comparatively little use, when the pupil is kept for too long a time every day in a combined state of bodily inactivity and mental tension.

Schools and Infectious Diseases.—The question is sometimes presented whether it is expedient to close a school, among some of the pupils of which infectious diseases have appeared. The fact that the conditions and customs of school associations give facilities for the dissemination of contagion which are quite unknown in any other phase of social life often makes it seem that the closing of the school is indispensable to the checking of the disease. The necessity of such an extreme measure may, however, be nearly always prevented by the exercise of proper foresight. The teacher should be watchful of absences and their causes, and should give notice, when infectious disease is in question, to the proper officers. The sick pupil should then be isolated from the well ones, and his home and family surrounded with the most rigorous sanitary precautions for not less than eight weeks. Dr. David Page, sanitary officer of Westmoreland, England, has always avoided the necessity of extreme measures by adhering to these principles. The school should be closed only when it has obviously become a starting-point of infection, or when the control specified above can not be exercised. The term of suspension must be determined by circumstances, and can not be previously regulated, but a premature reopening should be avoided; and the reopening should be preceded by a thorough disinfection, by fumigation with sulphur and washing the walls with lime and the wood-work with soap and carbolic acid. The continuance of day-schools during the prevalence of scarlatina is justified, says Dr. Page, when the children would be otherwise exposed to much risk in playing about their doors with children of infected families, and with those barely recovered from illness. Under such circumstances, always provided that due supervision over infected families is maintained, a child runs less risk in regular attendance at school. But in scattered country districts, where the children coming from all points are brought together only during school-hours, the breaking up of the school is the best and safest course.

Earth-Tremors. — The committee appointed by the British Association, two or three years ago, to measure the lunar disturbance of gravity, have met with unexpected difficulties in the accomplishment of their task, and have substantially given it up as for the present unattainable. The Messrs. Darwin, who undertook the observations at Cambridge, found that, as soon as they had made their instrument sensitive enough to record the lunar disturbances, they had to deal with other disturbances, "so incessant and so lawless that the steady march of the lunar swing was utterly overborne and lost." The earth was never really still. It quivered and throbbed and warped and bent under the pendulum night and day, and even, as it seemed, in the absence of all merely local agencies that could be detected." A situation at the bottom of a deep mine was then suggested, but with no better success. The earth yields there under the operation of deep-reaching causes that can not be got rid of, and which produce effects of the same order of magnitude as the direct effect of the moon, and are at present inextricably entangled with it. These causes are the varying mass of the air, that shifts and changes according to the indications of the barometer, and the varying mass of the water on the shores, that shifts and changes with the tides. It is easy enough to believe that, when a mountain-mass is set down upon the earth, the crust must yield and a depression form at the spot upon which the excess of weight is placed. "But it was probably never imagined till now that, when the barometer rises an inch over a land area like that of Australia, the increased load of air sinks the entire continent two or three inches below the normal level. Over a like sea area the water surface may be depressed a foot or more. Thus, as the mass of air sweeps in wind or creeps by slower convection from place to place, the yielding earth sways up and down beneath its weight"; a depression is formed, toward the center of which the surface slopes from all sides, and the plumb-line ceases to be perpendicular to the surface. The mass of air which hovers over the spot also acts like a mountain and draws the pendulum toward it; the two effects are superimposed, and the apparent displacement of the vertical is exaggerated. The two influences always act together, and are proportional; and this twofold deviation is of the same order as that which the moon produces, but is perpetually varying and incalculable. It therefore vitiates all pendulum observations. The tides exercise a similar power, depressing the shore at the flood and allowing it to rise at the ebb. The advance and retreat of the water will also tell on the plummet by mere attraction. The lead will seem to be pulled seaward at high water, and will swing back landward at the ebb. At sixty miles away from the Atlantic coast the deflection due to tidal action of this kind is probably quite as great as the greatest deflection due directly to the moon. These flexures are not confined to the surface, but must extend in almost equal degree beyond the depth of the deepest mine. Until the atmospheric pressure and the state of the tides at each moment can be accurately known for a great distance around any given spot, the experimental determination of the lunar disturbance of gravity is out of our reach; our instrument, even in the most favorable site, must needs record incessant variations of which no satisfactory account can be given. A gravitational observatory must, therefore, for the present content itself with registering the more or less irregular tremors of the earth that are allied with earthquake-movements.

English and Metric Measures.—The following comparative summary of English and French (or metric) standards of measures and weights will be useful: The English inch is equivalent to 2·54 centimetres; the foot to 30·48 centimetres; the yard, to 94·44 centimetres; the mile to 1609·33 metres; the nautical mile, to 1852·30 metres.

The square inch is equivalent to 6·45 square centimetres; the square foot, to 929·01 square centimetres; the square yard, to 8364·13 square centimetres.

The cubic inch is equivalent to 16·387 cubic centimetres; the cubic foot, to 28·516 cubic decimetres; the cubic yard, to 764·535 cubic decimetres; the pint, to 0·567 cubic decimetre; the gallon, to 45·410 cubic decimetres.

The English grain is equivalent to 64·799 milligrammes; the ounce avoirdupois, to 28·349 grammes; the pound, to 453·590 grammes; the ton, to 1016·050 kilogrammes.

The foot-pound is equivalent to 0·13825 kilogrammetre; the French horse-power, to 75 kilogrammetres a second; and the English horse-power (550 foot-pounds a second, or 33,000 foot-pounds a minute), to 76 kilogrammetres a second.

The metrical unit of pressure is the kilogramme per square centimetre. We may also count by centimetres of mercury or by atmospheres. A pressure of one atmosphere corresponds to a column of mercury 76 centimetres high, or to 1·033 kilogramme per square centimetre. The English pound per square inch corresponds with 70·3 grammes per square centimetre.

False Fangs in Harmless Snakes.—The blowing-viper or puffing-adder of the United States, although it is timid and unaggressive, and can rarely be provoked to bite, and then does no particular harm, has been reputed a dangerous and venomous reptile because it has long, fang-like posterior teeth. It belongs to the genus *Heterodon*, which is so called on account of this unusual and irregular dentition. It is of the same group as the *Xenodons*, or strange-tooths, of tropical America, which are also supposed there to be poisonous, possibly for no better reason than our North American genera are. Dr. Stradling allowed one to bite him, and suffered no ill effects from the wound. Mrs. Catharine C. Hopley states, in "Land and Water," that she has lately examined one of these strange-toothed snakes for the purpose of seeing the fangs, when she observed that they are mobile, or what are called in the viperine snakes hinged teeth—that is, they are so set that the snake can erect or depress them at pleasure by a volitional movement of the jaw. It is known, she says, that no poison-gland exists in this snake, "and it was only on venturing to feel the teeth, in order to judge of their relative sizes, that the reptile let me know it had a larger pair safely tucked away in case I took too many liberties."

NOTES.

A STEP toward fixing a system of uniform standards of time was made by the convention of railroad managers which was held at St. Louis, April 11th. Hour-lines were agreed upon at fifteen degrees of longitude apart, to which the clocks in the districts respectively appertaining to them shall be made to conform. Four standards were made: Eastern time, to agree with that of the 75th meridian; central time, one hour slower, to be regulated by the 90th meridian; and two other standards, two and three hours slower than Eastern time, to be fixed by the 105th and 120th meridians. All changes in time will be made at the termini of roads or at the ends of divisions.

The Cockerill Iron and Steel Company at Seraing, Belgium, employing about ten thousand workmen of all kinds, maintains free night-schools, which are attended by about two thousand boys and adults from the works; an industrial or technical school, which is attended by about eighty fitters and boiler-makers, and by the clever young men in all the departments; and a mining-school, with two hundred students. In the steel department all the young men under eighteen are required to attend the night-school, and those who willfully absent themselves are liable to expulsion. At the great zinc-works near Liége, also, the apprentices are required to attend evening-schools.

The Davenport (Iowa) Academy of Sciences has recently received from the Rev. J. Gass a number of the peculiar "curved-base" mound-builders' pipes. One of them is a finely carved stag's head, representing the antlers bent around the bowl, in relief; another is an eagle, perched and holding some small animal in its claws; two others are neatly carved birds; another is a finely sculptured black bear; a sixth is supposed to represent a fox, with the face turned backward; a seventh is a nondescript animal. Others are plain. The bear is cut from a black stone; the other pipes are in ash-colored pipestone or red catlinite.

Up to the present date, we understand, there have been received in answer to the official letter of inquiry to the members of the British Association, as to whether they intended to go to Montreal or not, replies in the affirmative from three hundred and forty. Among these are a good many who may be said to be really representative of English science, but, as might be expected, the younger men are present in a larger proportion than the older.—*Nature.*

Pierre Carbonnier, the distinguished French pisciculturist, has recently died. He was the author of several monographs on the natural history and cultivation of fishes, and contributed many papers to scientific journals. He was also director of the Aquarium of the Trocadéro at the French Exhibition of 1878.

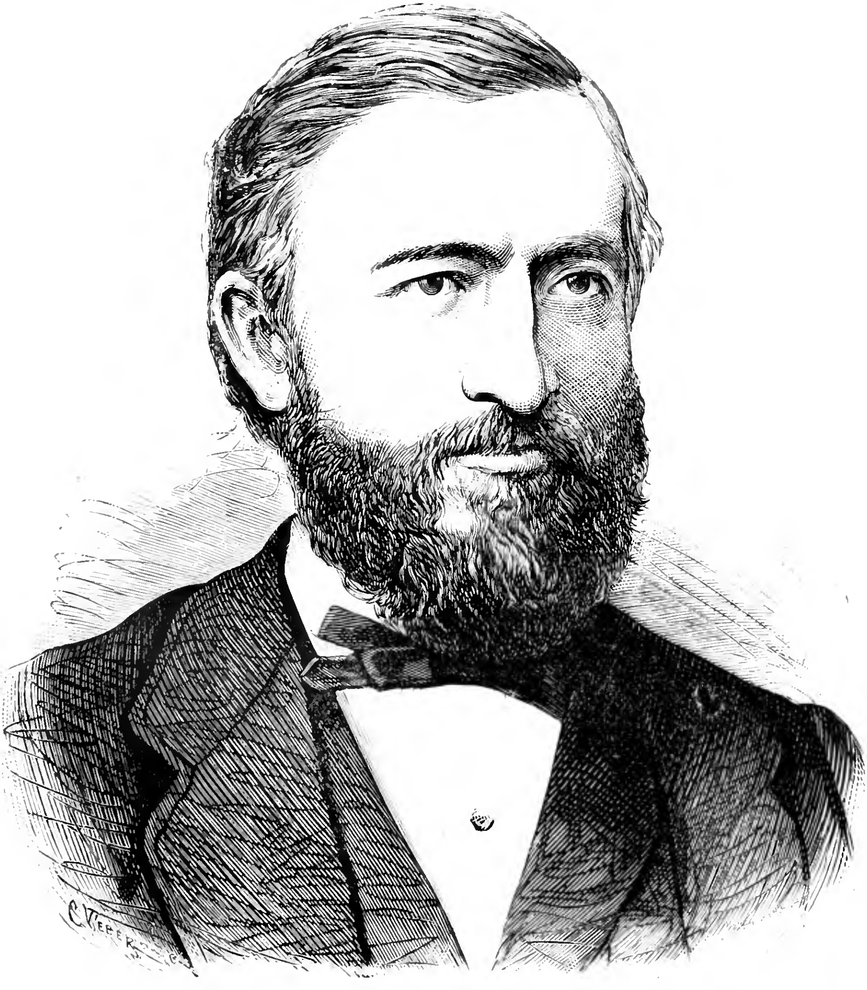
Mr. W. S. Barnard, of the Department of Agriculture, observes that ants may do valuable service as destroyers of larvæ and insects, particularly of the cotton-worm, which appears to be fiercely attacked by all the species. Even the smallest ant all alone will assault and worry the worm, and the insects appear plentiful in all the fields. They dispatch the younger worms very quickly, but the older ones more often escape. Ants are, however, detrimental, though indirectly, to vegetation, in that they protect aphides or plant-lice by keeping off the insects that would prey upon them. This they do for the sake of the honey-dew which the lice excrete while sucking the juices of the plants on which they live. It may be noticed that plants suffer most from aphides where ants are most numerous.

The agricultural interests of the south of France have been nearly ruined by the substitution of the artificial alizarine for madder in dyeing, the silk-worm disease, and the phylloxera. The cultivation of madder will have to be given up, for it can not again be made profitable. The disasters wrought by the silk-worm disease and the phylloxera, now that remedies have been discovered, may be repaired in time. To expedite the recovery of the depressed agriculture, an extensive scheme of irrigation has been arranged, by which water will be drawn from the river Rhône in canals, and distributed to all the country within reach.

Mr. George Sutton, of Aurora, Indiana, traces the causes of the floods in the Western rivers to the great aërial currents which bring on extensive storms independently of local influences, now in the Missouri, now in the Mississippi, now in the Ohio Valley, in summer or winter as the storms may occur. Whenever four inches of water fall suddenly over the seventy-seven thousand square miles of the Ohio Valley, a rise of sixty-three feet will be produced in the river at Cincinnati; and if the ground be deeply frozen and heavily covered with snow, the flood will be much higher. What the people of the river valleys need to enable them to avoid disaster from floods is to know beforehand the height to which the water will rise, and this may be determined by ascertaining how much rain is falling. The Signal-Service Office could provide this information by systematically collecting and publishing measurements of the rain-fall at points in all parts of the water-sheds of the large rivers.

An Association of American Naturalists was organized at Springfield, Massachusetts, in April last, of which Professor A. Hyatt was chosen president, Professors H. N. Martin and A. S. Packard, Jr., vice-presidents, and Professor S. F. Clarke, of Williams College, secretary. Twenty-seven members were enrolled. The Association adopted the name of the "Society of Naturalists of the Eastern United States."

A noteworthy feature of the recent third annual meeting of the German Geographical Society, at Frankfort, was the presence, as the hero of the occasion, of the youthful African explorer, Lieutenant Wissmann, and by his side Dr. Rüppell, now eighty-nine years old, who explored Egypt and Nubia seventy years ago, and Abyssinia and the other Red Sea countries twenty years later.



PHILIPP REIS.

From a Photograph by T. H. Voigt.

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CHANGES IN NEW ENGLAND POPULATION.

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

IN the history of a nation or a people there are sometimes important changes taking place, so gradually and quietly that they are scarcely perceptible at the time. It may require a series of years or several generations to work out the problems involved, but they may be followed with results of great magnitude.

Some changes of this character have been taking place in our New England population, which we purpose here briefly to notice. In the earlier history of New England there were few changes in the residence of her people. As agricultural pursuits constituted their principal occupation, the same farms and lands continued to a great extent in the same families from generation to generation. Prior to the Revolutionary War very little emigration took place out of New England. In the early part of the present century many persons removed to New York and some to Ohio. From 1810 to 1830 this emigration continued steadily to increase, not only to those States but to the States and Territories farther west. To such an extent had this emigration been carried on that, in 1840, the United States census reported nearly half a million of persons born in New England who were living in other States.

Whenever new lands were thrown into market by the Government, or by means of railroads, or some new mining interests, then a "Western fever" started up, and great numbers might be seen "going West." While we have no means of ascertaining the exact number removing from New England, during any one year or period of time, the United States census gives, every ten years, the *birthplace* of all people residing in every State at the time the count was made. The census of 1880 reports that the whole number born in New England but living in other States and the Territories was 566,848. This number is made up by emigration from the different States as follows: From Massachusetts, 175,349; from Vermont, 117,590; from Connecticut, 108,797; from Maine, 93,256; from New Hampshire, 49,397; and from Rhode Island, 22,459.

From another point of view it will be seen how these natives of New England are distributed. New York has 133,272; Illinois, 53,128; California, 46,908; Iowa, 38,170; Michigan, 37,865; Wisconsin, 37,615; Minnesota, 34,636; Ohio, 32,819; Pennsylvania, 26,787; Kansas, 19,338; New Jersey, 18,148; and other States under 10,000 and much less. Vermont has sent away the largest number for its population, and New Hampshire the least. Maine and Massachusetts have sent the largest delegations to California, being three fourths of all the emigrants in that State from New England. It appears by the census that the States bordering on New York—Vermont, Massachusetts, and Connecticut—have sent over 100,000 persons to that State, while the other New England States have sent only some 20,000. The representation from New England (178,207) in the Middle States is much larger than is generally supposed. This emigration has now been going on for three fourths of a century, and it would constitute a fact of great interest if we could ascertain the number of persons born in New England who have ever removed from her borders to the Middle and Western States as well as to the Territories.

The census of 1850 shows that at that time there were 454,626; in 1860 there were 562,997; in 1870 there were 615,747, and in 1880, 566,848. It will be seen by these figures that for twenty years the number has been very stationary, the new emigrants making not quite good the number who had deceased.

It is full two generations since this emigration commenced. As nearly all those persons emigrating were between the ages of twenty and forty, great numbers must have died at various periods. The exact amount of this mortality it is impossible to ascertain, and the data for forming anything like a correct estimate are altogether too uncertain. It may have been a quarter of a million, and possibly a half million. What has been the effect of this steady and large drain of people on New England opens a question of much interest.

Without entering upon the discussion of the subject, we make two or three suggestions. It will be admitted, we presume, that those young men and women, leaving their homes, possessed, as a general thing, more physical energy and mental stamina than those remaining behind. Such a loss of physical vigor and character must have had a decided effect upon business interests as well as the present state of society. But, from another point of view, the loss may have had a more decided and lasting influence, that is, in its permanent effect upon physical and mental development. The better the principles of physiology are understood the more we discover what a powerful influence physical organization has upon the character of a people. The permanent prosperity of any community depends far more upon the laws of inheritance than is generally supposed.

Let the most enterprising and promising among the young people emigrate from a place, and it must, in the course of time, have its influence. Whether the vital interests of New England have not suffered in this respect, from so many persons emigrating in the prime of life presents a question worthy of careful consideration.

INTERCHANGE OF POPULATION.—There is another change going on in these States quite different from the one described. This consists in frequent removals from one State to another.

The census of 1880 shows that Massachusetts had at that time 68,226 residents born in Maine; 54,088 born in New Hampshire; 26,869 in Vermont; 20,514 in Connecticut; and 17,067 in Rhode Island, making 186,764 persons who have removed there from other States. At the same time these five other States had 85,478 persons living in their bounds born in Massachusetts. Deduct these 85,478 from the 186,764, and Massachusetts gains over 100,000, mostly from Maine, New Hampshire, and Vermont.

There is very little migration from the other New England States to Connecticut or Rhode Island, and scarcely any from the latter to the former. Massachusetts, Connecticut, and Rhode Island, make very nearly equal exchanges, neither gaining nor losing much. These removals from one State to another are prompted from a great variety of interests, personal and local. The States most benefited by them are those employed largely in manufacturing business. These changes are carried on chiefly between villages and cities, and seldom take place in the rural or country districts. It may be said that the foreign element is largely concerned in these removals.

COUNTRY LIFE EXCHANGED FOR THE CITY.—This change is not governed at all by State lines. It commenced forty or fifty years ago, from country districts to places where trade or business demanded help. The introduction of manufactures and mechanical pursuits of various kinds, as well as the opening of railroads, created a great demand for laborers. By means of those changes and other agencies, trade and commerce became very much enlarged, and furnished employment for increased numbers.

Here and there new centers of business were formed; new villages sprang up, and large towns were converted into cities. In some parts of New England these removals have taken place to such an extent as to change the face of the country and the state of society. It commenced first in the small farming towns, and has prevailed most in places remote from markets and railroad accommodations.

The effect of such removals is especially marked in Massachusetts, as she possesses a larger number of cities, more railroad facilities, and a greater diversity of pursuits. The census shows the following facts:

That of 345 towns in Massachusetts, from 1845 to 1855, there was a decrease of population in 86 towns ; that from 1855 to 1865 there was a loss in 166 towns ; from 1865 to 1875 there was a loss in 142 towns, and the census of 1880 reports a loss in 143 towns.

It will be seen that the number of towns losing population varies at each census, but undoubtedly the same towns are reported as decreasing in numbers each decade. It should be stated that, in about one quarter of those towns, the loss was occasioned by a division of the town or annexing a part of it to some other place. It should also be stated that the removals from the country districts to villages and cities do not account for all these losses of population ; emigration to the West, and to other distant places, does a part of the work, and so also does death.

There is another item in the account : the birth-rate has so much declined in rural districts, that scarcely any addition, if any, comes from *natural increase*. But, as the death-rate in many places exceeded the birth-rate, the thinning out of the people is not confined to Massachusetts.

In Maine, New Hampshire, and Vermont, the hill towns and many of the agricultural districts are losing more or less population—not alone by death or emigration of young people, but by the removal of whole families to more populous places. In Rhode Island and Connecticut there is not the same extent of territory, and population is more equally distributed ; but still the census of Connecticut reports a decrease of population in some sixty towns in the western part of the State. Statistics show that this removal of people from the country to the city has been increasing every year ; and when it will cease, or what is to be the result, time only can tell.

Agriculture as related to other Pursuits.—Connected with this decrease of population in country districts, there is one very important consideration, that it involves a change of occupation. Farming is given up for work in the store, the shop, and the mill. Within half a century the business of New England has passed through great changes.

By the censuses of 1860, 1870, and 1880, we find, instead of an increased number engaged in agriculture with the increase of population, that the number has been actually diminishing. The census divides all kinds of business or occupation into four classes : 1. Agriculture ; 2. Professional and personal service ; 3. Trades and transportation ; and, 4. Manufactures and mechanics. An examination of the tables representing these four classes in the reports of 1870 and 1880 shows that the last three classes have increased relatively far more than the first class.

The number engaged in agriculture has fallen off in every State. Vermont and Massachusetts stand in respect to agriculture at extreme points ; the former has more people engaged in farming than in all other pursuits, while the latter has only about one tenth as many employed on the farm as are engaged in other pursuits.

Maine has the largest number of any State engaged in agriculture —about one third of her whole population—and she at the same time possesses the greatest amount of territory to cultivate. New Hampshire has half as many engaged in agriculture as in all other occupations; Connecticut has one fourth, and Rhode Island only one tenth. The whole number in New England engaged in agriculture was 301,765, and in other pursuits, 1,268,116—more than four times as many. In 1870 the proportion was one to three.

A comparison of this table (1880) with that in the census of 1870 shows a far greater increase in the class of professional persons than in that of any other occupation or pursuit. The census of 1870 reports only 145,324, while the census of 1880 reports 349,984 persons. This increase is found in every State, though in some States greater than in others. Whether this great increase of professional persons in ten years is an indication of an improved state of society or not, is a question upon which there might be differences of opinion.

It is well understood that, fifty years ago, farming constituted the principal occupation of New England; but, instead of maintaining its position, with a greatly increased population, it has fallen far behind other pursuits. The great additions made to her people have been absorbed in trade, in manufactures, and mechanical business. In considering this exchange of agriculture for other pursuits, a question of great interest arises: What is to be its effect upon physical organization and the permanent prosperity of a people?

No fact is more firmly established than that agricultural pursuits are the most healthy of all, and that those engaged in them transmit *physical development* in its best estate. All experience proves that an exclusive city population tends gradually to degenerate physically, and that the stock can not be kept good from generation to generation.

It is well understood that the only conservative power that can prevent this degeneracy in cities is that their population shall be constantly replenished by recruits from the country. But it should be borne in mind that the places in the country made vacant by those removals are soon occupied by a different race of people, and that this foreign element is pretty likely to increase more and more in the farming districts of New England.

Supposing this change should generally take place in the country districts, how is the purely American stock to improve or be kept good? It can be done only by an intermingling of the races, which is even questionable.

Change in Birth-Rate.—There is no one agency so closely connected with the vital interests of a people as the matter of the birth-rate. In the history of nations this has always been considered a question of the utmost importance. To a certain extent it operates as a thermometer to show the rise and fall of national prosperity. The process of its operations may seem slow, but certain results are sure to follow.

In respect to this agency, a most surprising change has gradually been taking place in New England. Near the close of the last century, Malthus, after making a survey of all the nations on the earth, selected the United States (virtually New England, which was the most populous part) upon which to base his theory of population. Seeing that the inhabitants of these States doubled in twenty-five years by natural increase, he considered that it afforded most favorable indications of prosperity. At that time the birth-rate was high, families were large, and few were found without children.

From the first settlement at Plymouth in 1620, this prosperous state of increase continued without much change for two hundred years, but early in the present century some decline in the birth-rate commenced. It is impossible to trace the exact changes which have taken place for the last two or three generations.

In some parts of New England the precincts and towns were accustomed to keep very correct records of all births, but they were not generally printed, so no comparison of them can be made. But for thirty years or more several of the New England States have published registration reports of births in their cities and towns, so that very correct comparisons can be instituted. Without going into a detailed sketch by statistics, figures, etc., of the changes in birth-rate, we present some general statements on this subject. Forty or fifty years ago large families, numbering six, eight, ten, and twelve, were quite common; now they are rare—in fact, a large number of such families can not at the present time be found in any one neighborhood or even in a single country town. Formerly, in the rural districts of New England, there were few families having only one, two, or three children, and in case there were none it was so rare as to attract particular attention, and was considered by many a great calamity. But what a contrast is found in the present state of society! In the great majority of our American families only one, two, or three children are now found, and in very many families not *one*. And such a state of society is approved by the fashions and prevailing sentiment of the day!

As registration reports generally return the births of the foreign population in the same tables with the American, and as the term *native* is applied to all infants whose parents were born in this country, though of foreign descent, it will be at once seen how difficult it is to obtain the exact birth-rate separate of each class. Two facts are pretty well established: 1. That the birth-rate of the foreign class is more than twice as large as the strictly American; and, 2. That, in the country districts of New England settled mainly by the Americans, it is questionable whether the birth-rate exceeds the death-rate—that is, there is no addition to the population by *natural* increase.

Should this birth-rate continue to decrease as it has for the last twenty or thirty years, the effect will become more and more manifest than it has in the past. The Board of Health for New Hampshire, having charge of the registry of births and deaths in the State, in their report just published, state an important fact bearing on this point. After carefully analyzing the births and deaths in 1880 to draw the line between the foreign and the American, the board make out that the deaths among the Americans exceed the births by eight hundred.

That is, New Hampshire lost population from this source. If this same test of birth and death rate as reported in New Hampshire should be found to apply to all the other New England States, the record would not be very creditable for the past nor encouraging for the future. In making comparison between the birth and death rate the latter must always be carefully taken into account. If the death-rate is unusually large, it affects at once the gain by natural increase. In New England the death-rate generally is not high, which is more favorable for the rate of increase. The same is true in Great Britain, but the birth-rate is much higher there than here. Thus large additions are made there to population by natural increase, far more than in New England. In France for several years the death-rate has been rather high, so that allowance must be made. As a matter of fact, the comparison with foreign nations is decidedly unfavorable to the New-Englander.

According to the latest and most authentic reports, the birth-rate of the New England States is less than that of any large European nation except France. And this birth-rate of New England is based upon both the foreign and American classes: could the latter be eliminated from the former, it would make the birth-rate of the strictly American even much lower than that of France.

It is well understood that population is steadily decreasing in certain portions of France, and that this decrease is every year extending. This decline in numbers is attracting more and more the thoughtful attention of the French *savants*, and the inquiry is made for the causes and the remedies. It may be found to resemble certain diseases, the causes of which can readily be discovered, but the remedies can not easily be applied.

Foreign Population in New England.—Of all the changes in New England, the introduction of the foreign element is the most important. The facts respecting the history of this immigration and the extent to which it has reached can be obtained, but no human sagacity can fully foresee its results. There are, however, certain features in these changes which should be carefully studied, and the developments or tendencies growing out of them should be better understood. More facts—more knowledge—are needed on this subject. What, then, is the history of this movement? Fifty years ago, the foreign element in New England was very small. In Massachusetts the census reports that in 1830 it was only 9,620, and increased as follows: In 1840 it was 34,818; 1850, 164,448; 1860, 260,114; 1870, 357,319; and 1880, 443,402.

It should be borne in mind that these figures represent only the "foreign-born," and not their children or descendants, which would greatly increase the number. In the other New England States the whole foreign element combined is not so large as that in Massachusetts, and has not increased so fast. In Maine, in 1850, it numbered 31,450, and in 1880 it was 58,883; in New Hampshire in 1850, 13,571, and in 1880, 46,294; in Vermont, 1850, 32,931, and 1880, 40,959; in Rhode Island, 1850, 23,111, and in 1880, 73,993; and in Connecticut, 1850, 37,473, and in 1880, 129,992. The whole number of foreign-born in New England, reported by the census of 1880, was 793,122, and 360,649 of these emigrated from Ireland.

The census reports the whole population of New England, born in the United States, as 3,234,317, but large numbers reported here as *natives* are of foreign descent. It is impossible here to draw the line, but, from the best evidences before us, we should say there must be about half as many in this class as that of the foreign-born, which would increase the foreign element to 1,200,000 in New England. It may be larger. The "Catholic Directory" six years ago stated that there were at that time 890,000 souls in New England connected with that church, and the number must have since considerably increased. Then, of the 793,122 reported by the census "foreign-born," there must be a large number of Protestants—being over 100,000 emigrants from England and Scotland. The same organ also six years ago stated that "nearly 25 per cent of the population of New England is composed of Roman Catholics." The census reports the whole population of New England as 4,027,439 in 1880. At the present time (1883) the foreign element must number over 1,200,000 persons in New England.

But it is quite unequally distributed. In Massachusetts, Connecticut, and Rhode Island, it numbers more than a third of the population; but in Maine, New Hampshire, and Vermont, it is not one quarter. As the birth-rate of this class is more than twice as large as the American, the foreign element will constantly gain in numbers upon the American.

Connected with this large addition to our population composed of a different people in race, type, and character, there are several points that deserve careful consideration. A few years ago it was thought that emigration from Ireland would very much diminish, if not cease, but of late it has taken a new start, and may again flourish. Emigration from England and Scotland is sure to continue; so also from the British Provinces and Canada. But this foreign element is destined to increase hereafter more by births than by immigration.

The marriage-rate is much higher in this class than with the American. It is possible that, in the process of time, changes in the style of living, and by adopting modern fashions, the birth-rate of this class may be somewhat reduced, but certainly not at present.

Religious influences have a powerful hold upon this class of people, so that they will be restrained from violating the laws of the physical system. In process of time, there may be such a change in the organization of this people as to reduce the birth-rate. The "Catholic World" stated six years ago that "nearly 70 per cent of the births in New England were those in Catholic families." This estimate we thought at the time was too large, but with the increase of births since belonging to this class, and the addition of the births of large numbers of the foreign-born and foreign descent who are not Catholic, it will increase this percentage.

In most of the cities more than half of the births for years have been connected with the foreign element, but it was not expected that the same proportion could be found to exist in rural districts and country towns.

It does not seem possible that three fourths of all the births in New England at the present time can be classed under a foreign head, but the indications are pretty certain that such will be the case before many years, and then we shall be compelled to believe the fact. The inquiry is frequently made if the two classes do not intermarry, and what is the prospect in this direction? There are occasional intermarriages between the American, the English, the Scotch, and the emigrants from the Provinces, but not often between the Americans and the Irish. Still, cases of this kind do occur occasionally between the laboring classes, and we think they are increasing. The registration reports divide certain married parties into two classes—the foreign-born father and native mother, and *vice versa*.

The term *native* here might apply to the strictly American, but a careful examination shows that each party called native was of foreign element, so that there was no mixing of the two races. This class of marriages has been constantly increasing. In Massachusetts, according to the registration report of 1881, there were 7,386 births of this class, nearly one eighth of the whole number.

Change in Physical Organization.—The most serious evil resulting from the introduction of this foreign element is in causing a *change in the physical organization of New-Englanders.* In the case of men—that part of farming requiring hard work—those kinds of the mechanical pursuits demanding physical strength, and, in fact, nearly all manual labor out-of-doors, have already passed mainly into the hands of foreign help. This change, commencing thirty or forty years ago, has everywhere been taking place, but more rapidly of late years.

This exchange of regular physical exercise for lighter employment and in-door work is calculated to develop nerve-tissue rather than the muscles, to impair the power of digestion, and reduce the vital forces of the system. That a course of physical degeneracy to some extent has thus been going on with New England men must now, upon thorough examination, be generally admitted.

But a change more marked and serious in its character has been taking place in female organization. Formerly all kinds of house-work and domestic duties were performed by New England women. Before foreign help could be obtained, our young women were generally employed as domestics in families. It was customary for the more wealthy and many families of the middling class, where there were no daughters, to employ one or more domestics.

In many families all the house-work was done by the daughters and mother, without any imported help. It was considered becoming and praiseworthy for all females, of whatever age or family connections, to engage on hire in domestic service.

All such employment was then considered respectable. Skill, fidelity, and success in domestic duties, were the best recommendations that any young woman could possess. Practice and public sentiment in these respects have entirely changed. Very few Yankee girls can now be persuaded at any price to engage in domestic labor. Such service is generally considered by them menial, and every kind of employment or business away from the kitchen and domestic hearth is preferred. In families where there are daughters, the hardest portion of the house-work is now performed by the mother or hired help. What are some of the effects of this change in domestic life? No kind of exercise in the world is so well calculated to develop all parts of the body in the female, and promote good health, as house-work. No study or employment whatever can fit the young girl so well for housekeeping as practical training in such duties.

In this way home and the family are pretty sure to secure a strong attachment. By these means all parts of the body are harmoniously developed; a sound constitution, good health, and long life, are secured. Instead of educating the girl in accordance with the *laws* of *her physical system*, and training her for the great practical duties of the family, from the age of ten to eighteen she is kept at school nearly all the time, so that the brain and nerves are developed at the expense of other organs. This partial and one-sided development of the body is increased and intensified in the female, by being thrown out of her natural sphere in domestic labor and family relation. Hence great multitudes of young women from fifteen to twenty-five have nothing to do, are everywhere seeking employment, and are constantly exposed to an excited or morbid state of feeling.

The ill-health of New England women is proverbial. It is less than half a century since it attracted public attention. A careful examination will show that its history and extent run almost parallel with the high pressure in education and the neglect of house-work. The nerves and the brain have been cultivated at the expense of the muscles and physical stamina.

In this artificial state of society wants multiply and fashion has a powerful influence. A high and extravagant standard of living is set up, and young people are unwilling to commence life as their fathers or grandfathers did before them. For twenty or thirty years there has been a steady decline in the marriage-rate. There are powerful influences, starting partly from internal sources and partly from external agencies, which threaten the permanency and best interests of the family. If the laws of the human system can be so changed or violated as to defeat its primary objects, this institution must suffer and decay. There is a normal and healthy organization of the body as well as of the brain, which favors married life and the family relations.

On the other hand, there is such a thing as an abnormal development of the body and a morbid condition of the nervous system, which is decidedly unfavorable to the domestic relations; especially is this the case with females.

The law of maternity is already violated to such an extent that it is questionable whether half our New England women can properly nurse their offspring. There is a general law in nature that "*supply and demand*" go together and are co-equal, and if one fails the other is endangered. There are also decided evidences that the maternal instinct, "love of offspring," one of the strongest and holiest instincts of our nature, is fading away.

It should be borne in mind that when the harmony or balance of organization in the body is materially changed—that is, certain parts obtain an extreme development, while the functions of others become very much weakened—a similar change and derangement of action apply to the brain. The fact is well established that certain portions of the brain perform distinct and separate functions. Let that portion of the brain whose functions pertain to the family relation, and to domestic life, fail in proper development and healthy action, and supreme attention be given to the culture of the intellect and moral sentiment, and, in process of time, its effects on character will become very manifest. If this change in mental development applied only to an individual here and there, its effects on society would not be so marked or injurious; but, when the great majority of persons are affected by it, the results become far more extensive and serious in their character.

Again: the family constitutes the foundation or groundwork of all society, and, when properly established, is the most powerful agency in the world for human improvement. This institution must have its bases and supplies in the social and domestic affections, guided by the intellect and controlled by the moral sentiments. Without such a foundation it can not be made permanent, happy, and prosperous. The intellectual faculties will never alone cement and perpetuate this institution. Some singular developments on this subject have recently been brought to public notice—that is, in matters connected with the subject of divorce.

Among no other civilized people is there such a breaking up of the family. Why should it occur here, among a people so highly educated and moral? Some attribute it to changes in legislation, but the primary causes of the evil existed before, and will continue, in spite of any changes in legislation. Its outward developments may by this means be checked, but the evil is not cured. The primary causes of these anomalous developments have, we believe, a broad and deep foundation in *physical organization*. We do not see how all the facts connected with this alarming evil can be accounted for in any other way.

There is one consideration connected with this whole subject, of vast importance, which can here only be mentioned—that is, *heredity*. The changes in organization are directly and most intimately connected with hereditary influences. The effects of such changes through the laws of inheritance are so great and far-reaching that they can not be described or measured. Judging from a physiological stand-point, the introduction of this foreign element into New England, instead of proving a blessing, may result in one of the greatest misfortunes that ever befell any race or people.

THE ANARCHY OF MODERN POLITICS.

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

IN the Editor's Table of the April number of this magazine, there appeared what seemed to me some most excellent remarks on "The Hindrances to the Science of Politics." One of the chief of these the writer declared to be the wide-spread skepticism as to the possibility of such a science. "In no country," he added, "was this skepticism so pronounced as in the United States." Members of Congress and of the State Legislatures would all alike agree that the idea of constituting such a science was wholly chimerical. It was also stated, and pretty conclusively shown, that popular forms of government "favor and foster states of mind that exclude all considerations of a scientific nature," by calling into ascendency in a special degree "the incalculable element of personal caprice. . . . In a country where everybody is eligible to office, where the incentives to office-seeking are universal, where politics has become such a natural pastime that the whole scheme of public education is subordinated to it, personal aspirations and the interests of selfish ambition will dominate unrestricted in the management of public affairs." Offices being filled by partisans, whose lives have been largely spent in intrigue and the practice of various vicious arts, "the first presumption in regard to an office-holder is, that he is unfit for the place. . . . These of course are not the men to appreciate the scientific elements and aspects of governmental affairs."

As I read all this, I could not help thinking how closely the writer's diagnosis of the conditions of modern political life resembled that given by Auguste Comte in the first chapter of the fourth volume of his "Philosophie Positive." But as Comte analyzes these conditions in greater detail, and treats the whole subject from the point of view of his own systematic philosophy, it occurred to me that something like a paraphrase of his views might not be unwelcome to the readers of the "Monthly," to whom the subject in its general bearings has been so well opened up in the article from which the above quotations are made.

The main *motif* of the "Positive Philosophy" is the importance, or rather the absolute necessity, if a stable and satisfactory condition of society is ever to be attained, of applying to social and political affairs those scientific principles and methods which have proved their efficacy in the physical domain. The circle of the sciences, he holds, can never be complete until there is a duly constituted science of society. So long as there exists a region, the phenomena of which are not recognized as subject to law, human thought can not assume a really integral character; while, in that outlying region, a more or less hurtful confusion must prevail. Theology has in the past assumed to rule human life, and has done so, according to a synthesis of its own. The feudal and ecclesiastical organization of society in the middle ages was the perfect exemplification of this rule. Now, however, the power of theology has been broken; it has its spokesmen still, who in its name issue mandates to the modern world; but the civilized nations have no mind to return to what would now be a house of bondage—though in its day it may have been, and in Comte's opinion was, a house of shelter. But, meantime, what are the civilized nations doing? What guidance, if any, are they now following? Comte recognizes, looking chiefly at the European nations, three doctrines, or schools, as striving for the mastery in our day—the reactionary, the revolutionary, and the stationary. The first, as its name imports, would fain bring modern society back under the theological *régime*, placing morality and government on a supernatural basis, and using the lures and terrors of another world as a means (supplemented, of course, by the hangman, in whom reactionists always have a fervent and affectionate belief) of repressing disorders in this. On this continent we have, perhaps, no school which openly avows these aims; and yet there are movements visible from time to time which show that Comte could at least find the rudiments of a reactionary party even in this land of liberty and light. Governor Benjamin F. Butler's recent Fast-day proclamation was a singularly impudent attempt to browbeat the Commonwealth of Massachusetts into a more pious observance of the day than that eminent official thought would be likely to be made in the absence of such pressure. The efforts of those who wish to inoculate the constitution with a particularly pure theological virus tend in the same direction, and would make the father of Positivism smile were he alive.

The revolutionary doctrine, according to Comte's nomenclature, is that which proclaims liberty in its widest sense—an unlimited right of free inquiry, and an unlimited freedom for the people of political action. As Comte well points out, this school offers to society no definite guidance whatever—simply proclaims that all principles are to be examined and all experiments tried. That, after a certain amount of examination and experimentation, some set of principles might emerge, which society could accept as final, the revolutionary leaders are careful not to hint, lest they should be suspected of having some such set of principles in their mind, and so being at heart *doctrinaires* and perhaps even partisans of order. No, the revolutionary ideal is the negation of all trammels, change for the sake of change, a constant bubbling of the social caldron, so that no unit may remain long at the top, or long at the bottom, or long anywhere. But society can not live on change; and, in the absence of any definite doctrines of their own, the revolutionary school, when they are at the head of affairs, are compelled to make use of the principles and habitudes they find established, and even to fall back on rags and tatters belonging by right to their reactionary opponents. Thus the free-thinkers who now control the government in France are dogmatically teaching theism in the public schools. They want to give *some* kind of support to ideas of duty; and, having no coherent views of their own on the subject, they adopt, as a temporary make-shift, a theory and a synthesis which some of them would individually reject, and which none of them probably would care to be called on to expound.

The "stationary" school is that which erects into a doctrine a permanent principle of political action—the necessity of balancing reaction against revolution; holding out to society no prospect beyond that of an eternal seesaw of opposite tendencies. Disdaining all Utopias, it yet proposes to itself, as Comte observes, the very wildest of Utopias—that, namely, of securing social well-being by playing off the instinct of order against the instinct of progress. Having no principles of its own, it subsists wholly upon contradictory borrowings from the two antagonist doctrines. While it acknowledges that neither the one nor the other is fit to preside over social and political action, it thinks that, if *both* can be applied at once, all will go well. What has chiefly given vitality to this school, according to Comte, has been the example of England—which, however, has been, he asserts, an eminently misleading one; the stability of the English polity having been due to altogether exceptional circumstances, which are not and can not be reproduced in the numerous countries to which English institutions are sought to be applied. This "essentially loyal *régime*," he further says, is approaching its end even in the country to which it is native; and English authorities, as I may have occasion to show before I close, are not wanting who share the same opinion. The polity to which the future belongs is one that will not set order against progress and progress against order, but that will make equal provision for both, and make each contribute to the other; so that order shall facilitate progress, and progress strengthen order. This is the positivist ideal.

On this continent political parties can not be said to be constituted on the lines here marked out. Owing to the absence of political privilege and the comparative uniformity of social conditions, we do not as yet see any party, of sufficient importance to be taken into account, to which the term revolutionary could be applied. For the same reasons we have no distinctly reactionary party. At the same time, taking a wider view of things, and looking rather at the constitution of *opinion* than at the structure of parties, we shall probably see that the two opposite schools mentioned by Comte are sufficiently well developed, and that the third or "stationary" school comprises a very large section of the entire population. The forces are at work, though, as the politicians say, they may not yet be "in politics." All three concur in creating and continually intensifying the confusion, skepticism, and apathy which are such marked characteristics of the political thought and action of our time. What now remains is to study the results of these general conditions in a little more detail.

By reason of their greater complexity,* and also on account of their closer contact with the whole range of human passions, social questions ought to be reserved more scrupulously than any others for intelligences, necessarily few in number, that by a severe preliminary training have been gradually prepared to work them out to satisfactory results. That this is the normal state of things we have abundant historical evidence to prove; and when, in an epoch of revolution, the situation is changed, we can only regard the case as pathological; though, possibly, as already explained, provisionally inevitable and indispensable. What, then, must have been the ravages of this social malady in a time when all individuals, however inferior their intelligence, however destitute of all suitable preparation, were summoned indiscriminately and by the most energetic modes of appeal to decide day by day, with the most deplorable levity, and without guidance or check of any kind, the most fundamental questions of politics! Instead of being surprised at the alarming divergence of

* From this point onward I shall, for the most part, be giving what at the outset I proposed to give, namely, a paraphrase rather than a translation of what Comte has written on this subject. (See "Philosophie Positive," first edition, vol. iv, p. 118 *et seq.*)

views produced by the universal propagation during the last century of this anarchical tendency, should we not rather experience a gratified wonder at discovering that, thanks to the natural good sense and intellectual moderation of men in general,* the disorder is not more complete, and that, beneath the decomposition of social maxims, certain rallying-points for humanity may still be dimly discerned? The evil has now reached such a point that all political opinions, though traceable to one or other of the sources mentioned, assume an essentially individual character, owing to the infinite number of variations produced by the intermingling of these three vicious principles. Except in cases where men are carried away by their interest in some common object or measure—which, however, each generally plans to turn to his own especial advantage—it becomes more and more impossible to get even a small number of individuals to adhere to anything like an explicit programme, or one in which vague and ambiguous language has not been employed to produce an illusory appearance of a really unattainable harmony of opinion. In the countries in which this intellectual disintegration has been, as it were, consecrated, since the commencement of the revolutionary era in the sixteenth century, by the political preponderance of Protestantism, diversities of thought, without being less intense, have been much more numerous, the popular mind having given itself over, in the absence of any energetic spiritual authority, to the indefinite discussion of religious opinions, which, of course, are at once the vaguest and the most discordant of all. No country has better verified this tendency than the United States of America, where Christianity is represented by some hundreds of sects radically at variance with one another, and daily undergoing further subdivision into shades of opinion which at last become almost purely individual. The countries that were not brought to a stand by the false "Halt!" of Protestantism do not present so great a total of vagaries; and the false opinions which have taken root in them, being more definite in their character, can be more hopefully dealt with.

The inevitable result of such an intellectual epidemic has been the gradual demolition of public morals. Such is the eminently complex character of social questions that, even when deliberate sophistry is absent, either side can be defended by extremely plausible arguments; seeing that there is no institution whatever, no matter how really indispensable to society, that has not many and serious drawbacks; while, on the other hand, the most extravagant Utopia always presents some undeniable advantages. We must not, therefore, be surprised if we see nearly all the great principles of public morality undergoing attack;

* This touch is very characteristic of Comte. He was no flatterer of "the people," and yet in the people he saw a reservoir of all the forces and all the virtues needful for the happiest regulation of the social state. The greatest philosopher, the mightiest leader of men, was in his view simply an organ of society, drawing all his strength and efficiency from the general life of society.

their defects being generally very obvious, while the facts that justify them, though in reality far more decisive, lie sometimes far below the surface, and are only brought to light by a careful and delicate analysis. But to abandon the rules of social action to the blind and arbitrary decision of an incompetent public, is really to destroy their authority. Before, therefore, there can be that convergence of opinion in relation to such matters which is indispensable to social well-being, there must be a voluntary and intentional abdication by the majority of their sovereign right of judgment—an abdication which they would probably be very willing to make if they could only find suitable organs for the exercise of the function. In the wretched routine of our political struggles, it is common to find the most judicious and honorable men accusing one another of folly or of wickedness, on the strength of the vain antagonism of their political principles; while, in every important crisis, the most opposite political principles are habitually defended by partisans of apparently equal respectability. How, then, is it possible that the influence of this double spectacle, essentially incompatible as it is with any deep and permanent conviction, should not destroy all true political morality in the minds of those alike who take part in it or who view it with admiration?

Private morality depends, fortunately, on many other general conditions besides fixity of opinion. Here, in ordinary cases, a true natural sentiment speaks much more powerfully than it does in regard to public relations. The disorganizing forces have, moreover, been counterbalanced to a great extent; partly by a progressive softening of manners, the result of more general intellectual culture, bringing in its train a greater familiarity with and a juster appreciation of the fine arts, and partly by the unceasing development of industry. It must be added that the rules of domestic or personal morality, as they depend on simpler conditions, and admit of easier demonstration, are naturally less endangered by the incursions of individual analysis. And yet the time has undoubtedly come when, in the private as well as in the public sphere, we are called upon to witness the lamentable results of the general unsettlement of opinion. Whether we consider the relations of the sexes, or of different ages and conditions, we shall find that the necessary elements of all satisfactory social life are directly compromised, and are daily becoming more so, by the action of a corrosive discussion, dominated by no real principles, which delivers up to hopeless uncertainty every idea of duty. The family, which the fiercest blasts of the revolutionary tempest in the last century had left untouched, is, in our day, radically assailed in its two essential foundations, marriage and inheritance. We have seen even the most general and obvious principle of individual morality, the subordination of the passions to the reason, flatly contradicted by certain would-be reformers, who, without stopping to consider the teachings of universal experience, rationally sanctioned as they are by the scientific study of human nature, have tried to establish, as the fundamental doctrine of their improved morality, the systematic domination of the passions!

As a necessary and direct result of such disorder in the intellectual region, we see corruption erected into a recognized and indispensable means of carrying on government. So powerless have general ideas become, into such discredit have they fallen, that they no longer avail to prompt any course of action; and governments find themselves, therefore, without any other resource for securing such union of individuals as is necessary to the maintenance of a rude material order, than an almost open appeal to purely personal interests. But, were men animated by profound convictions, such a means of influence would never have to be resorted to. Even in characters of the least elevation, human nature seldom debases itself so far as to follow out a line of conduct in direct opposition to any set of convictions. We see this proved in the case of men of science: in politics, where the reign of law is not yet established, they frequently exhibit the most shameful tergiversation; while they stand firm against all temptation to abandon their anti-theological opinions for which they believe they have a scientific warrant. We thus see that the prevalent intellectual confusion not only allows the development of political corruption, but absolutely renders it necessary as a means of government, which of course can not be carried on unless a certain number of individuals can be brought to act in harmony. This fact, however, does not excuse the governments of our time for showing such a preference as they do for this particular means of influence; nor for using it, as they do, almost exclusively in their own personal interests. Bad as the *instrument* is, it might be used to better *ends* than is commonly the case, if the "practical politicians," instead of casting scorn on all attempts to establish a science of politics, were to lend such aid as they could to its elaboration. They could lend some aid by a mere change of attitude.

The political corruption of our day is not confined, however, to the direct offer by governments of material inducements for political support. We see a form of it in the awarding of distinctions and titles; and, taking a wider view, we see that all our institutions work together to call into activity the selfish ambition of all the more energetic members of the community. In this most important respect, the existing condition of society itself may be said to be eminently corrupting. At the same time that the prevalent intellectual anarchy has dissolved any public prejudices that stood in the way of unlimited individual self-assertion, the inevitable decomposition of the ancient social classification has likewise thrown down the barriers to private ambition, which is now, in the name of progress, invited to take the very highest flights. Carried along by an irresistible current, governments have had to try and meet the new demands of the time by an extravagant multiplication of public offices, by making access to these as easy as possible, and by changing the incumbents as often as possible. Yielding in the first place to an evil necessity, they have afterward converted that necessity into a general resource of government, by trusting, as a regular thing, to the interested support of energetic and ambitious men with whom they divide the profits arising from the management of the public business. How dangerous such an expedient is from the point of view of the governments themselves, it is almost needless to point out ; since it must necessarily call forth far more claims than it can satisfy, and consequently excite against the established *régime* passions far stronger than any it can evoke for its support.* If we just look at the selections for a generation or two past for the most eminent political functions, is there any reason why the great majority of our aspiring men should not conceive the hope of climbing in their turn to similar positions? Another marked feature of the times is the disposition to trust to material agencies or mere acts of legislation for the removal of evils that have their root in men's ideas and in social customs. An amendment to a constitution or a charter is proffered as a plan of political salvation ; or, worse still, we are asked to rest our hopes on the substitution of this man for that in a cabinet. Meanwhile, the absence of any clear or comprehensive conception of the social future affords a career only to the most vulgar kind of ambition. At no former epoch, probably, were such chances ever offered to a presuming and adventurous mediocrity. The quality chiefly required in public life is fluency of speech ; above all, a fluency which suffers no abatement if it is suddenly called on to change sides on a question. In a time of weak and wavering convictions there has naturally been a demand for representatives characterized by the vagueness of their intellectual habits and an habitual lack of fixed opinions. Unless we could hope that such a condition of things would be but transitory, it would really constitute the most shameful social degradation. That hope we may, however, entertain. If there are forces of decomposition at work, there are also—though their action may not be so conspicuous—forces of regeneration ; and what is needed to give these a decisive victory is the formulation and application of a true political philosophy.

Such was the view taken by Comte, over forty years ago, of the then political situation in France and other countries enjoying constitutional *régimes.* Matters have not mended since his day : principles are more than ever discredited in political affairs ; parties no longer even profess them ; and government and legislation are carried on at mere hap-hazard. The great object with party managers is to get all important questions taken "out of politics," so that there may be

* How exactly this applies to the existing situation in France, and how nearly it describes the situation here, no reader will fail to remark.

nothing to embarrass the scramble for offices. The New York "Sun" lately reminded the Democrats that their business was "to elect a President," not to reform the tariff. Seek first, it says, to "elect a President," and all good things will be added unto you; but grapple with a great question like the tariff, and your opponents will surely get the better of you. Another leading organ observes that, now that the offices are no longer generally available, owing to the passage of the Pendleton civil-service bill, for the reward of political services, there remains nothing for a victorious party but "a damned barren ideality." The strength of the language, which we reproduce with absolute faithfulness, may be taken as a gauge of the disgust which the average politician feels when he sees nothing before him but a chance of doing his duty, without any special reward therefor. The novel, "Democracy," about which so much has been said, does not overstate the case in the least. When Mrs. Lee, in that lively story, tells the senator, who pays her the compliment of consulting as to the best course to take in a certain complication, to do "what is most for the public good," her counsel falls utterly pointless and abortive, simply because "the public good" had nothing whatever to do with the matter in hand. The senator himself could not pretend to tell her at what point the two things came into any kind of relation with each other. The questions involved were questions purely of self-interest, and, whatever course was taken, the country had nothing to gain.

If we turn to England, signs are not wanting that there too the absence of political principles is leading up to a crisis. "The notion," said the London "Times" recently, "that any particular set of men are in possession of principles especially calculated to promote the national well-being, or that any particular trick of government could add appreciably to the sum of happiness, is one which nowadays finds remarkably few advocates. Moreover, there is a pretty general feeling that it is very little use to rely upon principles of any kind. . . . At the present time we are not proceeding upon any principle known to either political party; and it is that fact which explains the hollowness of all political discussion, and the marked incredulity of the intelligent public toward all political professions. The fact is, that our political principles are worn out, and that the conflict which raged around them while they were vital is being mechanically carried on by men whose business it is to fight about something." When remarks like these can be made by the "leading journal," it would certainly seem as if Comte was not far wrong in his prediction that the English system would before long reveal its essential weakness. The question then arises, Can government be permanently carried on under these conditions? As Comte has remarked, the absence of principle in public life reacts upon private life; and certainly, in the latter sphere, the disorder we now witness is not what might have been expected in an age of such general enlightenment. It would seem as if, before long, those who now profess to take things as they come, and make light of all attempts to construct a philosophy applicable to human affairs, might be compelled to humble themselves to believe that Science may have a word to say in regard to the highest order of phenomena just as she has had in regard to all orders up to the highest. If the pride of individualism should ever have such a fall as this, there is no doubt, in the mind of the present writer, that Science will respond nobly to the new call upon her, and will show how order and progress can be reconciled, and a moving equilibrium be established which shall be the proper manifestation and expression of a normal and healthy social life.

RANK AND TITLE.

By F. D. Y. CARPENTER.

THERE is a lamentable want of method in the titular nomenclature of our public service. A first-class clerk on the civil list is a novice, receiving twelve hundred dollars a year; he becomes a fourth-class clerk, at eighteen hundred a year, only after three promotions. A lieutenant in the army is far beneath the major, but a lieutenant-general is above the major-general. Nor do the grades of lieutenant and captain in the army by any means correspond in importance with similar titles in the navy. Who can tell which is the higher officer of the navy, the chief-engineer or the engineer-in-chief? Or to whom shall we give precedence, the "chief clerk" of the Senate or the "principal clerk" of that body? The titles of the "door-keepers" of Congress convey but a faint idea of the importance and multiplicity of their duties.

During the last session of Congress an unsuccessful attempt was made to do away with the inferior titles of assistant surgeon and passed-assistant surgeon in the navy, and, in plain English, to call a surgeon a surgeon, as we call a spade a spade. The medical service of the army descends not only to the assistant surgeon, but also to the lower estate of acting assistant surgeon. But the latter official is a surgeon in every sense of the word. He has won the title by years of study and practice. His diploma gives him the right to it, and his professional experience has confirmed him in the possession of it. As such he is qualified to saw a leg off, or treat a fever; and when the Government degrades him with the title of acting assistant surgeon, which might be more properly applied to the boy who temporarily whets the knives and mixes the powders, it robs him of his reputation.

> "But he that filches from me my good name,
> Robs me of that which not enriches him,
> And makes me poor indeed."

The War Department is especially ungenerous in its designation of the civilians who are engaged upon its engineering work. Perhaps in order to keep this numerous class in the background, as far from the public appreciation as possible, and thus to increase the prominence of the engineer officers, it is ordained that, with one or two exceptions, no civilian shall be known other than as an assistant in some shape or other. Upon the geographical surveys, the topographers have been classified as topographical assistants, and the meteorologists under the cumbersome head of meteorological assistants. Since the topographers, or, more properly, geographers, conducted the triangulation, planned the surveys, and made the maps, it is difficult to see to whom they rendered assistance. Certainly not, in general, to the army officers, whose names appear conspicuously upon the maps as "executive officers and field astronomers." Though a Humboldt, or a Petermann, or a Guyot, should tender his services to the War Department as a maker of maps, he would probably be doomed to go down to posterity as a "topographical assistant." As such the public would picture him, if it thought of him at all, as sharpening the pencils and carrying the note-books of his superior officer! To the scanty recognition of civil co-operation, and to the consequent half-hearted interest and support of the civilians, is largely due the discontinuance of the surveys in question. The prestige of the Engineer Corps, upheld by the good work of the civil engineers, would have carried them through any crisis, if the latter class had seriously cared to continue the partnership longer, and if the scientific world had approved of so unequal a distribution of rewards as prevailed there.

When a man is appointed a civil engineer in the navy—there are a few of that profession employed at the several navy-yards throughout the country—he is entered upon the register under that name, he wears the imprint of his title upon his uniform, and, among his friends or in the witness-box, he has no difficulty in explaining his occupation. But in the army, or, rather, under the army, since he is not recognized as a component part of the organization, the position of the civil engineer is an exceedingly irregular one. There are several hundred civil engineers employed by the War Department upon the extensive river and harbor improvements constantly in progress. These are classed indiscriminately as assistant engineers, although they may have practical direction of the works upon which they are engaged. Sometimes their official mail comes to them addressed "U. S. Assistant Engineer," sometimes "Assistant U. S. Engineer," thus revealing a doubt or a carelessness even at headquarters concerning their appellation. As the officers of the army, by whom these things are regulated, are the greatest of sticklers in regard to their own rank, and there is no breach of military etiquette more serious than the mutilation of a title or the omission of a brevet, we would naturally expect from them greater consideration in their intercourse with civilians; and, if a man is a civil engineer by virtue of diploma and experience, he should be allowed the simple justice of remaining such. But, if one of these anomalous beings should presume to sign himself "U. S. Civil Engineer," which is his natural and most graphic description, he is guilty of a technical falsehood, as the War Department, by recognizing such a grade as that, and then leaving it practically empty, there being but two United States civil engineers on the rolls, has debarred from its use the many other civil engineers who are equally entitled to that distinction.

There are engineers and engineers—civil, mechanical, sanitary, geographical, hydraulic, steam, locomotive, fire-department, and dozens more. For a man to say that he is an engineer conveys but a vague idea of his business. To say that he is an assistant engineer adds humiliation to vagueness. To continue, that he is an assistant United States engineer, working under the Engineer Corps of the army, would probably place him, in the popular comprehension, as an assistant to one of the soldiers of the engineer battalion. At any rate, it is not a distinction in which the American civil engineer can take great pride. To show its worthlessness for purposes of classification and description, which is the principal use of titles, we have but to say that in the pay-rolls of the Engineer Department, as published in the "United States Official Register," we find "Engineer, $60 per month," and "Assistant Engineer, $250 per month"; the former, we infer, being a steam-engineer, and the latter, it is to be presumed, a civil engineer. The civil engineers of America are not a haughty class, but still they do not wish to pass into official history in such a shape as that.

Words are principally useful for the conveyance of ideas, and when they convey no idea, or, at best, an erroneous one, they fail of their mission. A man's title is in some sense the measure of the respect which the world gives him, and justice to himself and a due regard for the world's convenience demand that it should be expressed in words that will plainly describe his occupation. In private life this is so, and when a man is called an oculist, a photographer, or a grocer, we immediately know his place and importance as a member of society. When a barber dubs himself a "tonsorial artist," and when the Government, with its red tape, assembles lawyer, physician, and statistician under the *omnium gatherum* title of "clerk," it is an offense against good English language. Since the true worker is always an enthusiast in his profession, and resents being classified under any other head, it is equally an injury to himself. How, for instance, can the lawyer of the Interior Department or the financier of the Treasury go home to his friends and describe himself as a fourth-class clerk without feeling the blush of shame upon his brow?

It was left to the Coast Survey to invent the ingeniously menial designation of "acting sub-assistant," and it is difficult to see how any man, loaded down with the ignominy of such a name, could ever do good work or rise to better things. Whatever may be the duties of any participant in the excellent work of that organization, he can not, in good English, be less than an assistant, and yet only officers of the highest attainable grade are entitled to the latter distinction. Still below the assistants and sub-assistants come the aids, young officers whose inferiority of position is mollified by the possession of a title synonymous in meaning with that of their superiors, and therefore equally respectable in the popular comprehension. Such is the poverty of this nomenclature that it carries with it only the general idea of subordination. Surely it would not be impossible to devise some system of titles which would at the same time convey some hint of the duties and the relative rank of the scientists of that body.

ON RADIATION.*

By JOHN TYNDALL, F.R.S.

SCIENTIFIC discoveries are not distributed uniformly in time. They appear rather in periodic groups. Thus, in the first two years of this century, among other gifts presented by men of science to the world, we have the voltaic pile; the principle of Interference, which is the basis of the undulatory theory of light; and the discovery by William Herschel of the dark rays of the sun.

Directly or indirectly, this latter discovery heralded a period of active research on the subject of radiation. Leslie's celebrated work, "On the Nature of Heat," was published in 1804, but he informs us, in the preface, that the leading facts which gave rise to the publication presented themselves in the spring of 1801. An interesting but not uncommon psychological experience is glanced at in this preface. The inconvenience of what we call ecstasy, or exaltation, is that it is usually attended by undesirable compensations. Its action resembles that of a tidal river, sometimes advancing and filling the shores of life, but afterward retreating and leaving unlovely banks behind. Leslie, when he began his work, describes himself as "transported at the prospect of a new world emerging to view." But further on the note changes, and before the preface ends he warns the reader that he may expect variety of tone, and perhaps defect of unity, in his disquisition. The execution of the work, he says, proceeded with extreme tardiness; and, as the charm of novelty wore off, he began to look upon his production with a coolness not usual in authors.

The ebb of the tide, however, was but transient; and to Leslie's ardor, industry, and experimental skill, we are indebted for a large body of knowledge in regard to the phenomena of radiation. In the prosecution of his researches he had to rely upon himself. He devised

* A "Friday Evening Discourse," recently delivered in the Royal Institution.

his own apparatus, and applied it in his own way. To produce radiating surfaces, he employed metallic cubes, which to the present hour are known as Leslie's cubes. The different faces of these cubes he coated with different substances, and, filling the cubes with boiling water, he determined the emissive powers of the substances thus heated. These he found to differ greatly from each other. Thus, the radiation from a coating of lamp-black being called 100, that from the uncoated metallic surface of his cube was only 12. He pointed out the reciprocity existing between radiation and absorption, proving that those substances which emit heat copiously absorb it greedily. His thermoscopic instrument was the well-known differential-thermometer invented by himself. In experiment Leslie was very strong, but in theory he was not so strong. His notions as to the nature of the agent whose phenomena he investigated with so much ability are confused and incorrect. Indeed, he could hardly have formed any clear notion of the physical meaning of radiation before the undulatory theory of light, which was then on its trial, had been established.

A figure still more remarkable than Leslie occupied the scientific stage at the same time—namely, the vigorous, penetrating, and practical Benjamin Thompson, better known as Count Rumford, the originator of the Royal Institution. Rumford traversed a great portion of the ground occupied by Leslie, and obtained many of his results. As regards priority of publication, he was obviously discontented with the course which things had taken, and he endeavored to place both himself and Leslie in what he supposed to be their right relation to the subject of radiant heat. The two investigators were unknown to each other personally, and their differences hardly rose to scientific strife. There can hardly, I think, be a doubt that each of them worked independently of the other, and that, where their labors overlap, the honor of discovery belongs equally to both.

The results of Leslie and Rumford were obtained in the laboratory; but the walls of a laboratory do not constitute the boundary of its results. Nature's hand specimens are always fair samples, and, if the experiments of the laboratory be only true, they will be ratified throughout the universe. The results of Leslie and Rumford were in due time carried from the cabinet of the experimenter to the open sky, by Dr. Wells, a practicing London physician. And here let it be gratefully acknowledged that vast services to physics have been rendered by physicians. The penetration of Wells is signalized among other things by the fact recorded by the late Mr. Darwin, that, forty-five years before the publication of the "Origin of Species," the London doctor had distinctly recognized the principle of Natural Selection, and that he was the first who recognized it. But Wells is principally known to us through his "Theory of Dew," which, prompted by the experiments of Leslie and Rumford, and worked out by the most refined and conclusive observations on the part of Wells himself, first revealed the cause of this beautiful phenomenon. Wells knew that through the body of our atmosphere invisible aqueous vapor is everywhere diffused. He proved that grasses and other bodies on which dew was deposited were powerful emitters of radiant heat; that, when nothing existed in the air to stop their radiation, they became self-chilled; and that while thus chilled they condensed into dew the aqueous vapor of the air around them. I do not suppose that any theory of importance ever escaped the ordeal of assault on its first enunciation. The theory of Wells was thus assailed; but it has proved immovable, and will doubtless continue so to the end of time.

The interaction of scientific workers causes the growth of science to resemble that of an organism. From Faraday's tiny magneto-electric spark, shown in this theatre half a century ago, has sprung the enormous practical development of electricity at the present time. Thomas Seebeck in 1822 discovered thermo-electricity, and eight years subsequently bars of bismuth and antimony were first soldered together by Nobili so as to form a thermo-electric pile. In the self-same year Melloni perfected the instrument and proved its applicability to the investigation of radiant heat. The instrumental appliances of science have been well described as extensions of the senses of man. Thus the invention of the thermopile vastly augmented our powers over the phenomena of radiation. Melloni added immensely to our knowledge of the transmission of radiant heat through liquids and solids. His results appeared at first so novel and unexpected that they excited skepticism. He waited long in vain for a favorable report from the Academicians of Paris; and finally, in despair of obtaining it, he published his results in the "Annales de Chimie." Here they came to the knowledge of Faraday, who, struck by their originality, brought them under the notice of the Royal Society, and obtained for Melloni the Rumford medal. The medal was accompanied by a sum of money from the Rumford fund; and this, at the time, was of the utmost importance to the young political exile, reduced as he was to penury in Paris. From that time until his death, Melloni was ranked as the foremost investigator in the domain of radiant heat.

As regards the philosophy of the thermopile, and its relation to the great doctrine of the conservation of energy, now everywhere accepted, a step of singular significance was taken by Peltier in 1834. Up to that time it had been taken for granted that the action of an electric current upon a conductor through which it passed was always to generate heat. Peltier, however, proved that, under certain circumstances, the electric current generated cold. He soldered together a bar of antimony and a bar of bismuth, end to end, thus forming of the two metals one continuous bar. Sending a current through this bar, he found that when it passed from antimony to bismuth across the junction, heat was always there developed, whereas, when the direction of the current was from bismuth to antimony, there was a development of cold. By placing a drop of chilled water upon the junction of the two metals, Lenz subsequently congealed the water to ice by the passage of the current.

The source of power in the thermopile is here revealed, and a relation of the utmost importance is established between heat and electricity. Heat is shown to be the nutriment of the electric current. When one face of a thermopile is warmed, the current produced, which is always from bismuth to antimony, is simply heat consumed and transmuted into electricity.

Long before the death of Melloni, what the Germans call "Die Identitäts-Frage," that is to say, the question of the identity of light and radiant heat, agitated men's minds and spurred their inquiries. In the world of science men differ from each other in wisdom and penetration, and a new theoretic truth has always at first the minority on its side. But time, holding incessantly up to the gaze of inquirers the unalterable pattern of Nature, gradually stamps that pattern on the human mind. For twenty years Henry Brougham was able to quench the light of Thomas Young, and to retard, in like proportion, the diffusion of correct notions regarding the nature and propagation of radiant heat. But such opposing forces are, in the end, driven in, and the undulatory theory of light being once established, soon made room for the undulatory theory of radiant heat. It was shown by degrees that every purely physical effect manifested by light was equally manifested by the invisible form of radiation. Reflection, refraction, double refraction, polarization, magnetization, were all proved true of radiant heat, just as certainly as they had been proved true of light. It was at length clearly realized that radiant heat, like light, was propagated in waves through that wondrous luminiferous medium which fills all space, the only real difference between them being a difference in the length and frequency of the ethereal waves. Light, as a sensation, was seen to be produced by a particular kind of radiant heat, which possessed the power of exciting the retina.

And now we approach a deeper and more subtile portion of our subject. What, we have to ask, is the origin of the ether-waves, some of which constitute light, and all of which constitute radiant heat? The answer to this question is that the waves have their origin in the vibrations of the ultimate particles of bodies. But we must be more strict in our definition of ultimate particles. The ultimate particle of water, for example, is a *molecule.* If you go beyond this molecule and decompose it, the result is no longer water, but the discrete *atoms* of oxygen and hydrogen. The molecule of water consists of three such atoms held tightly together, but still capable of individual vibration. The question now arises, Is it the molecules vibrating as wholes, or the shivering atoms of the molecules, that are to be considered as the real sources of the ether-waves? As long as we were confined to the experiments of Leslie, Rumford, and Melloni, it was difficult to answer this question. But, when it was discovered that gases and vapors possessed—in some cases to an astonishing extent—the power both of absorbing and radiating heat, a new light was thrown upon the question.

You know that the theory of gases and vapors, now generally accepted, is that they consist of molecular or atomic projectiles darting to and fro, clashing and recoiling—endowed, in short, with a motion not of vibration, but of translation. When two molecules clash, or when a single molecule strikes against its boundary, the first effect is to deform the molecule, by moving its atoms out of their places. But gifted as they are with enormous resiliency, the atoms immediately recover their positions, and continue to quiver in consequence of the shock. Held tightly by the force of affinity, they resemble a string stretched to almost infinite tension, and therefore capable of generating tremors of almost infinite rapidity. What we call the heat of a gas is made up of these two motions—the flight of the molecules through space, and the quivering of their constituent atoms. Thus does the eye of Science pierce to what Newton called "the more secret and noble works of Nature," and make us at home amid the mysteries of a world lying in all probability vastly farther beyond the range of the microscope than the power of the microscope, at its maximum, lies beyond that of the unaided eye.

The great principle of radiation, which affirms that all bodies absorb the same rays that they emit, is now a familiar one. When, for example, a beam of white light is sent through a yellow sodium-flame, produced by a copious supply of sodium-vapor, the yellow constituent of the white beam is stopped by the yellow flame, and, if the beam be subsequently analyzed by a prism, a black band is found in the place of the intercepted yellow band of the spectrum. We have been led to our present theoretic knowledge of light by a close study of the phenomena of sound, which in the present instance will help us to a conception of the action of the sodium-flame. The atoms of sodium-vapor synchronize in their vibrations with the particular waves of ether which produce the sensation of yellow light. The vapor, therefore, can take up or absorb the motion of those waves, as a stretched piano-string takes up or absorbs the pulses of a voice pitched to the note of the string. This action of sodium-vapor may be shown by an experiment which startled and perplexed me on first making it, more than twenty years ago. The spectra of incandescent metallic vapors are, as you know, not continuous, but formed of brilliant bands. Wishing, in 1861, to obtain the brilliant yellow band produced by incandescent sodium-vapor, I placed a bit of sodium in a carbon crucible, and volatilized it by a powerful voltaic current. A feeble spectrum overspread the screen, from which it was thought the sodium band would stand out with dominant brilliancy. To my surprise, at the very point where I expected this brilliant band to appear, a band of darkness took its place. By humoring the voltaic arc a little, the darkness vanished, and the bright band which I had sought at the beginning was obtained. On reflection the cause was manifest. The first ignition of the sodium was accompanied by the development of a large amount of sodium-vapor, which spread outward and surrounded, as a cool envelope, the core of intensely heated vapor inside. By the cool vapor the rays from the hot were intercepted, but on lengthening the arc the outer vapor in great part was dispersed, and the rays passed to the screen. This relation as to temperature was necessary to the production of the black band, for, were the outside vapor as hot as the inside, it would, by its own radiation, make good the light absorbed.

An extremely beautiful experiment of this kind was lately made here by Professor Liveing, with rays which, under ordinary circumstances, are entirely invisible. Professor Dewar and Professor Liveing have been long working with conspicuous success at the ultra-violet spectrum. Using prisms and lenses of a certain kind, and a powerful dynamo-machine to volatilize our metals, like Professor Liveing, I cast a spectrum upon the screen. Far beyond this terminal violet, waves impinge upon the screen which have no sensible effect upon the organ of vision; they constitute what we call the ultra-violet spectrum. Professor Stokes has taught us how to render this invisible spectrum visible, and it is by a skillful application of Stokes's discovery that Liveing and Dewar bring the hidden spectrum out with wondrous strength and beauty.

A small second screen is at hand, which can be moved into the ultra-violet region. Felt by the fingers, the surface of this screen resembles sand-paper, being covered with powdered uranium glass, a highly fluorescent body. Pushing the movable screen toward the visible spectrum, at a distance of three or four feet beyond the violet, where only darkness existed before, light begins to appear. On pushing in the screen, the whole ultra-violet spectrum falls upon it, and is rendered visible from beginning to end. The spectrum is not continuous, but composed for the most part of luminous bands derived from the white-hot crucible in which the metals are to be converted into vapor. I beg of you to direct your attention to one of these bands in particular. Here it is, of fair luminous intensity. My object now is to show you, with Professor Dewar's aid, the reversal, as it is called, of that band, which belongs to the vapor of magnesium, exactly as a moment ago you were shown the reversal of the sodium band. An assistant will throw a bit of magnesium into the crucible, and you are to observe what first takes place. The action is rapid, so that you will have to fix your eyes upon this particular strip of light. On throwing in the magnesium, the luminous band belonging to its vapor is cut away, and you have, for a second or so, a dark band in its place.

I repeat the experiment three or four times in succession, with the same unfailing result. Here, as in the case of the sodium, the magnesium surrounded itself for a moment by a cool envelope of its own vapor, which cut off the radiation from within, and thus produced the darkness.

And now let us pass on to an apparently different, but to a really similar result. Here is a feebly luminous flame, which you know to be that of hydrogen, the product of combustion being water-vapor. Here is another flame of a rich blue color, which the chemists present know to be the flame of carbonic oxide, the product of combustion being carbonic acid. Let the hydrogen-flame radiate through a column of ordinary carbonic acid—the gas proves highly transparent to the radiation. Send the rays from the carbonic-oxide flame through the same column of carbonic acid—the gas proves powerfully opaque. Why is this? Simply because the radiant, in the case of the carbonic-oxide flame, is hot carbonic acid, the rays from which are quenched by the cold carbonic-acid gas, exactly as the rays from the intensely heated sodium-vapor were quenched a moment ago by the cooler envelope which surrounded it. Bear in mind the case is always one of synchronism. It is because the atoms of the cold acid vibrate with the same frequency as the atoms of the hot that the pulses sent forth from the latter are absorbed.

Newton, though probably not with our present precision, had formed a conception similar to that of molecules and their constituent atoms. The former he called corpuscles, which, as Sir John Herschel says, he regarded "as divisible groups of atoms of yet more delicate kind." The molecules he thought might be seen if microscopes could be caused to magnify three or four thousand times. But, with regard to the atoms, he made the remark already alluded to: "It seems impossible to see the more secret and nobler works of Nature within the corpuscles, by reason of their transparency."

I have now to ask your attention to an illustration intended to show how radiant heat may be made to play to the mind's eye the part of the microscope, in revealing to us something of the more secret and noble works of atomic Nature. Chemists are ever on the alert to notice analogies and resemblances in the atomic structures of different bodies. They long ago pointed out that a resemblance exists between that evil-smelling liquid, bisulphide of carbon, and carbonic acid. In the latter substance we have one atom of carbon united to two of oxygen, while in the former we have one atom of carbon united to two of sulphur. Attempts have been made to push the analogy still further by the discovery of a compound of carbon and sulphur which should be analogous to carbonic oxide, where the proportions, instead of one to two, are one to one, but hitherto, I believe, without success. Let us now see whether a little physical light can not reveal an analogy between carbonic acid and bisulphide of carbon more occult than any hitherto pointed out. For all ordinary sources of radiant heat the bisulphide, both in the liquid and vaporous form, is the most transparent, or diathermanous, of bodies. It transmits, for example, ninety per cent of the radiation from our hydrogen-flame, ten per cent only being absorbed. But when we make the carbonic-oxide flame our source of rays, the bisulphide shows itself to be a body of extreme opacity. The transmissive power falls from ninety to about twenty-five per cent, seventy-five per cent of the radiation being absorbed. To the radiation from the carbonic-oxide flame the bisulphide behaves like the carbonic acid. In other words, the group of atoms constituting the molecule of the bisulphide vibrate in the same periods as those of the atoms which constitute the molecule of the carbonic acid. And thus we have established a new, subtile, but most certain resemblance between these two substances. The time may come when chemists will make more use than they have hitherto done of radiant heat as an explorer of molecular condition.

The conception of these quivering atoms is a theoretic conception, but it is one which gives us a powerful grasp of the facts, and enables us to realize mentally the mechanism on which radiation and absorption depend. We will now turn to a more practical view of the subject. It is pretty well known that for a long series of years I conducted an amicable controversy with one of the most eminent experimenters of our time, as regards the action of the earth's atmosphere on solar and terrestrial radiation. My contention was that the great body of our atmosphere—its oxygen and nitrogen—had but little effect upon either the rays of the sun coming to us, or the rays of the earth darting away from us into space ; but that mixed with the body of our air there was an attenuated and apparently trivial constituent which exercised a most momentous influence. That body, as many of you know, is aqueous vapor, the amount of which does not exceed one per cent of the whole atmosphere. Minute, however, as its quantity is, the life of our planet depends upon this vapor. Without it, in the first place, the clouds could drop no fatness. In this sense the necessity for its presence is obvious to all. But it acts in another sense as a preserver. Without it as a covering, the earth would soon be reduced to the frigidity of death. Observers were, and are, slow to take in this fact, which nevertheless is a fact, however improbable it may at first sight appear. The action of aqueous vapor upon radiant heat has been established by irrefragable experiments in the laboratory ; and these experiments, though not unopposed, have been substantiated by some of the most accomplished meteorologists of our day.

I wished much to instruct myself a little by actual observation on this subject, under the open sky, and my first object was, to catch, if possible, states of the weather which would enable me to bring my views to a practical test. About a year ago, a little iron hut, embracing a single room, was erected for my benefit upon the wild moorland of Hind Head. From the plateau on which the hut stands there is a free outlook in all directions. Here, amid the heather, I had two stout poles fixed firmly in the ground eight feet asunder, and a stout cord stretched from one to the other. From the center of this cord a thermometer is suspended with its bulb four feet above the ground. On the ground is placed a pad of cotton-wool, and on this cotton-wool a second thermometer, the object of the arrangement being to determine the difference of temperature between the two thermometers, which are only four feet vertically apart.

Permit me at the outset to deal with the subject in a perfectly elementary way. In comparison with the cold of space, the earth must be regarded as a hot body, sending its rays, should nothing intercept them, across the atmosphere into space. The cotton-wool is chosen because it is a powerful, though not the most powerful, radiator. It pours its heat freely into the atmosphere, and by reason of its flocculence, which renders it a non-conductor, it is unable to derive from the earth heat which might atone for its loss. Imagine the cotton-wool thus self-chilled. The air in immediate contact with it shares its chill, and the thermometer lying upon it partakes of the refrigeration. In calm weather the chilled air, because of its greater density, remains close to the earth's surface, and in this way we sometimes obtain upon that surface a temperature considerably lower than that of the air a few feet above it. The experiments of Wilson, Six, and Wells have made us familiar with this result. On the other hand, the earth's surface during the day receives from the sun more heat than it loses by its own radiation, so that, when the sun is active, the temperature of the surface exceeds that of the air.

These points will be best illustrated by describing the course of temperature for a day, beginning at sunrise and ending at 10.20 P. M. on the 4th of last March. The observations are recorded in the annexed table, at the head of which are named the place of observation, its elevation above the sea, and the state of the weather. The first column in the table contains the times at which the two thermometers were read. The column under "Air" gives the temperatures of the air, the column under "Wool" gives the temperatures of the wool, while the fourth column gives the differences between the two temperatures. It is seen at a glance that, from sunrise to 9.20 A. M., the cotton-wool is colder than the air; at 9.30 the temperatures are alike. This is the hour of "intersection," which is immediately followed by "inversion." Throughout the day, and up to 4 P. M., the wool is warmer than the air. At 4.5 P. M. the temperatures are again alike; while from that point downward the loss by terrestrial radiation is in excess of the gain derived from all other sources, the refrigeration reaching a maximum at 7.30 P. M., when the difference between the two thermometers amounted to 10° Fahr. When the observations are continued throughout the night, the greater cold of the surface is found to be maintained until sunrise, and for some hours beyond it. Had the air been perfectly still during the observations, the nocturnal chilling of the surface would have been in this case greater: for you can readily understand that even a light wind sweeping over the surface, and mixing the chilled with the warmer air, must seriously interfere with its refrigeration.

Hind Head, elevation 850 feet; sky cloudless; hoar-frost; wind light, from northeast. Course of temperature, March 4, 1883.

TIME.	Air.	Wool.	Difference.
	Degrees.	Degrees.	Degrees.
6.50 A. M. (sunrise)	31	25	6
7.20	32½	24½	8
7.40	34	25	9
8.5	35	27	8
8.20	35	30	5
9.15	40	38	2
9.20	41	40	1
9.30 (intersection)	41	41	0
9.40 (inversion)	41	42	1
10.15	42½	45	2½
11.	45	52	7
11.30	47	55	8
12 noon	50	58	8
12.30 P. M.	50	59½	9½
1.	50	57½	7½
2.	49	60	1
2.30	48	58	10
3.	49	56	17
3.30	48	52	4
4.	47	48	1
4.5 (intersection)	47	47	0
4.10 (inversion)	47	45	2
4.15	47	43	4
4.30	46	41	5
7.	35	26	9
7.30	35	25	10
8.30	34	24½	9
9.40	33	24½	8½
10.20	32	24	8

Glacial wind from northeast. Stars very bright.

Various circumstances may contribute to lessen, or even abolish, the difference between the two thermometers. Haze, fog, cloud, rain, snow, are all known to be influential. These are visible impediments to the outflow of heat from the earth; but we have now to deal with the powerful obstacle to that outflow to which reference has been already made, and which is entirely invisible. The pure vapor of water, for example, is a gas as invisible as the air itself. It is everywhere diffused through the air; but, unlike the oxygen and nitrogen of the atmosphere, it is not constant in quantity. We have now to examine whether meteorological observations do not clearly indicate its influence on terrestrial radiation:

January 16th.—Extremely serene; air almost a dead calm; sky without a cloud; light southwesterly air.

TIME.	Air.	Wool.	Difference.
P. M.	Degrees.	Degrees.	Degrees.
3.40	43	37	6
3.50	42	35	7
4.	41	35	6
4.15	40	34	6
4.30	38	32	6
5.	37	28	9
5.30	37	30	7
6.	36	32	4
6.30	36	31	5
7.	36	28	8
7.30	35½	28	7½
8.	35	26	9
8.30	34	25	9
9.	35	27	8
10.	35	28	7
10.30	35	29	6

With a view to this examination, I will choose a series of observations made during the afternoon and evening of a day of extraordinary calmness and serenity. The visible condition of the atmosphere at the time was that which has hitherto been considered most favorable to the outflow of terrestrial heat, and therefore best calculated to establish a large difference between the air and wool-thermometers. The 16th of last January was a day of this kind, when the observations recorded in the annexed table were made.

During these observations there was no visible impediment to terrestrial radiation. The sky was extremely pure; the moon was shining; Orion, the Pleiades, Charles's Wain, including the small companion star at the bend of the shaft, the North Star, and numbers of others, were clearly visible. After the last observations, my note-book contains the remark: "Atmosphere exquisitely clear; from zenith to horizon cloudless all around."

A moment's attention bestowed on the column of differences in the foregoing table will repay us. Why should the difference at 6 P. M. be fully 5° less than at 5 P. M.; and again 5° less than at 8 and at 8.30 respectively? There was absolutely nothing in the aspect of the atmosphere to account for the approach of the two thermometers at six o'clock—nothing to account for their preceding and subsequent divergence from each other. Anomalies of this kind have been observed by the hundred, but they have never been accounted for, and they did not admit of explanation until it had been proved that the intrusion of a perfectly invisible vapor was competent to check the radiation, while its passing away reopened a doorway into space.

It is well to bear in mind that the difference between the two thermometers on the evening here referred to varied from 4° to 9°, the latter being the maximum.

Such observations might be multiplied, but, with a view to saving space, I will limit the record. On the evening of January 30th the atmosphere was very serene; there was no moon, but the firmament was powdered with stars. At 7.15 P. M. the difference between the two thermometers was 6°; while at 9.30 P. M. it was 4°, the wool-thermometer being in both cases the colder of the two. On February 3d, observations were made under similar conditions of weather, and with a similar result. At 7.15 P. M. the difference between the thermometers was 6°; while at 8.25 P. M. it was 4°. On both these evenings the sky was cloudless, the stars were bright, while the movement of the air was light, from the southwest.

In all these cases the air passing over the plateau of Hind Head had previously grazed the comparatively warm surface of the Atlantic Ocean, where it had charged itself with aqueous vapor to a degree corresponding to its temperature. Let us contrast its action with that of air coming to Hind Head from a quarter less competent to charge it with aqueous vapor. We were visited by such air on the 10th of last December, when the movement of the wind was light from the northeast, the temperature at the time being very low, and hence calculated to lessen the quantity of atmospheric vapor. Snow a foot deep covered the heather. At 8.5 A. M. the two thermometers were taken from the hut, having a common temperature of 35°. The one was rapidly suspended in the air, and the other laid upon the wool. I was not prepared for the result. A single minute's exposure sufficed to establish a difference of 5° between the thermometers; an exposure of five minutes produced a difference of 13°; while after ten minutes' exposure the difference was found to be no less than 17°. Here follow some of the observations:

December 10th.—Deep snow; low temperature; sky clear; light northeasterly air.

TIME.	Air.	Wool.	Difference
A. M.	Degrees.	Degrees.	Degrees.
8.10	29	16	13
8.15	29	12	17
8.20	27	12	15
8.30	26	11	15
8.40	26	10	16
8.45	27	11	16
8.50	29	11	18

During these observations, a dense bank of cloud on the opposite ridge of Blackdown virtually retarded the rising of the sun. It had, however, cleared the bank during the last two observations, and, touching the air-thermometer with its warmth, raised the temperature from 26° to 27° and 29°. The very large difference of 18° is in part to be ascribed to this raising of the temperature of the air-thermometer. I will limit myself to citing one other case of a similar kind. On the evening of the 31st of March, though the surface temperature was far below the dew-point, very little dew was deposited. The air was obviously a dry air. The sky was perfectly cloudless, while the barely perceptible movement of the air was from the northeast. At 10 P. M. the temperature of the air-thermometer was 37°, that of the wool-thermometer being 20°, a refrigeration of 17° being, therefore, observed on this occasion.

From the behavior of a smooth ball when urged in succession over short grass, over a gravel-walk, over a boarded floor, and over ice, it has been inferred that, were friction entirely withdrawn, we should have no retardation. In a similar way, when, under atmospheric conditions visibly the same, we observe that the refrigeration of the earth's surface at night markedly increases with the dryness of the atmosphere, we may infer what would occur if the invisible atmospheric vapor were entirely withdrawn. I am far from saying that the body of the atmosphere exerts no action whatever upon the waves of terrestrial heat; but only that its action is so small that, when due precautions are taken to have the air pure and dry, laboratory experiments fail to reveal any action. Without its vaporous screen, our solid earth would practically be in the presence of stellar space; and with that space, so long as a difference existed between them, the earth would continue to exchange temperatures. The final result of such a process may be surmised. If carried far enough, it would infallibly extinguish the life of our planet.—*Contemporary Review.*

THE LITTLE MISSOURI BAD LANDS.

BY PROFESSOR T. H. McBRIDE.

I.

"All things are engaged in writing their history. The planet, the pebble goes attended by its shadow. The rolling stone leaves its scratches on the mountain; the river its channel in the soil. . . . The falling drop makes its sculpture in the sand or stone."—EMERSON.

BAD Lands, so called, occur in various parts of the wide plateaus adjacent to the Rocky Mountains. There are Bad Lands in Kansas, Bad Lands in Nebraska, in Dakota, and in the Territories farther west. The English name, probably because of intelligibility and brevity, seems about to supplant the old French *Mauvaises Terres* by which early travelers were wont to describe these remarkable regions. Either appellation is appropriate, for these lands, at ordinary estimate, are in many places nearly valueless, and yet the *voyageur* meant by his *mauvaises* probably nothing more than that the country was difficult of transit—*terres mauvaises à traverser.* However this may be, it is certain that these regions are full of interest and attraction for the traveler, the student, and the naturalist.

Although Bad Lands are everywhere much the same thing, and a discussion of one locality might seem applicable to all, yet there are differences—due, no doubt, to varying conditions in times long gone by. It is not intended here to discuss these differences, but to speak briefly of what may be seen in the valley of the Little Missouri River, in Northwestern Dakota.

This little stream, by courtesy a river, rolling its murky waters northward and eastward for a distance of about two hundred miles, near the line separating the Territories of Montana and Dakota, is bordered by landscapes which in detail are without parallel, and in general effect transcend the possibilities of description. As the visitor approaches from the east, there arises suddenly before him from the monotonous plain a wondrous array of myriads of hills and hillocks —hills of nearly uniform height, but of every conceivable shape and form. Some are almost rectangular, with precipitous sides; many are conical; many are dome-shaped; some have the form of a frustum of a cone, and, on the summits of some, perfectly conical heaps appear. The greater number are flat-topped, and, rising to about the same level, give the impression of some splendid rampart extending for miles and miles along the horizon; some slope up gently from a narrow valley for seventy-five or a hundred feet, and end in a lofty rotund tower of naked sandstone. To all this diversity of form there is added diversity of color. The sides of all these mounds are almost verdureless, so that the absence of green is conspicuous, but almost every other hue is represented. Colors occur in broad bands across the faces of the hills—red and gray and yellow and black, purplish-blue and ashy and pink—in an unending series of shades and tints. Nothing is brilliant, but everything soft and beautiful. Here and there, from a broader base, a hill towers away above all its surroundings, and becomes a landmark visible from afar. In the parlance of the West such a landmark is called a *butte*,* and, if one has strength and patience to climb the summit of a butte, surely his reward is great. From no other *point d'avantage* on this continent does a man open his eyes upon a panorama wilder or more weird. In one direction a thousand motley heaps cover the plain like the tents of some wide-spread army; in another, the flat-topped mounds stretch away to meet the horizon, and seem like the steps of some Giant's Causeway leading to the sky; while, as evening comes on and the sun goes down, the play of colors, the shifting light and shadow present a scene in presence of which the most prosaic must for the nonce feel the inspiration of the poet.

But, if this weird region is thus interesting to the ordinary tourist, much more so is it to the student—to him who seeks to know the how,

* This term is also applied to a high hill of any sort, even to a mountain-peak.

if not the why, of all things terrestrial. Here is a corner of the world in which the evidences of change—of transition—are so patent that a glance reveals them to the dullest beholder. It is as if Nature were here trying to impress upon her children a great object-lesson, as if the universal Dame had said: "Behold! Look! Here have I stripped all the hills and laid bare all the valleys, that you might learn my time-honored methods, and once for all see something of how worlds are made." No man would say, as he looks for the first time out over these naked hills: "Such have they ever been; such shall they always be." By no means. These, at least, are not the "everlasting hills." Here is transition. Now, transition is to the student a word of magic sound—echoing the past, prefiguring the future. Let him but behold any of Nature's processes in intermediate stage, and mystery as to mode and method vanishes; the solution is easy.

But, now that our object-lesson is before us, what can we learn about it? Let us look again from the top of the butte, this time for instruction rather than for pleasure. See, there the river winds—a silver thread, shut in by long lines of banded bluffs. Into the river-valley principal ravines debouch, others into these, and so on to the very base of the bluff on which we stand. And now, you say, the problem is solved; the river is the outlet, and all these strange phenomena are due to surface-drainage. Here is the water-system, and here are its effects. But this answer can be but part of the truth, else why are no Bad Lands seen along the Desmoines or the Tennessee? Why are they not of universal occurrence? Besides, the beds of all these ravines are, for the most part, flat and level as a floor, scantily covered with short grass, or white with sage-brush (*Artemisia*). Only here and there a gully without water, or perchance, in some larger ravine, we may find a tiny, scarcely flowing streamlet, brown with alkali. Manifestly the river-system accounts for the general features of the country, but not for that which is peculiar. But let us look at the problem in another way. Let us begin at the bottom of these hillocks, at least as low down as we may come, and study for a moment the hillocks themselves.

We have already incidentally noticed the uniform stratification which characterizes the whole country, and is revealed by the banded appearance of the hills. At the base of one of these hills we may find (Fig. 1) a stratum of pale, yellowish clay. Just above, and perfectly conformable, is a layer of lignitic coal, inferior to soft coal, of a deep-brown color, rapidly crumbling on exposure to the air, and even, when in sufficient mass, liable to spontaneous ignition. Overlying the coal is another bed of clay of an ashy hue, containing more or less sand in composition. Next comes a layer in which sand predominates, a distinct gray in color; then a bed of clay of a bluish tint, another layer of coal, a layer of yellow clay, a stratum of very soft sandstone, another bed of clay, and then a foot or two of reddish-brown sandstone, very unequally hardened and mixed with clay. Surmounting the whole is a bed of soft clay of varying thickness, mostly a sort of remnant, persisting only in mounds and the conical heaps already referred to.

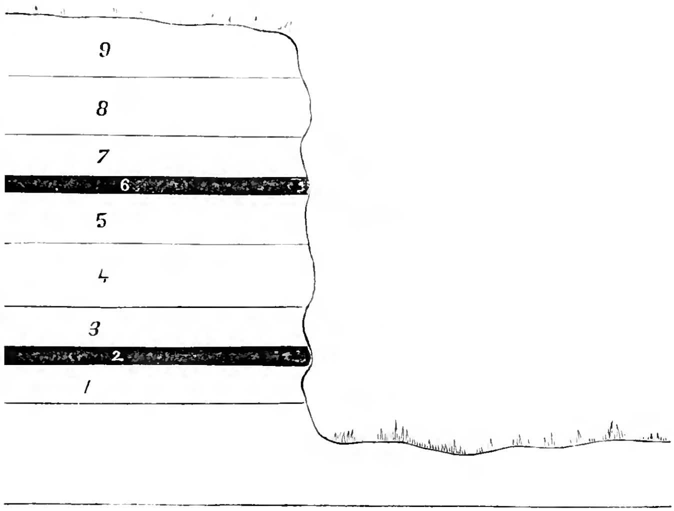

FIG. 1.—DIAGRAMMATIC SECTION OF A SINGLE BUTTE.

Now, all these strata, except the uppermost sandstone, have this common characteristic: they are composed of particles excessively fine, so that, if from any of the beds a little bit be taken, it may, when dry, be reduced between the fingers to an impalpable powder as fine as ashes. Even the lignite is no exception. If, now, in connection with this fact, and remembering the arrangement of the strata, we take into account the arid climate which prevails in all these regions, we are in position to understand much of the peculiar conformation of the Bad Lands. In the winter the snows are light, and in summer the rain that falls comes in sudden, violent, but short-lived storms. For perhaps half an hour after one of these storms, torrents flood the valleys and low plains between the hills, the rushing waters heavily charged with particles of clay, but particles so fine that they do not readily leave the water or become precipitated, but are borne on to the river, thence to the Missouri proper, which latter stream parts with them only as it blends in the clearer waters of the Mississippi. If, after the storm, we examine again the face of the bluff, we find it striated with numberless tiny channels, down which have just poured little rivulets of water hardly so much as wetting the surface, while from top to bottom the erosion has been about the same, the slightly increased density of the upper layer enabling them to sustain the brunt of the storm, and yet suffer no more wear than the softer strata beneath.

It is manifest that if this process be continued, and if all the hills are like that described, the reduction of all these terraces and mounds is but a question of time, and we may look forward to the day when all this now wild and impassable country shall be but a prairie of gentle undulations and monotonous outlook, not dissimilar to the wide plains which even now stretch off far to the east to blend with the Missouri Valley. Every mountain shall be made low and every valley filled, and no force more violent be concerned than the gentle action of the wind and rain.

I have said that the *detritus* of the storm is non-precipitate, is borne away by the water; and yet some of the moving particles do find lodgment by the way. There is no such thing as a talus at the foot of the bluff, but after each flood a thin film of fine silt is spread over the plain, and the flat bottoms of the ravines are by imperceptible pace forever creeping up the wasting buttes, particularly of those remote from the river.

But such a butte as that described, while revealing much, does not reveal all the facts necessary to the full understanding of our subject. One of the first things to strike the attention of the tourist among the hills is the evidence of the wide-spread action of powerful heat. The bands of red which everywhere mark the landscape are certainly traces of some glowing fire. But what a fire! Here are whole beds of clay baked until they have taken on the color and character of hard-burned brick or unglazed pottery. The resonance of the dry fragments under the hammer or the wheels of our vehicle is precisely that of broken terra-cotta. Sometimes the top of the butte is bare and red; sometimes the whole mass, from top to bottom, has been burned, and at a distance seems like a brick-kiln fallen into ruin. The splintery fragments, broken as macadamizing stone, form over the entire surface a natural riprap, on which the elements spend their force in vain. Such buttes are not transient; the fire has saved them, and in this dry climate they may stand forever. Here and there, so hot has been the fire, that the clay has been not only baked but fused, and great clinker-like masses rest upon the hill-top, thrust themselves out from the hill-side, or stand naked like monuments on the plain.

In looking for the source of heat capable of producing such phenomena men seem instinctively to revert to volcanic fires, and the burned clay is everywhere designated scoria. In one place where the railroad cuts through a hill of this material we have "Scoria Cut," and scoria constitutes for miles the favorite ballast. But probably volcanic fires were never nearer than at present. Of crater, lava, trap, or other usual volcanic concomitants, there is not the remotest sign; but to-day, while we are theorizing over the matter, some of the furnaces which have baked all these regions are still glowing, the smoke yet ascends, and our own eyes may witness something of the transformation. The lignite-beds furnish the fuel, the slow-paced erosion lays the fuel bare, spontaneous combustion supplies the torch, and the whole phenomenon is explained.

That the lignite is in some way connected with the fiery metamorphosis of the Bad Lands we might have inferred from the fact that no lignite ever appears above the burned belts, and in a hill entirely burned the lignite is entirely wanting. The burned clay also corresponds in position to beds overlying the coal in hills immediately adjacent. But, as we have said, the fires in isolated spots are still burning; in some places wholly subterranean, smoldering and smoking, at other points readily seen both in nature and effects. We may discover the coal on one side of a broad-topped hill, and on the other we may look from the hill's summit down through gaping rifts to the same horizon and see everything molten at white heat, while hot air, smoke, and coal-gas, as from a furnace, make the region almost inaccessible. The accompanying diagrams (Figs. 2, 3) illustrate a burn-

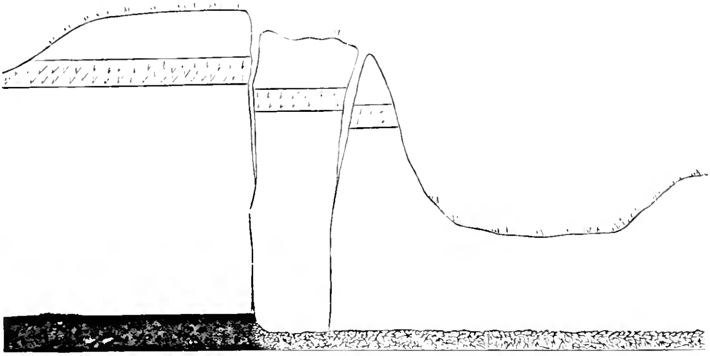

Fig. 2.—Transverse Section of Burning Lignite—Thickness of Lignite-Bed exaggerated.

ing coal-bed, which has been photographed and dubbed "The Crater." Here the fire is burning out the lignite beneath a valley lying between two rounded ridges. As fast as the coal is removed by combustion

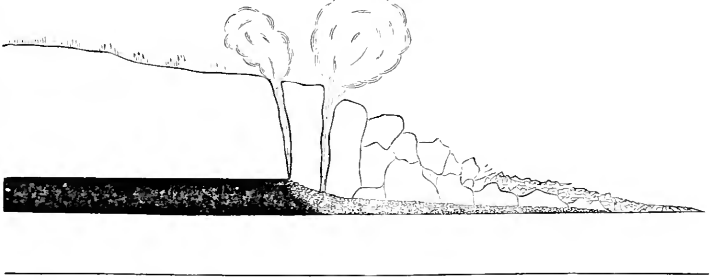

Fig. 3.—Longitudinal Section of Burning Lignite—Thickness of Lignite-Bed exaggerated.

the whole section of the valley sinks, creating with respect to the stratification what geologists term a *fault*. At the lowest part of the valley, where the fire is nearest the surface, the entire superstratum breaks up and crumbles to ruin. When, after a summer storm, the flood comes down the valley, shoots into the crevices, and runs along the fissures, something like an explosion takes place. On every side volumes of steam ascend, but the fire is not extinguished. The loosened earth is much of it swept away, and a deep gulch forms between the ridges, and so the air comes freely to the fire, which might otherwise be smothered in its own ruin. Meanwhile the hearts of the hills themselves are baked like tiles in a close kiln, and while the fire would seem to hasten erosion, as in some places it certainly does, yet the metamorphism accomplished tends in the opposite direction, and is efficient in proportion to the completeness of the change.

And so the work goes on; one bed of lignite after another takes fire, one butte after another becomes the cover of a kiln, a furnace, and the whole country is transformed. I say the work goes on; better, *has* gone on, for it is nearly done. Glowing or smoldering through ages past, now hidden in darkness, now breaking forth to light, these secret fires have been burning, burning like a hidden fever, until the fair face of Nature has become an arid desert.

Thus the Bad Lands, as we know them, are the results of the action of two opposing elements, the water and the fire. Of these two the first had doubtless acted alone long before the second entered at all into the problem of disintegration. These level tops bespeak a former continuous level plain. More than this: into the highest of the buttes we may trace the same strata which make up the lower hills. The level must at one time have been higher still than we had first supposed. The changes of the past are enormous as compared with anything shown by the present, or even possible in the future of these strata. Owing to the peculiar nature of the strata, their uniformity and lack of solidity, the erosion has produced effects unique, and to these the fire has brought permanence and stability. Far as the coal-beds extend erosion has been or is liable to be arrested, and the country doomed to infertility. But the coal is not universally present. Many places are free from it entirely, and here erosion may continue unchecked its peaceful processes until all is beaten down to the common plain. In other places the coal takes fire in but isolated hills, and these become permanent while all else is reduced to prairie. And now we remember that away to the east the plains sometimes show a solitary hill, whose sides, reddening beneath the sparse grass, and whose summit, glowing in the sunshine, betray its origin.

TECHNICAL EDUCATION.

By A. CURTIS BOND.

THE general increase in schools of design, technical schools, and like institutions, has created no little comment, and given rise, to some extent, to opposition.

It is a difficult matter to reconcile the differences between the opponents and those who favor this form of instruction, for the reason that the question, in a measure, is one of pecuniary interest to both parties.

There are many instances in which technical education may justly be claimed to be a necessity, and naturally, in those professions which demand a knowledge or a character of schooling, that can be more thoroughly conveyed by means of that which instructs in the *theories* of a craft or art, as distinct from its practice.

In the case of the architect, for example, nature may indicate the urgencies of the profession ; it provides for the beautiful, for the attractive features, but the details it avoids ; teachers must show the mechanical portions of the work, and instruct in the principles which make the building possible and form a support for the decorative exterior. The necessity of such teachings was recognized by early nations, and in their architecture and designing its value was taken into consideration, and its spirit must have existed among the early Aryans, as its materialized form did with the skilled and finished draughtsmen of Egypt and Greece.

We may easily realize the increased need of technical training to-day over the necessity of two thousand years ago. At that time, the artist himself did the work, the actual labor ; he evolved the idea and executed it, the brain that conceived the thought guided the hand that gave that thought substance and shape. Every touch of the chisel imparted life, for the spirit of the worker went into the stone, and it was molded and shaped by the genius of the thinker. Now it is mechanical : the artist originates, others execute, and this execution must follow patterns, designs, plans. No scope is given the workman ; he is bound by lines beyond which he dare not go, and his fancy, if he has any, serves naught in the creation of his subject ; drawings control this creation, and the living translator of those drawings, from what was in the past an intelligent reasoner, has become in the present an automatic machine.

Disposing thus of a man's individuality, some means are essential to convey the thought of the designer into the hand of the worker, and customs have grown and laws have been adopted that will serve as a sort of mental telegraph between these two—laws which govern the flight of the artist's fancy and instruct the artisan in an understanding of the designer's purposes. Taking this view of the situation, it is certainly necessary that talent should be technically tempered.

It is not to be expected that every one learning a trade will become an expert or an innovator ; ability to comprehend the requirements of trades are developed in either the shop or the school, but the regrets so often expressed by those who have grown up from apprentices for their lack of education evinces the limited possibilities of practical knowledge simply, and demonstrates, in a measure, the necessity for an early instruction in the theories, if one thinks to introduce improvements and progressions in his profession.

The want of education, with which most apprentices must contend, interferes in other ways with their progress. The master is apt, in many instances, to exaggerate the difficulties to be overcome, and enlarge upon the mysteries surrounding his work-bench. The doubt this would arouse in an unschooled mind might be fatal to success, and the superstition that there was something impossible for the apprentice to comprehend, is liable to remain with him as a drag-net to his future usefulness, trammel his ambition, and perhaps turn his abilities into a channel less profitable to himself and to the world.

Technical schools, adopting as they do a different course, impress the students with the comparative simplicity of business, and give them the feeling of ability to grasp and utilize the intricacies and peculiarities of the trades. That which is formidable to the uninstructed becomes a *bagatelle* to those familiar with the details and with those who have an intelligent theoretical acquaintance with the governing principles. It is true, this theoretical knowledge can not provide for all emergencies that are likely to occur in the workshops, but it lays a foundation which will aid the student, when those emergencies present themselves, in comprehending and overcoming the difficulty ; and it is a question we would be loath to decide in the negative, whether or not a mechanic, who, after being educated in a technical school, had had a reasonable experience in a shop, would not find a readier and more effective remedy for an accident than one who had been brought up in a shop and lacked school training.

Another consideration worth noting is the comparatively short time during which a man improves his skill in the trade or art he may have adopted. The Technical Commission of Great Britain sets the period at from ten to fifteen years as a maximum, and this may be regarded as a reasonable estimate for the time at the end of which progress in the individual ceases; and, such being the case, it is proper to give at the outset all the helps toward developing talent that are attainable. Technical education may be one of these helps.

If it were possible to acquire theory and practice at one and the same time, its desirability would be indisputable, but, we imagine, this in its true sense is impracticable. The practice obtained in technical schools is not the real, genuine, unadulterated article, and it would be a dishonest teacher who would put forth any such claim. It is impossible to foresee, as we have said, all the necessities that arise, and are likely to arise, in the course of business experience, and they absolutely require, when they obtrude upon the regular course, the judgment of a mind that has been accustomed to coping with difficult situations where a failure to devise a remedy at once meant an utter failure of the entire work.

But one of these qualifications must, in the order of things, precede the other, and we are confronted with the question, Which shall it be?

Theory—that is, the comprehension and understanding of whatsoever we undertake—is the foundation upon which practice may build; theory will necessarily acquire the mechanical ability to put its ideas into shape by a reasonable amount of practice; but practice, though it be of years, does not by any means guarantee theoretical or even an intellectual appreciation of the results that labor accomplishes, and without this what can be expected from the mechanic? We certainly should not ask for improvements from a man who does not understand the foundation principles of the mechanical part of his work. Starting with a fairly good technical or theoretical education, one grapples with the problems of business more intelligently and, in most cases, more successfully. If one chance to become an employer, he can utilize the practice of his employés to demonstrate his theories, and often will this theorizing, and the thoughts created by an early technical education, suggest means for lightening, simplifying, and improving the labor that practice had failed to find an opportunity of modifying.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

CLIMATIC FEVERS.

LIFE is a sun-child; and nearly all species of plants and animals attain the highest forms of their development in the neighborhood of the equator. Palm-trees are tropical grasses. The python-boa is a fully developed black-snake; the tiger an undiminished wild-cat. With every degree of a higher latitude, Nature issues the representatives of her arch-types in reduced editions—reduced in beauty and longevity, as well as in size and strength.

The human animal, however, seems to form an exception to that general rule. For the last two thousand years, nine out of ten international wars ended with the victory of northern nations over their southern neighbors. The hegemony of commerce and superior civilization moves farther and farther north. Our oracles have been transferred from Delphi to Berlin, to Edinburgh and Boston. The Muses and Graces are wearing fur cloaks. Has the sun of the south lost its stimulating power? The truth seems to be, that *cold air is an antidote.* The antiseptic effect of a cold climate enables us to indulge with comparative impunity in numerous vices which our southern neighbors have paid with the loss of their moral and physical health. It has been ascertained that alcoholic stimulants, instead of increasing actually *decrease* the temperature of the system, and that cold weather constitutes no valid excuse for the use of intoxicating drinks, but it is equally certain that a low temperature promotes recovery from the effects of intoxication. Many hyperboreans eat flesh as a stimulant rather than as a medium of calefaction; tea-drinkers contract a morbid craving for boiling-hot beverages. But climatic influences increase the activity of their digestive organs to a degree that enables Nature to compromise the violation of her laws. Gluttons and topers die in the south and survive in the north, not because a warm climate *per se* is incompatible with the normal vigor of the human system, but because a cold winter counteracts the effects of gluttony and intemperance in much the same way as rum counteracts the effects of a snakebite, or mercury the virus of the *lues veneris.* Frost is a counter-poison. Protracted impunity tempts sinners to believe in the innocence of their habits. During the two centuries when the Cæsars vied in the gratuitous purveyance of bread, oil, and circus-games, the Roman citizens had no special reason to admit the turpitude of idleness. Under the protection of the Holy Inquisition dunces were secure enough against the competition of genius to consider ignorance as a virtue. Thus the prophylactic influence of a frigid climate has made the propriety of many of our daily sins so axiomatic that the neglect of their practice excites a sort of virtuous indignation. A German proverb, traced to the table-talk of an eminent reformer, denounces the demerits of the man who fails to worship music, women, and—wine. To many minds closed bedroom-windows and three warm meals a day are essential conditions of true respectability. Even in the dog-days, the impropriety of Scotch knee-breeches would be thought worthy of a harsher name. When financial embarrassments obliged the later Cæsars to abolish the free-lunch system, the astonishment of the *cives Romanus* was only equaled by his wrath at the injustice of the innovation; and with a similar mixture of indignation and surprise thousands of exiles from the regions of prophylactic frost denounce the malignity of a climate that fails to protect them from the logical consequences of their sins against nature. In summer weeks, when the creoles pass the night on their flat house-roofs, with a mattress and a linen bed-sheet, and regret at the necessity of adding a mosquito-cap, the foreign resident insists on sleeping in a flannel undershirt, under woolen blankets, and the impression that his life depends on keeping his doors and windows hermetically closed. During the noontide glare, when the youngsters of the native patricians run about in white muslin inexpressibles, and their plebeian comrades in a still less expressible and certainly unspeakably sensible costume, the children of the north have to mourn their exile in black broadcloth, woolen stockings, boots or air-tight gaiters, tight-fitting collars, neckties, and waistcoats, besides the unavoidable flannel undershirt. And, worse than that, the ex-hyperborean not only continues to gorge himself with an amount of calorific food that would more than suffice for the climatic exigencies of his own latitude, but persists in eating that excessive amount in the specially indigestible form of fried and broiled meat, served smoking hot with greasy sauces, after a prelude of sudorific doses of hot soups or narcotic drinks. In a cold climate the pathological results of overfeeding are chiefly limited to the evils of mal-nutrition, i. e., the difficulty of eliminating the cachectic elements of a mass of accumulated and fermenting ingesta. But in a warm climate that result is complicated by the further difficulty of maintaining the normal temperature of the system. For the organic functions of the animal body require a uniform degree of warmth as a condition of their healthy performance, and in the human body the normal average of that temperature has been found to be about 98° Fahr. A variation of only two degrees denotes an abnormal depression or acceleration of functional activity, a difference of five degrees indicates a serious disease. In the polar regions, where a rousing stove-fire often fails to thaw the rime-frost on the stove-pipe, the organism of the human body contrives to maintain its blood-heat within half a degree of the normal average, i. e., sometimes at a temperature of 150° above that of the external air. In the tropics the same marvelous organism becomes a refrigerating apparatus, and lowers its temperature as much as thirty degrees below that of the outer atmosphere, which in British India, for instance, has been seen at 132° above zero, or a hundred degrees above the freezing-point.

In these thermal regulations, Nature has, however, to rely on the co-operation of instinct or reason; and a mariner who would wear the same dress on a north-pole expedition and a trip to Suez could hardly hope to escape the consequences of his imprudence. But even if the Arctic explorer should not only forget his furs, but intentionally chill his blood by sitz-baths on an ice-floe, and promenades in the costume of the Nereids, his chances of continued health could hardly be worse than those of the British merchant who practices in the tropics the calorific artifices of his native land, and aggravates the blood-seething effects of a West Indian summer by superfluous clothes and worse than superfluous beefsteaks and sudorific drinks. The blood of the sitz-bathing mariner would congeal; the blood of the beef-eating merchant does *ferment*. With all diversity of opinion as to the proximate cause of climatic fevers, there is no doubt that the febrile blood-changes indicate the agency of a catalytic, or fermentative process. In yellow fever the temperature of the body rises to 105°, and *after death* often to 112°; the progress of decomposition separates the serum from the red blood-globules (whence the chlorotic hue of the skin), and the bodies of the victims need immediate interment on account of the rapidity with which putrefaction begins, or rather completes, its work. The clinical study of the disease in such towns as Vera Cruz and New Orleans has preserved the record of many curious cases of molecular life after somatic death. Dr. Bennett Dowler ("New York Journal of Medicine," 1846) mentions the case of an Irishman whose arms, after the cessation of respiration, rose and fell with a rhythmical motion, and of a Kentuckian whose flexor muscles, four hours after death, reacted against the slightest mechanical stimulation. The symptoms of ordinary "chills and fevers" can be temporarily suppressed by antiseptic drugs—quinine, arsenic, strychnine, ferro-cyanide of iron—in fact, by all chemicals that would arrest a process of decomposition. Hence also the prophylactic effect of alcohol ("tonic bitters") and of Nature's great antiseptic, frost. That marsh-miasma is only an adjuvant cause of endemic fevers can be abundantly demonstrated by the comparative study of the typographical and climatic conditions of the chief fever-centers, as well as by many unmistakable analogies of "climatic fevers" and certain enteric diseases which can be traced to purely subjective causes. The swampiest districts of Central and South America—the Peninsula of Yucatan, Tehuantepec, the Brazilian province of Entre-Rios, the Orinoco Valley, the "Gran Chaco," or monster-swamp, between Bolivia and Paraguay—enjoy an almost perfect immunity from pyrexial diseases, while Vera Cruz and Pernambuco with their zone of barren sand-hills, or La Guayra, Havana, and Rio Janeiro, with their mountainous vicinity, are subject to yearly visits of the plague. During our last two epidemics the vast Arkansas river-swamps, and the coast-fens of Georgia, Florida, and Texas, escaped, while Vicksburg and Memphis, on their dry bluffs, and Chattanooga, at an elevation of six hundred feet above sea-level, suffered more in proportion to their populations than any place this side of Vera Cruz. During every fever-epidemic the focus of the disease seems to be some commercial city of the tropics or sub-tropics, a town uniting torrid summer climate with the presence of a large number of northern foreigners.

In all fevers ascribed to a malarial origin the success of the conventional mode of treatment depends chiefly upon the efficacy of chemical antiseptics which temporarily suppress or palliate the symptoms of the disease, but (aside from the deleterious after-effects of such drugs) the disease itself can be cured only by the removal of the cause. That cause is the inability of the vital powers to withstand the influence of moist heat from within and without. The proper method of cure, therefore, consists in diminishing the thermal product of that complex cause, either by flight to a colder climate, or by adopting a less calorific regimen. The latter expedient is the cheaper, and generally the shorter and safer one; and in no other disease is the remedy more clearly indicated by the promptings of instinct. The premonitory stage of yellow fever is characterized by an intense longing for *refrigeration:* fresh air, cold water, cooling fruits or fruit-extracts. The fever-dreams of an ague-patient are crowded with visions of tree-shade and mountain-brooks. Even "chills" are often accompanied by a burning thirst; and during the cold stage of an intermittent fever the temperature of the system is actually higher than during the sweating stage; according to Dr. Francis Home, respectively 104° and 99°.

In the first place, remove the patient to the airiest available room in the house. The art of house-cooling seems to have been lost with the ancient civilization of Southern Europe. There is not a room in the narrowest alley of the Naples Jew quarter where open windows and ten cents' worth of ice would fail to lower the temperature from twenty to thirty degrees below that of the outer atmosphere. Create a draught, and if possible a cross-draught, without fear that the admission of air from a sun-blistered courtyard, for instance, would make the room equally uncomfortable; the thermal contrast itself will create an air-current, and that draught will be cooler to the feeling than stagnant air of an actually lower temperature. The shade of a leafy tree is never more grateful than when the surrounding fields tremble under the rays of a vertical sun. The evaporation of ice-water, or even of common cistern-water, will greatly aid the good work. Pour it into flat basins, tubs, etc., and place them in the center of the room, or get a wheelbarrow full of unglazed bricks, that can be procured at any pottery, put them close together on the floor and sprinkle them from time to time with cold water. The water will soak into the porous mass and evaporate more rapidly than from an impervious surface. A bundle of bathing-sponges or a sheaf of bulrushes, suspended from the ceiling and sprinkled from time to time, will serve the same purpose; and, where ice is cheap, a dog's-day sirocco can be easily reduced to an April breeze.

But the best time to begin the refrigeration-cure is an hour after sunset. On this continent alone, the *night-air superstition* costs annually the lives of about fifteen thousand human beings; for at least one half of the thirty thousand North Americans who succumb every year to yellow fever, ague, and congestive chills, could have saved themselves by opening their bedroom-windows. In the jungles of our Southern Gulf-coast thousands of hunters and lumbermen breathe with impunity the air of the very swamps to whose neighborhood the city-dweller ascribes the summer epidemics. Their febrifuge is the cooling night-wind, for here, as in the dyspeptic shopkeeper cities and consumptive factory-towns, each night labors to undo the mischief of each day.

The flat-boat men who often contract the ague during a week's delay in a Southern inland port, need no quinine by the time they reach New Orleans, a week or two of chill night-camps on the open river having cured them as effectually as the first November frosts cure the chlorotic city-dweller.

For direct refrigeration a *sponge-bath* is more effective as well as less disagreeable than a wet-pack; though an *air-bath*, before an open window (under cover of night) is preferable to both, if the strength of the patient is reduced by a protracted ague or injudicious medication. In obstinately sultry weather an *ice-pack* will afford almost immediate relief—a pailful of crushed ice, stuffed into linen bags and wrapped for a few minutes around the neck and arms, or around the wrists of a bedridden patient.

"Stuff a cold and starve a fever" was, in regard to fevers, at least, not a bad plan, when "stuffing" implied a monster dose of beef and beer. But the want of appetite which characterizes all febrile affections is properly defined as only an abhorrence of calorific food—flesh, hot soups, and greasy made-dishes. The mere sight of such comestibles is enough to aggravate the sick-headache that precedes yellow fever and follows an ague-fit, and, when the idea of food has become closely associated with visions of smoking grease, the voice of instinct is apt to be in favor of total abstinence. But that protest is always accompanied by a passionate craving for cooling drinks, which easily connives at an admixture of solid nourishment, after a refrigerating diet has once been tasted in the form of cooling fruits. Cold sweet milk, whipped eggs with a drop of lemon-flavor, a sherbet of ice-water, sugar, and orange-juice, offered to the rebellious stomach of a fever-patient, are not only tolerated, but absorbed with an almost conscious satisfaction. Fruits, however, rank first among the dietetic febrifuges of Nature, especially tropical fruits. "Under the exhaustion of a blazing sun," says Sir Emerson Tennent,* "no more exquisite physical enjoyment can be imagined than the chill and fragrant flesh of the pineapple, or the abundant juice of the mango, which, when freshly pulled, feels almost as cool as ice-water. . . . It would almost seem as if plants possessed a power of producing cold, analogous to that exhibited by animals in producing heat. Dr. Hooker, when in the valley of the Ganges, found the fresh, milky juice of the *mudar* (calotropis) to be but 72°, while the damp sand in the bed of the river where it grew was from 90° to 104°."

With a biscuit or two, a sliced pineapple, two or three bananas or a couple of oranges, will make a sufficient meal; and in very warm weather bananas alone would do for a couple of days, for the nutritive value of saccharine fruit is generally underestimated; our next relatives, whose digestive organs are a close copy of our own, are exclusively frugivorous, and withal the most active and indefatigable crea-

* "Ceylon," p. 121.

tures of their size. With cold, sweetened orangeade alone, the physicians of the Spanish-American hospitals often support their comatose patients for days together.

These remedies should be applied in the very beginning of the disease. As soon as the yawning and stretching languor of a bilious remittent announces the approach of an ague-fit, the patient should prepare for refrigeration by sponge-baths, air-baths, and rest, in a shady, well-ventilated room. The thirst that announces the needs of the internal organism should be freely indulged with fresh spring-water (or the next best thing, filtered and ice-cooled cistern-water). I would not prevent a fever-stricken child from drinking five quarts of water in as many half-hours, if its system craves it, for, besides its refrigerating influence, fresh water fulfills an important expurgative purpose, and helps to eliminate the catalytic germs of the tainted blood. During the shivering stage of a fever there would not seem to be much need of artificial refrigeration ; but I have noticed that a fit of "chills" is far more supportable if the craving for a warm cover is justified by an external cause. In a sultry room a woolen blanket is apt to turn a shaking fit into the ugliest symptoms of the hot and headachy stage, while in a cold room the shivering patient (covered up, but with his head exposed to a cooling draught) soon finds relief in a quiet slumber. The ancient Romans cured their fever-patients in subterranean grottoes, and where the means of refrigeration are as cheap as in the New Orleans ice-factory I would keep the yellow-fever ward of a hospital at a maximum temperature of 55°, and at night, if possible, below 50°. Wet-packs and a frequent change of posture greatly alleviate the throbbing pains in the loins, where the pyrexial process of a yellow-fever paroxysm seems to center its activity. * These pains are often accompanied by a stupor-like oppression of the brain and are grievously aggravated by a stagnant atmosphere.

In the tent-camp of Medellin, to where the French authorities had removed the fever-stricken paupers of Vera Cruz, I noticed that comatose symptoms occurred only in a small minority of cases, while their worst forms were frequently observed in all the city hospitals, except the excellently ventilated infirmary of the Catholic orphan asylum. In common ague, fresh air alone, and without the aid of fruit and ice (which can not be readily procured in some inland districts of our Southern States) will modify the paroxysms sufficiently to reduce them to debilitating rather than distressing symptoms—tremors, followed by perspiration, and a cerebral excitation somewhat resembling the first effects of certain intoxicants.

During the hot stage of an intermittent, delirium can be obviated

* "It is curious that the maximum of the heat observed after death should have been in the thigh, and the minimum in the brain. Dr. Bennett Dowler, of New Orleans, ascertained it to be (ten minutes after death) 102 in the brain, 109 in the axilla, and 113 in the thigh" (Carpenter's "Physiology," p. 619).

by keeping the patient in a half-sitting posture, and cooling his temples from time to time with a wet towel, or, in extreme cases, with the above-mentioned ice-pack.* After a profuse perspiration the pulse will gradually become normal, and the feverish brain pass into a sort of twilight state between slumber and more or less fantastic day-dreams, but without obstreperous symptoms and without oppressive headaches.

All this, however, on condition that the bark of *Cinchona calisaya* is left severely alone. I have seen *quinine-drunk* patients break away from their nurses and rush out into the street like Indian amuck-runners, or sit moaning on their beds, freed from the febrile diathesis, but afflicted with ear-aches that pierce the head like twinges of neuralgia, and often impair the hearing for months together. Quinine sticks to the system like mercury, and I doubt if there is such a thing as perfect recovery from the effects of its protracted use. Strychnine, bitter-orange peel, valeriana, arsenic, and snake-root, are equally objectionable, and often produce after-effects that are ascribed to other causes, or to a lingering nervousness induced by the fever itself. Besides, the removal of the cause is the only radical fever-cure ; chemical antiseptics merely palliate the symptoms, as a cloth mantle would smother a fire, till it gets strong enough to break out through cloth and all. Frost kills out flies where arsenic fails. By the refrigeration-cure the zymotic disease-germs are, as it were, *frozen out:* the blood-heat of the system is reduced below the temperature which is a condition of their development. The quinine-treatment is an attempt to *poison them.* For a time that attempt may prove successful, but the patient becomes a slave to his drug, and, till frost sets in, one of the most nauseous of all medicines has to be applied from week to week, and generally in increasing doses. But, if the febrile diathesis has been subdued by a refrigerating diet, the most ordinary precautions suffice to keep the disease in abeyance. The cause has been removed. I will venture the prediction that the zymotic agency of climatic fevers, as of tuberculosis, will be traced to the development of a living organism, and I suspect that Nature's effort to eliminate the tainted humors constitutes the critical symptoms of the affection, while the periodicity of the disease is due to the periodical redevelopment of the parasites from their ova or vital rudiments. In the vomit of cruor that precedes the crisis of yellow fever, the system seems to make an attempt to eradicate the evil by a direct extrusion of the tainted particles of the blood (the fibrine and red corpuscles), at the risk of exhausting the vital pabulum by the impoverishment of the humors. The success of that heroic remedy ends the trouble : yellow fever

* Six parts of sulphate of soda and four parts of hydrochloric acid make an effective freezing mixture. The first piece of ice thus obtained can be used with common salt to continue the freezing process, and, mixed in a tin cup, will reduce the temperature of water in a smaller cup, immersed in the mixture, by as much as thirty degrees.

hardly ever attacks the same person more than once. Ague, on the contrary, recurs with the return of every favorable opportunity ; nay, persons who have suffered most from remittent fevers are especially liable to relapses, and, if the disease is allowed to continue, its result is the same impoverishment of the blood (chlorosis and jaundice) which the paroxysm of yellow fever effects in a few hours. It is not safe to count upon an early frost, or immediate relief by a change of climate (in midsummer, especially, when the weather is often as warm at the borders of the Arctic Circle as fifty degrees farther south). And the persistent neglect of dietetic precautions under reliance on the prophylactic effect of a weekly dose of quinine would be strictly analogous to an attempt to legalize the sins of Don Juan by saturating the system with mercury.

In yellow fever large doses of quinine directly increase the chief danger of the disease by arresting the excretion of uric acid, which, passing into the circulation, has been recognized as a main cause of the convulsions and coma which so often inaugurate the hopeless stage of the deliquium.

During the delirious paroxysms of climatic fevers, ice-water may be administered like medicine, by spoonfuls, but *solid food should never be forced upon the patient.* When coolness, sweetness, and fruity flavors can not make a dish acceptable to the appetite, its obtrusion upon the stomach would do more harm than good, and it is a great mistake to suppose that even total abstinence could in such cases aggravate the danger of the disease. At San Nazaro, near Brescia, the Austrian hospital-town after the battle of Solferino, a wounded Hungarian sergeant, whose three tent-comrades had died of typhus syncopalis ("spotted fever"), cured himself of the same disease by an absolute fast of eight days, not including the two days of his transport from the battle-field, when he had taken a cup of coffee and a mouthful of bread. In malignant cases of yellow fever the revulsions of the bowels often invert the digestive process for days together ; chyle, as well as the nutritive elements of the blood, are forced back upon the stomach and disgorged in that eruption of *cruor* commonly called the "black-vomit" ; and the ingestion of food would, under such circumstances, only aggravate the gastric distress.

With the power of assimilation, the appetite for solid nourishment gradually returns ; but this re-establishment of the digestive process is greatly retarded by the obtrusion of a distasteful diet, especially animal food and all greasy made-dishes. The peculiar dietetic whims of fever-patients, their sudden cravings for a special kind of food, drink, or condiment, can with certain exceptions (or the revival of an alcohol passion) be indulged without danger, and generally indicate a favorable turn of the crisis. "*Ya se va á volver ; pide chilé*"—"He'll soon be all right ; he's asking for chilé" (red pepper or pepper-sauce) —is a standing form of congratulation among the Spanish-American friends of a yellow-fever convalescent. But even with chilé they would hesitate to tempt him with *garbanzas* or *guisado*, well knowing that the mere smell of greasy viands is often enough to bring on a relapse of the vomit. Disagreeable smells of any kind are, in fact, a potent adjuvant, if not independent cause, of a febrile diathesis. "A manufacture of artificial manure," says Professor Grainger, "formerly existedimm ediately opposite Christchurch workhouse, Spitalfields, which building was occupied by about four hundred children with a few adult paupers. Whenever the works were actively carried on, particularly when the wind blew in the direction of the house, there were produced numerous cases of fever, of an intractable and typhoid form. . . . The proprietor at last was compelled to close his establishment, and the children returned to their ordinary health. Five months afterward, the works were recommenced; in a day or two subsequently, the wind blowing from the manufactory, a most powerful stench pervaded the building. In the night following forty-five of the boys, whose dormitories faced the manufactory, were again seized with severe diarrhœa, while the girls, whose dormitories were in a more distant part, and faced in another direction, escaped. The manufactory having been again suppressed, there was no subsequent return of the diarrhœa" ("Report on the Hygienic Condition of the Metropolis," p. 36).

The Turkish custom-house officers fumigate their quarantine-buildings with a powerful but agreeably aromatic kind of incense-powder, which seems to serve all the purposes of disinfection, and could in many cases be substituted for the carbolic-acid libations that fill our hospitals with their scandalous odors. To the stomach of a fever-patient, however, the smell of boiling fat is still more offensive, and kitchen-fumes should be carefully excluded from the sick-room.

If these precautions are adopted in time, a common remittent generally terminates with the third fit, and yellow fever takes the form of a "walking case," as the Memphis physicians call that mild type of the disease which limits its symptoms to a few shivering fits, and a night's headache, and seems, in fact, to be nothing but a modified sort of a summer ague. Every pyrexial affection is essentially an enteric disorder, a bowel-complaint, and dietetic management alone will generally insure a favorable issue of the disease. The Spanish cigar-peddlers and Spanish and Italian fruit-venders of New Orleans inhabit the vilest alleys of the "French quarter," but their frugality has saved them again and again, when their flesh-eating neighbors died by hundreds. I have known vegetarians to survive in tenements where the rooms above, below, and around them were filled with fever-stricken families—decimated from week to week, dreading removal to the hospital like a sentence of death, but sticking to their flesh-pots and alcoholic "tonics." How *fruit*, the chief febrifuge of nature, came ever to be suspected of being the *cause* of pyrexial disorders, would be utterly inexplicable without the analogies of the *post hoc ergo propter hoc* fallacy—our liability to mistake a coincidence for a causal connection. In cold weather the hyperborean biped retreats to his unventilated den and contracts a catarrh, which he ascribes, not to its true cause, foul air, but to *cold* air, having noticed that winter and pulmonary affections are annual concomitants. Fruits, like countless other products of nature, are most abundant when they are most needed, and have for ages *preserved* the health of our tropical ancestors; but their carnivorous descendant ascribes his affliction, not to his daily beefsteaks, but to the occasional peaches and watermelons of which he happened to partake about the *time* the fever took hold of him. At the end of the year, when fruits become scarce, fevers too disappear, and the proof seems complete. Inductive logic: but the precipitate follower of Viscount Verulam fails to explain the fact that in the swampiest and hottest districts of the Eastern Continent fevers and fruits exclude each other like science and superstition, and the still stranger fact that hundreds of Northlanders who scrupulously abstain from fruit are nevertheless victimized whenever they brave the sun of the lower latitudes. In cholera the fruit-delusion may have derived a color of plausibility from the circumstance that persons who have for months subsisted upon beef and farinaceous food are liable to an attack of diarrhœa after their first experiments with a more digestible diet. For analogous reasons a long incarceration makes a prisoner unable to bear the fresh air and clear light of the outer world. The creoles use pepper enough with their meat to dispense with other antiseptics, and yet eat fruit with every meal as the French serve a dessert of cakes and raisins—"*pour la bonne bouche.*" A dime's worth per day for every man, woman, and child, of such fruits as oranges, melons, or "Chickasaw plums," that can be bought in almost every Southern town, would soon ruin the business of the quinine-manufacturers and reduce the trade of the "bitters" distillers to customers who like to drink whisky under some more respectable name.

The Spaniards divide all articles of diet into *comidas frias* and *comidas calientes;* but their definition of calorific food does not quite coincide with Liebig's theory.* According to the nitrogenous and non-nitrogenous system, starch, sugar, gums, are "respiratory" food, and as exclusively heat-making as fat, while the experience-taught South American would unhesitatingly class starchy potatoes and starchy corn-bread with the *comidas frias*, the "cooling comestibles"; and flesh, eggs, and rich cheese with the heat-producers. Cold milk would be assigned to the former class, and, together with unleavened and

* Professor Draper ("Human Physiology," p. 27) warns us that Liebig's classification has been only "adopted for the sake of convenience," having no natural foundation. Funke, in his "Lehrbuch der Physiologie," p. 186, accepts it with considerable reservations. Verdeil, Robin, Mulder, and Moleschott, reject it as wholly untenable.

"unshortened" bread, fruit, or fruit-jelly, constitute the dietetic specifics for convalescents from climatic fevers. Subacid fruits are, on the whole, more cooling than purely saccharine ones (figs, for instance); but *bananas*, though sweetish rather than acid, are, *par excellence*, an anti-fever food, being refreshing, palatable, and nutritive, as well as exceedingly digestible. Oranges, biscuits, and cold water, during the critical stage of the disease—milk, bread, and bananas, after the crisis is past—ought to be the standard regimen in our semi-tropical seaport towns; inland and farther north substituting pears or baked apples, and perhaps sweet-potatoes, for bananas, and watermelons for oranges. A frugal diet has the further advantage of obviating the tendency to fretfulness and splenetic humors which results from the use of animal food in indigestible quantities, i. e., in hot weather from a very moderate quantum. In midsummer, persons of a "nervous temper" could often cure their disposition by a change of diet. Mental energy exercises a remarkable influence on the idiopathic symptoms of climatic fevers. Pluck is a febrifuge. Men of exceptional will-force, or under the stimulus of an exceptional enthusiasm, contrive to hold the foe at bay; they keep on their legs till their work is done, even though the presence of a febrile diathesis continues to manifest itself by indirect symptoms. During the carnival of chaos following the end of our civil war and preceding the collapse of the Mexican "Empire," the Sheriff of Cameron County, Texas, undertook to escort a Mexican prisoner across the Rio Grande, in order to save him from a mob who unjustly but obstinately accused him of complicity in the "Cortina riot." It was a ticklish job, but the sheriff, though prostrated by a malignant ague and almost blind from the use of quinine, declined to intrust his *protégé* to a deputy, and preferred to rely on luck and his reputation as a "dead shot." Like most pistol *virtuosos* he was able to fire off-hand, and was confident that no shakiness would interfere with the accuracy of his aim, but was rather uneasy on account of his impaired eyesight. But on the morning of the critical day his fever left him, together with all sequelæ and concomitant symptoms, and he returned, with the conviction that the expedition had saved his own life as well as that of his prisoner.

Even scientific enthusiasm may exercise a similar prophylactic effect, and has supported more than one African explorer and East Indian officer whom no quinine could have saved from the combined influence of solar and animal heat. The trouble is, that the effect is so apt to subside with the cause: heroes and explorers who survive a summer campaign in the wilderness die upon the return to their comfortable winter quarters. The fate of Sir Stamford Raffles is a melancholy instance: A naturalist, a patriot, and a zealous philanthropist, his triple enthusiasm carried him safely through the swampiest regions of the Sunda Archipelago, and, as long as his expedition required his personal presence, Fortune seemed to favor him in every enterprise; but, upon his return to his palatial residence at Bencoolen, he and all his household were prostrated by the jungle-fever, and, at the end of a life perhaps unequaled for successful activity, he found himself bankrupt, childless, and hopeless. At a time when beef or pork steaks and a bottle of porter were the essentials of a Christian breakfast, a vegetarian official of the East India Company might have defied ill-luck to outweigh the advantage of permanent good health where good health obtained the highest premium. Even now, by their obstinate adherence to their native diet, the British residents of the East Indies are almost decimated every year, especially where the zymotic tendency of that diet is aggravated by the effect of foul air.*

For on the other hand it is equally sure that strict attention to ventilation and a liberal use of cold air and sponge-baths will palliate the effects of many dietetic sins. The patient has either to adapt his diet to the temperature of the South, or adapt his temperature to the diet of the North. Experience has taught the creoles to *take things coolly*. With all their excitable temperament, they avoid violent outbursts of passion; they do not overwork themselves; they preserve the even tenor of their way, even if they are behind time and know that their dinner is getting cold. And, above all, they indulge in liberal *siestas*. Hard work in the hot sun, with a stomach full of greasy viands, obliges the vital force to resist the triple fire of a furnace heated by the sun-rays, by exercise, and by calorific food. Brain-work, too, is apt, in hot weather, to exert an undue strain on the vital energies, and to complicate the difficulties of the digestive apparatus. Cold air is a peptic stimulant, but even in the North a man can not labor with his brain without impeding the labors of his stomach; but, in the languid atmosphere of a southern marsh-land, that impediment becomes an absolute prevention, and the brain-worker who eats for the purpose of nourishing his organism had better save his food for supper than oblige his stomach to carry it for half a day in an undigested condition. For during that half day putrescent decomposition anticipates the work of gastric disintegration; the ingesta ferment, catalytic humors pass into the circulation and prepare the way for the reception and development of zymotic germs from without. The hygienic alternative is, therefore, a long *siesta*, or a considerable postponement of the dinner-hour. South of Cape Hatteras, Nature exacts an account for every superfluous act that tends to raise the temperature of the system by a single degree. *Keep cool* becomes the first commandment of her sanitary code. He who scrupulously avoids anger, enthusiasm, and other calorific passions, who performs the prin-

* "In the [East Indian] jails under British control there are usually confined no fewer than 40,000 prisoners, and the average annual mortality of the whole was recently ten per cent, rising in some cases to twenty-six per cent, or more than *one in four*" (Dr. MacKinnon's "Treatise on the Public Health of Bengal," Cawnpore, 1848, chap. i).

cipal part of the day's work in the cool of the morning, and eats his principal meal in the cool of the evening, who rests during the hottest hour of the afternoon, and takes active exercise only in the swimming-school, may indulge in the dietetic prerogatives of the higher latitudes; Nature will condone his beefsteaks, pork-fritters, and some of his cocktails; his mince-pies will not rise and bear witness against him.

But the happier biped who can waive those prerogatives will free his stomach from the necessity of digesting winter food in a summer climate, and, in return, will enjoy the freedom of the land, the privilege to work, play, eat, rest, laugh, or get mad, at any time he pleases. He has reconciled himself to Nature, and shares the natural rights of the creatures who have not forfeited their earthly paradise; for the artificial comforts of the North are, after all, only more or less imperfect imitations of the gratuitous luxuries which our forefathers enjoyed in their tropical garden home.

ASSOCIATION OF COLORS WITH SOUNDS.

By HENRI DE PARVILLE.

POPULAR expressions are often very significant. "I saw three dozen lights of all colors," or some similar expression, may frequently be heard from persons who have received violent blows on the head or face. Under the influence of shocks of this kind, the eye really seems to see infinite numbers of sparks. Shocks of a certain class impressed upon the nervous system seem to have the faculty of producing phenomena of light. This remark has been suggested by the facts we are about to relate, which lead us to suppose that sonorous vibrations are susceptible in certain cases of provoking luminous sensations. There are, in fact, persons who are endowed with such sensibility that they can not hear a sound without at the same time perceiving colors. Each sound to them has its peculiar color; this word corresponds with red and that one with green, one note is blue and another is yellow. This phenomenon, "color-hearing," as the English call it, has been hitherto little observed.

Dr. Nussbaumer, of Vienna, appears to have been the first person who took serious notice of it. While still a child, when playing one day with his brother, striking a fork against a glass to hear the ringing, he discovered that he saw colors at the same time that he perceived the sound; and so well did he discern the color that, when he stopped his ears, he could divine by it how loud a sound the fork had produced. His brother also had similar experiences. Dr. Nussbaumer was afterward able to add to his own observations nearly identical ones made by a medical student in Zürich. To this young man, musical notes were translated by certain fixed colors. The high notes induced clear colors, and the low notes dull ones. More recently, M. Pedrono, an ophthalmologist of Nantes, has observed the same peculiarities in one of his friends. M. Pedrono's friend had become so accustomed to the double perception of sounds and colors that he took no notice of it, and never told it to any one, having forborne to speak of it at the outset for fear of being considered singular. At one time several persons were amusing themselves by repeating in all kinds of applications, as a kind of joke, a slang expression which they had found in some story: "That is as fine as a yellow dog." So everything was declared to be as fine as a yellow dog. "Have you noticed his voice?" said one of the company; "it is as fine as a yellow dog." "Not at all," said M. Pedrono's friend, quickly, "his voice is not yellow, it is pure red." The observation was made in so earnest a manner that the whole company laughed out. "What!" they said, "a red voice! what do you mean?" M. X—— had to explain the curious faculty he had of seeing the color of voices. Each of the company, then, of course, wanted to know what was the color of his own voice, and M. X—— had to satisfy them all. It so happened that one of them had a yellow voice.

According to M. Pedrono, this friend of his had no trouble in his eyes or ears. His hearing was good, his sight perfect, and his general health excellent. Yet the chromatic sensitiveness was so sharp that the luminous impression seemed to be made a little while before the sonorous one; and, before it was possible to judge the quality and intensity of the sound, he had already seen and already knew whether it was red, blue, yellow, or of other color. He did not, like the Zürich student, perceive an appreciable change of color with every modification of tone. A sharp note was only brighter, a flat one duller, than the natural. But, when the same piece was played upon different instruments, varied sensations were produced. A Breton melody gave the sensation of yellow when it was played on a saxophone, red on a clarinet, and blue on the piano, showing that in this case the phenomenon was chiefly influenced by the *timbre.* The intensity of the color corresponds with the energy of the sound. Loud noises bring out brilliant colors. Very sharp tones determine a grayish sensation, that passes to a bright silver-white when they become intense. The human voice gives multifarious impressions. The vowels *i* and *e* (French) produce the most lively colors, *a* and *o* less defined ones, *u* a dark tint. Generally, with this subject, *e* gives yellow, *a* dark blue, *o* red or orange, *u* black. The diphthongs give combined colors: *eu* (French) is gray, *oi* clear gray, *ue* violet.

M. X—— can see all kinds of sounds and noises and distinguish all voices, but, curiously, can not perceive his own. When he is asked for the definite form under which he sees the sounds, he replies that the colored appearance is displayed on the vibrating object, the sonorous body. If the string of a guitar is twanged, that is what is colored;

if the piano is touched, the color appears over the keys. The seat of color, he says, "appears to me to be principally where the sound is made above the person who is singing. The impression is the same if I do not see any one. There is no sensation in the eye, for I think of the same color with my eyes shut. It is the same when the sound comes from the street through walls and partitions. When I hear a choir of several voices, a host of colors seem to shine like little points over the choristers; I do not see them, but I am impelled to look toward them, and sometimes while looking toward them I am surprised not to see them."

These phenomena are strange; possibly the description of them may lead to the discovery of other equally singular examples, and it will become feasible to group them and look for an interpretation of them. It is now a question whether they are hallucinations, like the well-known ones of hearing voices and seeing phantoms, or whether they result from accidental confusion of the auditory and visual nervous fibers. As we now know that there are motor nerve-centers, specially adapted to particular functions, there may be also chromatic centers near the acoustic centers, and these different centers may echo to each other; and the acoustic fibers may cause synchronous vibrations at definite periods of the chromatic fibers. Without multiplying hypotheses, we have pointed out the facts, and must be satisfied to wait for the explanation of them till it is possible to make it.—*Le Monde de la Science et de l'Industrie.*

THE FORMATION OF SEA-WAVES.

By ÉMILE SOREL.

ONE of the first things to be observed in a storm is the way the wind acts. It does not blow regularly, but in gusts. At one moment it bends over the branches of the trees; in the next, it has loosened its hold, and let them fly back. We see it swelling out a ship's sails into a full puff; a minute later the sails hang flapping as if they had been struck down.

We can account for these phenomena and explain the intermittence of the wind-puffs by assuming that the molecules of air, displacing each other, excite a vibratory movement, which gives rise to little undulations following one after another at intervals of a few seconds. The resultant of a series of these undulations is a puff of wind which comes on suddenly and is followed by a short lull. A series of puffs constitutes a squall, and an aggregation of squalls forms the atmospheric wave which is called a gale of wind. We should naturally expect to observe the same phases in the formation of sea-waves; and, in fact, if we carefully examine a wave, we shall find that it is covered with very fine ripples, that correspond to the atmospheric vibrations. The ripples give rise to wavelets, which correspond to the undulations of the air, and are seen on the upper part of the waves. The wave proper appears to consist of a series of wavelets. A number of waves constitute a billow; a series of billows gives rise to a heavy sea (*paquet de mer*); a series of heavy seas produces the great swell or tidal wave of the storm.

From the nautical point of view, the ripples are of no importance, for they are seldom more than a few millimetres in diameter; but from the scientific point of view they may be considered as the origin of the swing of the liquid element, for they engender the wavelets. The last are still of no interest to the sailor, but are important in their relation to works of art, which are disintegrated by their blows, apparently insignificant, but infinitely multiplied. The wavelets are from ten to thirty centimetres in diameter and not very long. A very heavy wind breaks them up and contributes to the formation of a fine dust of salt water or salt spray, which is destructive to vegetation on exposed coasts. The wave proper may, in the English Channel, be about ten feet high, thirty feet or more broad, and eighty feet long; its proportions do not disturb large ships, but it is destructive, in the long run, to port works, and is dangerous to small craft when it breaks. We may estimate that ten waves make a billow. The first of the ten may be relatively small, but the others go on increasing to the last.

The heavy seas are the terror of sailors. They represent an enormous volume of water in motion. A gust of wind can not possibly raise up such a mass, and it can only be the result of the combined efforts of the tempest. A heavy sea may reach a height equal to twenty-five or thirty or more feet. It is massive, and strikes like a battering-ram. On the land it causes great damage, and makes breaches in works of earth and stone; at sea, it can send a transatlantic packet to the bottom with a single blow.

The great tidal wave is produced by two causes. On one side, it is the general resultant of the billows and the great seas; and, on the other hand, it is produced by barometrical depressions causing the waters of the ocean to rise. In cyclones, the rise of the water in the center would be neutralized by the centrifugal force, and it is therefore probable that the former cause acts alone. The tidal wave has but small amplitude, but, when inclosed by parallel coasts, it may rise to a height of several metres. It then causes inundations of low shores.

The singular fact has been remarked at Havre that in a storm the swell almost always comes after the tide. The sea rises to its normal high-water mark at the prescribed hour, and then begins to retire as usual; all at once it rises again, to a height generally much greater than before. This high sea continues for a considerable time, sometimes for several hours; and it has been known to last twenty-four hours.

The billows, heavy seas, and tidal waves possess a considerable inertia, and keep up the swell after the tempest has subsided. The real waves fall, while the billows still subsist, but flattened. It is then easy to estimate the distance between them. On the 26th of March, 1882, I counted eight in a space of four thousand metres.

The most serious event that can take place at sea is a change of wind, such as nearly always occurs in cyclones. The phenomena we have described being well established and sure to continue for a considerable time by virtue of their inertia, when the wind veers around so as to reproduce them in another direction, the new waves cross the old ones, and a chopped sea, dangerous to navigation, is the result.

If any one interested in scientific matters comes to the shore to study the formation of waves, he will experience some disappointment, for the configuration of the coasts, the eddies, and the currents, modify the phenomena in a thousand ways. They are, however, always apparent, even in the calmest weather, and vary only in their amplitude. To observe them it is enough to take notice of the level of the water against a post, a jetty, or other structure. Changes of level are produced there quite similar to the pulsations of the sea; and the extent of these pulsations gives quite exact data respecting everything that we have mentioned.

Waves may be classified as direct waves and waves of transmission. The former, with which the surface of the sea is frequently agitated, are those which the wind raises directly. Waves of the second class may be produced in the calmest weather; their origin is frequently quite distant from the places where they are observed; and they reach those places by transmission. A well-known physical experiment will suggest an explanation of the phenomenon of an agitated and raging sea when there is no wind. If we have a long line of billiard-balls arranged in contact one with another, and give a quick blow to the first one, the last one will roll away. The shock is transmitted from the first ball to the last one, without the intermediate ones suffering any appreciable motion. Marine disturbances caused by direct waves, tides, earthquakes, etc., may in the same way be transmitted through molecules of still water without agitating them. If the liquid space is free, the vibrations are gradually extinguished; if they meet an obstacle, there is a shock. If the obstacle is a shore, they form a tidal-wave and raise large billows, while a few miles away from the shore the sea is quiet. When the obstacle is a shoal or a contrary vibration, heavy waves are raised on the surface of the sea; they seem to start from the bottom, and put ships in great danger. The waves produced in both cases are waves of transmission, as also are those which beat on reefs in pleasant weather, and those which prolong the swell after storms. The transmission may be effected at very great distances—several hundred miles, for example. It presents a kind of analogy with earthquake-shocks which pass over dead points, and make themselves felt only in places where there are faults or differences in the density of the terrestrial strata.

At Havre, on stormy days, the perturbations of the open sea, transmitted to the shoals of the roadstead, cause oscillations of the water within it, and produce what the sailors call the *levée*, which, in bad weather, prevents the transatlantic steamers from entering the port. Crossing the entrance of the port, with its breakwaters, the *levée* penetrates into the outer harbor and spreads out there, attaining two or three metres in amplitude. It enters the *Bassin du Roi* through a sluice sixteen metres in width, and thence is propagated through a sluice thirteen metres wide to the *Bassin du Commerce*, where, involved in the ins and outs of the quays, it does not reach more than thirty or fifty centimetres in amplitude. This remarkable phenomenon of the *levée*, passing into a chain of basins, appears analogous to that of the vibrations of a tense cord divided into sections by a series of frets in contact with it. When we draw a bow over one of the sections of the cord, the others will also vibrate, while a dead point or node will be formed at each place of contact. In the phenomenon under consideration, the entrance of the port and each sluice give rise to a node.

When a mass of water in motion meets an obstacle, it accumulates against it by virtue of its inertia ; the water rises, then falls back. This is called the surf, and may be observed along all coasts. It is produced at sea after every tide. The most curious effect induced by it is the back-flow in rivers. The Seine, for instance, flows rapidly at low water ; but, as the tide rises, a liquid obstacle several metres high is piled up in less than two hours against the mouth of the river. The water of the Seine then stops, rises, and falls back as surf, while the surf in its turn acts as an obstacle to the current of the river above it. The phenomenon is repeated, and again, and so on, steadily going higher up the river, so that in effect a strong wave ascends the stream. The phenomenon may be easily reproduced on a small scale ; every time we suddenly stop the rapid current of a brook or any stream of water, we may see a back-water ascend it.

The amplitude of the movement of waves remains to be spoken of. It appears to be proportional for direct waves to the force of the wind. On the other hand, since each ripple, wavelet, or wave, occupies a given space, and since, as I have already said, a certain number of these are necessary to give rise to a billow or a heavy sea, it is evident that, with a given wind, a billow of a particular dimension can be formed only if a sheet of water extends over a certain area of surface. This is precisely what takes place, and the dimensions of the billows produced by a given wind appear to be proportional to the extent of the sea in which they are formed. Thus the largest surface of water to be found on the earth is in the latitude of the Cape of Good Hope; and the strongest waves are met in the neighborhood of this cape. In the Mediterranean the wave is short.

In all ages men have sought for means of calming the agitation of the waves, which is so prejudicial to shipping. The best means hitherto employed has been that of breakwaters, the operation of which is too well known to need description. It may be added that floating wave-breaks, such as would be constituted by a large number of spars or planks left to drift, afford a perfect amelioration of the agitation of the waves. Hitherto engineers have applied their efforts only against the larger waves. Why not attack the evil in its origin? Why not take up the ripples and the wavelets, and oppose them with floating ripple-breaks? Such breaks might be made with twigs, saw-dust, or soot, etc., and experiment has proved that they will be efficacious. The needles of ice which form in cold weather on the surface of the water are excellent natural wavelet-breaks. Generally, every cause hindering the formation of wavelets appeases the agitation of the waves. Thus a rain, every drop of which breaks a ripple, calms the sea to a certain extent. Sailors know this. Billows have been fought against with ordinary wave-breaks. Wavelets may be destroyed by employing light bodies, ripples with dust, microscopic ripples with an infinitely fine powder. A liquid will serve the end admirably. Oil is the best of all agents for the purpose. It has the property (to which capillarity is probably not foreign) of spreading over the water as a pile of billiard-balls spreads over a well-polished marble table. Its molecules form as many floating microscopic pebbles, in the intervals between which the ripples break, as the billows break upon the shingle of the coasts. Oil thus acts as a lubricant, attenuating the friction of the wind. Capillary phenomena, due to the minuteness of the intervals between the oleaginous molecules, intervene to divide up and draw off the surface of the water and completely neutralize the force of the wind. All of these causes together may give us the reason of the efficacy of oil in destroying waves.

It should be understood that all the means of restraining the agitation of waves here indicated are good only against direct waves due to the formation of ripples. They have but slight influence on waves of transmission, which are due to other causes. Oil may appease the billows, but the swell will continue.—*Translated for the Popular Science Monthly from La Nature.*

MENTAL CAPACITY OF THE ELEPHANT.

By WILLIAM T. HORNADAY.

ACCORDING to the popular idea, *man* is the only animal endowed with reason. Even after modern scientific classification forced from all the humiliating admission that man is an animal, the idea of his supreme superiority over all the rest of the animal kingdom was embalmed in the formula, "Man is a reasoning being." The reasoning faculty is, to the popular mind, the gulf which separates him from the so-called dumb brutes, wide, fathomless, and impassable. While there are many who believe that this gulf which separates reason from absence of reason is occasionally bridged over, as it were, in the case of individual animals of phenomenal intelligence, there are a few who deny its existence altogether. Whenever enough evidence is accumulated to compel the unconditional surrender of the ground man has assigned for his exclusive occupancy, whenever it is clearly and conclusively shown that man's intellectual supremacy over the lower animals is due to the degree and not to the quality of his intellect, it will mark the beginning of a new era in psychological thought.

The principal purpose of this paper is to show the scope and quality of intelligence displayed by the animals of a certain species, the elephant, and to afford some data for a comparison of the mental processes of this animal with those of man.

Of late years, or we may even say during the last decade, the question as to whether any of the lower animals are ever capable of reasoning has been often discussed. Hundreds of instances of unusual intelligence displayed by domestic animals have been related, and in many cases the actions of certain individuals have been admitted to be the result of reasoning. The dog has furnished a far greater number of such instances than any other animal, but we believe that this is due not so much to his superior intelligence as to the fact that he is brought into closer relations with his master, man, than is any other animal. A great many stories are told of the horse, cat, and elephant, and a few others detailing the performances of three or four remarkably intelligent chimpanzees and orangs have been repeated until they are now worn threadbare. Siamangs, baboons, and other members of the monkey tribe, parrots, canaries, and even fleas, have also attracted attention by their intelligent independent actions, or their performances under training. It appears that by universal consent the dog has been given the first place in the arrangement of animals according to their intelligence. Dr. W. L. Lindsay, however, who has made a careful, critical, and highly elaborate study of the subject of "Mind in the Lower Animals," thus arranges the orders of mammalia in a descending series according to the degree of intelligence manifested by their most gifted members:

1. *Bimana*, higher man only, however,
2. *Quadrumana*, especially the larger anthropoid apes.
3. *Carnivora*, including especially the dog and cat.
4. *Proboscidia*, the elephant.
5. *Ungulata*, especially the horse, mule, and ass.
6. *Rodentia*, especially the beaver and rat.

Apparently the elephant has always been regarded as an animal of third or fourth rate intelligence, as compared with common domestic animals and the great apes. Cuvier, in his "Règne Animal," records his conviction that in sagacity the elephant in no way excels the dog, and some other species of carnivora. Sir Emerson Tennent, even after a careful study of the elephant, is disposed to award the palm for mental superiority to the dog, but he hastens to add, "not from any excess of natural capacity, but from the higher degree of development consequent on his more intimate domestication and association with man."

Surprising as these opinions may seem in the light of certain facts to be presently adduced, much more surprising is the opinion of Mr. G. P. Sanderson, who has been more intimately associated with elephants than any man living. After several years' continuous service, entirely devoted to the capture of wild herds and their management while under training in captivity, he writes as follows of the Indian elephant:

"Its reasoning faculties are undoubtedly far below those of the dog, and possibly of other animals; and in matters beyond the range of its daily experience it evinces no special discernment. While quick at comprehending anything sought to be taught to it, the elephant is decidedly wanting in originality."

An opinion from such an authority is entitled to great weight in a consideration of the entire subject, and it is possible that Sanderson's estimate of the elephant's powers of original reasoning is correct; but in the mind of the writer there is no question of the elephant's *general* intellectual superiority over all other animals, except higher man. More than this, I believe that the hitherto universal failure to recognize this fact has been a *real loss* to the student of psychology.

While the subject-matter of this article has been drawn almost wholly from observations of the Indian, or Asiatic, elephant both in a wild state and under various conditions of captivity, there is no evidence whatever to prove that, according to an idea which has quite generally prevailed, the African elephant is less intelligent and tractable than his East Indian congener. While many intelligent people have been led to believe that *Africanus* can not be trained to service at all, actual proof of his intellectual inferiority is wholly wanting, and there is no good reason for believing that *any* can be found. Whenever it becomes necessary to accumulate evidence in his favor, the task will be a simple and easy one.

Ælian and Pliny describe the performances of African elephants in the amphitheatre at Rome, the former with considerable detail. African elephants were used by the Carthaginians in their wars with the Romans, but it is stated by the historian Armandi that, from inexperienced and deficient training, they proved less effective than the elephants of India.

A gentleman who lately arrived in this city from the west coast of Africa informed the writer that he had just seen at St. Paul de Loanda an African elephant, considerably larger and older than Jumbo, at work loading timbers into a ship, and that the animal performed his tasks with surprising intelligence and precision.

The Indian elephant's reputation for mental superiority over the African is apparently due to accidental circumstances. It is true that trained elephants of the former species outnumber the African by perhaps more than sixty to one, but it is also true that in Africa the inhabitants are mostly negro savages who have neither the resources, intelligence, nor inclination necessary to the wholesale capture and domestication of elephants. Unlike the inhabitants of Hindostan, Ceylon, Burmah, and Siam, who from time immemorial have made a business of the capture and training of wild elephants, the negroes of Africa look upon the elephant only as an ivory-producer. The splendid tusks of *Africanus* make his total extermination only a question of time. Long before the world will have reached the necessity of utilizing this animal as a beast of burden, the ivory hunters will have finished their war of extermination, now being waged with such alarming success, and the chances are that the zoölogist of the future will describe this animal as so entirely inferior to the Indian species, both in intelligence and temper, that only a few individuals were ever successfully trained. It is the misfortune of *Africanus* that he belongs to the undeveloped continent. Two centuries hence, when the last of his race goes to join the mammoth and the mastodon, his captive congener in India will still be devouring his four hundred pounds of green fodder per day, in peaceful domestication, while in the jungles, the progeny of the wild herds which now roam the forests, secure from destruction under the stringent English laws, will still be protected for the perpetuation of the species.

The intelligence of an animal may be measured by taking into account, separately, its *intellectual qualities*, as follows :

1. Powers of independent reasoning or observation.
2. Memory.
3. Comprehension under tuition.
4. Accuracy in the execution of man's orders.

Closely allied to these are the *moral qualities* which go to make up an animal's temperament and disposition, about as follows :

1. Amiability, which guarantees security to his human associates.
2. Patience, or submission to discipline and training.
3. Courage, which gives self-confidence and steadiness.
4. A disposition to obedience, with cheerfulness.

Before entering upon a discussion of the intellectual powers and moral qualities of the elephant in accordance with the outlines just given, I wish to state that in matters involving facts I shall confine myself strictly to my own observations made on *Elephas Indicus*, except where otherwise stated. A point to which we ask special attention from beginning to end is, that in endeavoring to estimate the mental capacity of the elephant, we shall base no arguments upon any *particularly intelligent individual* of a given race or species, as is *always* done in discussions of intelligence in the dog, the cat, the horse, parrot, and ape. On the contrary, it is the intention to reveal the mental capacity of *every elephant living*, tame or wild, of both the Indian and African species, except a few individuals with diseased minds. It is not to be shown how successfully *an* elephant has been taught by man, but how *all* elephants in captivity have been taught, and what *every* wild elephant is known to be capable of. In endeavoring to determine the mental status of the dog, horse, cat, ape, or elephant, or even human beings, the *average intelligence of all the members of an entire species*, or at least an entire race, should be the objective point of the inquiry.

Under the head of intellectual qualities we have first to consider the elephant's

Powers of Independent Observation and Reasoning, or Reasoning from Cause to Effect.

While many wonderful stories are related of the elephant's sagacity and independent powers of reasoning, it must be admitted that an indefinitely greater number of much more wonderful anecdotes are told on equally good authority of dogs. But the circumstances in the case are wholly to the advantage of the dog, and against the elephant. While the former roams at will through his master's house and out-door premises, through town and country, mingling freely with all kinds of men and domestic animals, with unlimited time and liberty to lay plans and execute them, the elephant in captivity is chained to a stake, with no liberty of action whatever, aside from eating and drinking, and amusing himself by swaying his body, swinging one foot, or switching his tail. Such a ponderous beast can not be allowed to roam at large among human beings, and he never leaves his stake and chain except under the guidance of his *mahout*, who directs his every act. There is no telling what wonderful powers of reasoning captive elephants might develop if they could only enjoy the freedom accorded all dogs, except the blood-hound, bull-dog, and a few others.

But in our dealings with incontestable facts none of the many sagacity-stories alluded to can be used. We are, therefore, for the reasons just given, compelled to find the most of our evidences of independent reasoning in *wild* elephants. The writer has frequently seen wild elephants—

1. Reconnoitre dangerous ground by sending a scout or spy.
2. Communicate intelligence by signs.
3. Retreat in orderly silence from a lurking danger.
4. Invariably march in single file, like the jungle tribes of men.

Having on one occasion in hunting elephants approached to within fifty yards of the stragglers of a large herd of about thirty animals, which was scattered over about four acres of very open forest and quietly feeding, certain individuals of the herd on the side nearest us suddenly suspected danger. One of them elevated his trunk with the tip bent forward, and scented the air from various points of the compass, a sure sign of danger suspected. A moment later an old elephant left the herd and started straight for our ambush, scenting the air with upraised trunk as he slowly and noiselessly advanced. We instantly retreated, unobserved and unheard, and the elephant advanced until he reached the identical spot where we had a moment before been concealed. He paused and stood motionless as a statue for about two minutes, then wheeled about and quickly but noiselessly rejoined the herd. In less than half a minute the whole herd was in motion, heading directly away from us, moving very rapidly but *without the slightest noise.* The huge animals simply vanished like shadows into the forest. The entire herd formed in single file before proceeding a quarter of a mile, and continued strictly in that order, one directly behind another, for several miles. Like the human dwellers in the jungle, the elephants know that the easiest and most expeditious way for a large body of animals to traverse a tangled forest is for the leader to pick the way, while all the rest follow in his footsteps.

In strong contrast with the stealthy and noiseless manner in which elephants steal away from a lurking danger or ambush discovered, from an open attack, accompanied with the noise of fire-arms, they rush away at headlong speed, quite regardless of the noise they make. On one occasion a herd which I was designing to attack, and had approached to within forty yards on one side, as they were feeding in some thick bushes, discovered my presence and retreated so silently that they had been gone five minutes before I discovered what their sudden quietude really meant. In this instance, also, the alarm was communicated by silent signals, or *sign-language.*

Tame elephants are never known to tread on the feet of their attendants or knock them down by accident ; or, at least, no instances of the kind have ever come to my knowledge. The elephant's feet are very large, his range of vision is very circumscribed, and his extreme and wholly voluntary solicitude for the safety of his human attendants can not be due to anything else than independent reasoning. The most intelligent dog is apt to greet his master by planting a pair of dirty paws on his coat or trousers. The most sensible carriage-horse is liable to step on his master's foot or crowd him against a wall in a moment of excitement; but even inside the *keddah*, with wild elephants all about, and a captive elephant hemmed in by two, three, or four tame ones, the noosers actually work under the bodies and between the feet of the tame animals until the feet of the captive are tied.

All who have witnessed the tying of captives, one by one, in a keddah, wherein a whole wild herd have been entrapped, testify to the human-like quality of intelligence displayed by all the tame elephants who assist in the tying and leading out and subjugation of the captives. They enter into the business with both spirit and understanding, and as occasion requires will deceitfully cajole or vigorously punish a troublesome captive. Sir Emerson Tennent asserts that the tame elephants display the most perfect conception of every movement, both of the object to be attained and the means to accomplish it. While this statement probably exceeds the exact truth, it truthfully conveys the impression made upon the beholder.

We come now to the second intellectual quality, or MEMORY.

So far as this may be regarded as an index of an animal's mental capacity, the weight of evidence is overwhelmingly in favor of the elephant. Every one who attended either Barnum's or Forepaugh's circus during the last year witnessed an imitation military drill performed by from twelve to sixteen elephants, which, in animals of any other species, would be considered a most remarkable performance. The following were the commands given by the trainer, understood and remembered by each elephant, and executed without an instant's hesitation or any mistake. These we will call the

Accomplishments of Performing Elephants.

1. Fall in line.
2. Roll-call. (As each elephant's name is called, he takes his place in another rank.)
3. Present arms. (Trunk uplifted, with tip curved forward and held in that position for a short time.)
4. Forward, march.
5. File left, march.
6. Right about face, march.
7. Left about face, march.
8. Right by twos, march.
9. Double quick, march.
10. Single file, march.
11. File right.

12. Halt.
13. Ground arms. (All lie down, and lie motionless.)
14. Attention. (All get up.)
15. Shoulder arms. (All stand up on their hind-legs.)

In all, fifteen commands obeyed by the whole company of elephants.

It being impossible, or at least impracticable, to supply so large a number of animals with furniture and stage property for a further universal performance, certain individuals were supplied with the proper articles when necessary, for a continuation of the performance, as follows:

16. Ringing bells.
17. Climbing up a step-ladder.
18. Going lame in a fore-leg.
19. Going lame in a hind-leg.
20. Stepping up on a tub turned bottom up.
21. Standing on a tub on two right-legs only.
22. The same, on opposite fore- and hind-leg.
23. The same, on the fore-legs only.
24. The same, on the hind-legs only.
25. Using a fan.
26. Turning a hand-organ.
27. Using a handkerchief to wipe the eyes.
28. Sitting in a chair.
29. Kneeling, on the knees proper.
30. Kneeling on "fore-knees" (so called), or wrists.
31. Walking astride a man lying lengthwise.
32. Stepping over a man lying crosswise.
33. Forming a pyramid of elephants by using tubs of various sizes.

While it is true that every act in the latter part of this performance was not participated in by every one of the elephants who went through the military drill, there is no room for doubt of the entire ability of each individual to understand the meaning of the whole thirty-three commands, and to remember them all accurately and without confusion. The most astonishing feature of the performance was, aside from the perfect obedience of the huge beasts, their power of memory, which is without a parallel in the history of trained animals.

We come now to a consideration of the

Accomplishments of Working Elephants.

In all the timber-forests of Southern India every captive elephant is taught to perform all the following acts and services, as I have witnessed on many occasions:

1. To *salaam*, or salute, by raising the trunk.
2. To kneel, to receive a load or a passenger.
3. When standing, to hold up a fore-foot, to serve the driver as a block in climbing to his place.

4. To lie down to be washed, first on one side and then on the other.

5. To open the mouth.

6. To "hand up" any article from the ground to the reach of a person riding.

7. To pull down an obstructing bough.

8. To halt.

9. To back.

10. To pick up the end of a drag-rope and place it between the teeth.

11. To drag a timber.

12. To kneel and with the head turn a log over, or turn it with the tusks if any are present.

13. To push a log into position parallel with others.

14. To balance and carry timbers on the tusks, if possessing tusks of sufficient size.

15. To "speak," or trumpet.

16. To work in harness.

In all, sixteen distinct acts.

Every working elephant in India is supposed to possess the intelligence necessary to the performance of any of the acts enumerated above at the command of his driver, either by spoken words, a pressure of the knees or feet, or a touch with the driving goad. For the sake of generalization I have purposely excluded from this list all tricks and accomplishments which are not universally taught to working elephants. We have seen, however, that performing elephants are capable of executing nearly double the number of acts commonly taught to the workers; and, while it is useless to speculate upon the subject, it must be admitted that, were a trainer to test an elephant's memory by ascertaining the exact number of commands it could remember and execute in rotation, the result would far exceed anything yet obtained. For my own part, I believe it would exceed a hundred, if not many times that figure. The performance in the circus-ring is limited by time and space, and not by the mental capacity of the elephants.

When we come to consider the comparative comprehension of animals under man's tuition, we find the elephant without a rival.

On account of the fact that an elephant is about eighteen years in coming to anything like maturity, according to the Indian Government standard for working animals, it is far more economical and expeditious to catch full-grown elephants in their native jungles than it would be to breed and rear them. About ninety per cent of all the elephants now living in captivity were caught in a wild state and tamed, and of the remainder at least eight per cent were born in captivity of females that were gravid when captured. It will be seen, therefore, that the elephant has derived no advantage whatever from ancestral association with man, added to the most careful selection and breeding which, all combined, have made the colly, the pointer, and the setter the wonderfully intelligent animals they are. For many generations the horse has been bred for strength, for speed, or for beauty of form, but the breeding of the dog has been based *chiefly* on his intelligence. With all his advantages, his comprehensive faculties, even in the most exceptional individuals of a whole race, are not to be compared to those of any adult elephant fresh from the jungle.

The extreme difficulty in teaching a dog of mature age even the simplest thing is so well known that it has passed into a proverb : "It is hard to teach an old dog new tricks." In other words, the conditions *must* be favorable. What is the case with the elephant? The question shall be answered by Sanderson. In his "Wild Beasts of India," he says : "Nor are there any elephants which can not be easily subjugated, whatever their size or age. The largest and oldest elephants are frequently the most easily tamed, as they are less apprehensive than the younger ones."

The most striking feature in the education of an elephant is the suddenness of his transition from a wild and lawless denizen of the forest to the quiet, plodding, good-tempered, and cheerful beast of draught or burden. There takes place in the keddah, or pen of capture, a mighty struggle between the giant strength of the captive and the ingenuity of man, ably seconded by a few powerful tame elephants. When he finds his strength utterly overcome by man's intelligence, he yields to the inevitable, and accepts the situation philosophically. Sanderson once had a narrow escape from death while on the back of a tame elephant inside a keddah attempting to secure a wild female. She fought his elephant long and viciously, with the strength and courage of despair, but she was finally overcome by superior numbers. Although her attack on Sanderson in the keddah was of the most murderous description, he states that her conduct after her defeat was most exemplary, and she never afterward showed any signs of ill-temper.

Mr. Sanderson and an elephant-driver once mounted a full-grown female elephant on the sixth day after her capture, without even the presence of a tame animal. Sir Emerson Tennent records an instance wherein an elephant fed from the hand on the first night of its capture, and in a very few days evinced pleasure at being patted on the head. Such instances as the above can be multiplied indefinitely. To what else shall they be attributed than philosophic reasoning on the part of the elephant? The orang-outang, so often put forward as his intellectual superior, when captured alive at any other period of life than that of helpless infancy, is vicious, aggressive, and intractable for weeks and months, if not during the remainder of its life. Orangs captured when fully adult exhibit the most tiger-like ferocity, and are wholly intractable.

If dogs are naturally superior to elephants in general intellect, it should be as easy to tame and educate newly-caught wild dogs or wolves of mature age as newly-caught elephants. But, so far from this being the case, it is safe to assert that it would be *impossible* to train the most intelligent company of pointers, setters, or collies ever got together to perform the feats accomplished with such promptness and accuracy by all regularly trained circus-elephants.

The successful training of all elephants up to the required working point is so fully conceded in India that the market value of an animal depends wholly upon his age, sex, build, and the presence or absence of good tusks. The animal's education is either sufficient for the buyer, or, if not, he knows it can be made so.

The time required for the training of newly-captured elephants, and fitting them for all kinds of work, varies from four to six months, although instances are known wherein some have been worked in harness two months after capture.

The fourth quality, which serves as a key to the mental capacity and mental processes of an animal, is the degree of its

Promptness and Accuracy in the Execution of Man's Orders.

The most impressive feature of a performance of elephants in the circus-ring is the fact that every command uttered is obeyed with true military promptness and freedom from hesitation, and so accurately that an entire performance is often conducted and concluded without the repetition of a single command. One by one the orders are executed with the most human-like precision and steadiness, amounting sometimes to actual nonchalance. Human beings of the highest type could scarcely do better. To some savage races—for example, the native Australians, the veddahs of Ceylon, or the jackoons of the Malay Peninsula—I believe such a performance would be impossible, even under training. I do not believe their minds act with sufficient rapidity and accuracy to enable a company of them to go through with such a wholly artificial performance as successfully as the elephant's.

The thoughtful observer does not need to be told that the brain of the ponderous quadruped acts, *as far as it goes*, with the same lightning rapidity and clearness as that of the most intelligent man—this, too, be it remembered, in a performance wholly artificial and acquired, in which the animal depends solely upon the *words* of the trainer. I particularly noted the fact that the performance of Barnum's elephants was conducted without the use of any signs whatever.

In the performance of Bartholomew's horses, of which I once kept a record in detail, even the most accomplished members of his stud often had to be commanded again and again before they would obey. A command was often repeated for the sixth time before the desired result was obtained. I noted particularly that not one of his horses, which are perhaps the most fully trained of any living, was an exception to this rule, or performed his tasks with the prompt obedience and self-confidence so noticeable in every one of the sixteen elephants. The horses usually obeyed with tardiness and hesitation, and very often manifested nervousness and uncertainty.

In the mind of the elephant, e. g., *each* elephant, there was no confusion of ideas, but, on the contrary, a mental grasp on the whole subject, so secure and comprehensive that the animal felt himself master of the situation.

I have never yet seen a performance of trained dogs which could be considered worthy of serious comparison with the accomplishments of either performing or working elephants. In the matter of educational capacity the dog can not on any grounds be considered the rival of the elephant. The alleged mental superiority of the dog is based almost wholly upon his powers of independent reasoning and observation as exhibited in a state of almost perfect freedom. Until the educated elephant, who has grown to maturity under man's influence, is allowed the dog's freedom to plan and execute, no comparison can be made between them in this respect.

Finally, we come to a consideration of the elephant's moral qualities, but it is not pertinent to this inquiry to discuss more than those having a direct bearing upon the subject. In India the elephant bears a spotless reputation for patience, amiability, and obedience, except in the case of such individuals as have been afflicted with insanity, either temporary or permanent. I know of no instances on record wherein an elephant has been guilty of culpable homicide, or even of attempting it. I have never heard of an elephant in India so much as kicking, striking, or otherwise injuring either human beings or other domestic animals. There have been several instances, however, of persons killed by elephants which were temporarily insane, or "*must*," and also by others permanently insane. It is the misfortune but not the fault of the elephant that in advanced age and by want of necessary exercise he is liable to be attacked by a fit of *must*, during which period he is clearly irresponsible for his acts.

So many men have been killed by elephants in this country that the idea has of late years been steadily gaining ground that they are naturally ill-tempered and vicious to a very dangerous extent. Nothing could be further from the truth. We have seen that in the hands of the "gentle Hindoo" the elephant is gentle and reliable, and never attacks man except under the circumstances already stated. In this country, however, where he is at the mercy of quick-tempered and sometimes brutal showmen, who very often do not understand the temperament of the animals under their control, and who during the traveling season are rendered perpetually ill-tempered and vindictive by reason of overwork and insufficient sleep—with such masters as these to mete out punishment, without judgment or reason, it is no wonder that the animal occasionally rebels, and executes vengeance. I am convinced that an elephant could by ill-treatment be driven to insanity, and I have no doubt this has been done more than once in this country.

When commanded by man, the elephant will tear a criminal limb from limb, or crush him to death with his knees, or go out to battle holding a cimeter in his trunk. He will, when told to do so, attack his kind with fury and persistence; but, in the course of many hours, or even days, spent in watching wild herds, I never yet saw a single individual show any signs of impatience or ill-temper toward his fellows.

It is safe to say that, thus far, not one half the elephant's mental capabilities have been developed or even understood. It would be of great interest to determine by experiment the full educational capacity of this interesting quadruped, and, but for the lack of a permanent menagerie in this city, it would ere now have been undertaken. It would be equally interesting to determine the exact limit of its reasoning powers in applied mechanics. An animal that can turn a hand-organ with regularity at the proper speed, can be taught to push a smoothing-plane invented purposely for him; but whether he would learn of himself to plane the rough surfaces smooth, and let the smooth ones remain untouched, is an open question.

While it is generally fruitless and unsatisfactory to enter the field of speculation, I can not resist the temptation to assert my belief that an elephant can be taught to read written characters, and also to express some of his own thoughts or states of feeling in writing. It would be a perfectly simple matter to prepare suitable appliances by which the sagacious animal could hold a crayon in his trunk, and mark upon a surface adapted to his convenience. In Ælian's work on "The Nature of Animals," eleventh chapter of the second book, he describes in detail the wonderful performances of elephants at Rome, all of which he saw. One passage is of peculiar interest to us, and the following is a translation of it: ". . . I saw them writing letters on Roman tablets with their trunks, neither looking awry nor turning aside. The hand, however, of the teacher was placed so as to be a guide in the formation of the letters; and, while it was writing, the animal kept its eye fixed down in an accomplished and scholar-like manner."

I can conceive how an elephant may be taught that certain characters represent certain ideas, and that they are capable of intelligent combination. The system and judgment and patient effort which developed an active, educated, and even refined intellect in Laura Bridgman—deaf, dumb, and blind from birth—ought certainly to be able to teach a clear-headed, intelligent elephant to express at least *some* of his thoughts in writing. In this way it may, some day, be possible to open a channel for the communication of thought between man and the lower animals; in this way it may be possible to prove, beyond all possibility of dispute, the presence of the true reasoning faculty in other animals than man. That it does exist, to a greater or less degree, in all vertebrate animals, I have no doubt whatever. I believe that elephants have immortal souls as much as men, and are, as a species, far more deserving of immortality. I believe it is as much an act of murder to wantonly take the life of a healthy elephant as to kill a native Australian or a Central-African savage. If it is more culpable to kill a highly developed man than an elephant, it is also more culpable to kill an elephant than an echinoderm. Many men are both morally and intellectually lower than many quadrupeds, and are, in my opinion, as wholly destitute of that indefinable attribute called the soul as all the lower animals are commonly supposed to be.

If an investigator like Darwin or an educator like Dr. Howe should take it in hand to develop the mind of the elephant to the highest possible extent, his results would be awaited with peculiar interest, and it would be strange if they did not necessitate a revision of the theories now common among those who study the purely speculative portion of theology, which is based on man's immortal soul.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

VII.

A SHEEP or an ox, a fowl or a rabbit, is made up, like ourselves, of organic structures and blood, the organs continually wasting as they work, and being renewed by the blood; or, otherwise described, the component molecules of these organs are continually dying of old age as their work is done, and replaced by new-born successors generated by the blood.

These molecules are, for the most part, cellular, each cell living a little life of its own, generated with a definite individuality, doing its own life-work, then shriveling in decay, dying in the midst of vital surroundings, suffering cremation, and thereby contributing to the animal heat necessary for the life of its successors, and even giving up a portion of its substance to supply them with absorption-food. The cell-walls are mainly composed of gelatine, or the substance which produces gelatine, as already explained, while the contents of the cell are albuminous matter or fat, or the special constituents of the particular organ it composes. A description of all these constituents would carry me too far into details. I must, therefore, only refer to those which constitute the bulk of animal food, and which are altered in the process of cooking.

In the lean of meat, i. e., the muscles of the animal, we have the albuminous juices already described, the gelatinous membranes, sheaths, and walls of the muscular fiber, and the fiber itself. This is composed of *muscular fibrin*, or *syntonin*, as Lehmann has named it. Living blood consists of a complex liquid, in which are suspended a multitude of minute cells, some red, others colorless. When the blood is removed and dies, it clots or partially solidifies, and is found to contain a network of extremely fine fiber, to which the name of *fibrin* is applied. A similar change takes place in the substance of the muscle after death. It stiffens, and this stiffening, or *rigor mortis*, is effected by the formation of a clot analogous to the coagulation of the blood, and the substance of this clot (*myosin*) is so nearly like the fibrin of the blood and the material of the muscular fiber (*syntonin*) that for our purpose they may be all described as varieties of fibrin.

The properties of fibrin, so far as cookery is concerned, place it between albumen and gelatine; it is coagulable like albumen, and soluble like gelatine, but in a minor degree. Like gelatine, it is tasteless, and non-nutritious *alone*. This has been proved by feeding animals on lean meat, which has been cut up and subjected to the action of cold water, which dissolves out the albumen and other juices of the flesh, and leaves only the muscular fiber and its envelopes. The same is the case with the spontaneously coagulated fibrin of the blood; it is, when washed, a yellowish, opaque, fibrous mass, without smell or taste, insoluble in cold water, alcohol, or ether, but imperfectly soluble if digested for a considerable time in hot water.

The following is the chemical composition of these three constituents of lean meat, according to Müller:

	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
	100·0	100·00	100·0

There are two other constituents of lean meat which are very different from either of these, viz., *Kreatine* and *Kreatinine*, otherwise spelled creatine and creatinine. These exist in the juice of the flesh, and are freely soluble in cold or hot water, from which solution they may be crystallized by evaporating the solvent, just as we may crystallize common salt, alum, etc. They thus have a resemblance to mineral substances, and still more so to some of the active constituents of plants, such as the alkaloids, *theine*, and *caffeine*, upon which depend the stimulating or "refreshing" properties of tea and coffee.

Their chemical composition and general relations have suggested the theory that they are the dead matter of muscle, the first and second products of the combustion which accompanies muscular work, urea being the final product. According to this, their relation to the muscle is exactly the opposite of that of the albuminous juice, this being probably the material from which the muscle is built up or renewed. The following is their composition, according to Liebig's analyses:

	Kreatine.	Kreatinine.
Carbon	36·64	42·48
Hydrogen	6·87	6·19
Nitrogen	32·06	37·17
Oxygen	24·43	14·16
	100·00	100·00

The juices of lean flesh also contain a little lactic acid—the acid of milk—but this does not appear to be an absolutely essential constituent. Besides these there are mineral salts of considerable nutritive importance, though small in quantity. These, with the kreatine and kreatinine, are the chief constituents of beef-tea, properly so called, and will be further treated when I come to that preparation. At present it is sufficient to keep in view the fact that these juices are essential to complete the nutritive value of animal food.

I may now venture to state my own view of a somewhat obscure subject, viz., the difference between the roasting or grilling and the stewing of meat. It appears to me that, with the exception of the superficial "browning," it consists simply in the difference between the cooking media; that a grilled steak or chop or a roasted joint is meat that has been stewed in its own juices instead of stewed in water; that in both cases the changes taking place in the solid parts of the meat are the same in kind, provided always that the roasting or grilling is properly performed. The albumen is coagulated in all cases, and the gelatinous and fibrous tissues are softened by being heated in a liquid solvent. I shall presently apply this definition in distinguishing between good and bad cookery.

In the roasted or grilled meat the juices are retained in the meat (with the exception of that which escapes as gravy on the dish), while in stewing the juices go more or less completely into the water, and the loosening of the fibers and solution of the gelatine and fibrin may be carried further, inasmuch as a larger quantity of solvent is used.

Roasting and grilling may be regarded as our national methods of flesh cookery, and stewing in water that of our Continental neighbors. The difference between the flavor of English roast beef and French *bouilli* or Italian *manzo* is due to the retention or the removal of the saline and highly flavored soluble materials. (Concentrated kreatine and kreatinine are pungently sapid.) The Frenchman takes them out of his *bouilli*, or boiled meat, and transfers them to his *bouillon*, or soup, which with him is an essential element of a meal. If he ate his meat without soup, he would be like the dogs fed on gelatine by the bone-soup commissioners. To the Englishman, with his roast or grilled meat, soup is merely a luxury, not a necessary element of complete dietary.

What we call boiled meat, as a boiled leg of mutton or round of beef, is an intermediate preparation. The heat is here communicated by water and the juices partially retained.

NOTE.—A correspondent tells me that he has tried the method of cooking eggs which I recommended, and he states that his eggs "were not cooked at all." From what I can learn by his letter, he omitted to attend to the quantity of water I named, viz., *about a pint.*

As this is of essential importance, I should perhaps have stated it with some emphasis. More than a pint of water should be used rather than less, as upon the quantity of water depends the retention of the heat. If the quantity of water is smaller, it should be kept boiling about half a minute before setting aside.

VIII.

The application of the principles already expounded to the processes of grilling and roasting is simple enough. As the meat is to be stewed in its own juices, it is evident that these juices must be retained as completely as possible, and that in order to succeed in this we have to struggle with the evaporating energy of the "dry heat" which effects the cookery.

It should be clearly understood that the so-called "dry heat" may be communicated by convection or by radiation, or both. When water is the heating medium, there is convection only, i. e., heating by actual contact with the heated body. In roasting and grilling there is also some convection-heating due to the hot air which actually touches the meat; but this is a very small element of efficiency, the work being chiefly done, when well done, by the heat which is radiated from the fire directly to the surface of the meat, and which, in the case of roasting in front of a fire, passes through the intervening air with very little heating effect thereon.

I am not perpetrating any far-fetched pedantry in pointing out this difference, as will be understood at once by supposing that a beefsteak should be cooked by suspending it in a chamber filled with hot dry air. Such air is actively thirsting for the vapor of water, and will take into itself, from every humid substance it touches, a quantity proportionate to its temperature. The steak receiving its heat by convection, i. e., the heat conveyed by such hot air, and communicated by contact, would be *desiccated, but not cooked.*

This distinction is so important that I will illustrate it still further, my chief justification for such insistence being that even Rumford himself evidently failed to understand it, and it has been generally misunderstood or neglected.

Let us suppose the hot air used for convection cooking to be at the cooking-point, as the hot water in stewing should be, what will follow its application to the meat? Evaporation of the water in the juices, and with that evaporation a lowering of temperature at the surface of the meat, keeping it below the cooking-point. If the air be heated above this, the evaporation will go on with proportionate rapidity, and as nearly one thousand degrees of heat are lost *as temperature*, and converted into expansive force whenever and wherever evaporation of water occurs, the film of hot, dry air touching the meat is cooled by this evaporation, and sinks immediately, to be replaced by a rising film of lighter, hotter, and drier air, which drinks in more vapor, cools and sinks, to give place to another, and so on till the inner juices gradually ooze between the fibers to the porous surface, where they are carried away by the hot, dry air, and a hard, leathery, unmasticable mass of desiccated gelatine, albumen, fibrin, etc., is produced, which, if given to a dog for the purpose of watching its effect on the animal, would render an unlicensed experimenter liable to prosecution under the vivisection act.

Now, let us suppose a similar beefsteak to be cooked by radiant heat, with the least possible co-operation of convection.

To effect this, our source of heat must be a good radiator. Glowing solids are better radiators than ordinary flames ; therefore coke, or charcoal, or ordinary coal, after its bituminous matter has done its flaming, should be used, and the steak or chop may be placed in front or above a surface of such glowing carbon. In ordinary domestic practice it is placed on a gridiron above the coal, and therefore I will consider this case first.

The object to be attained is to raise the juices of the meat throughout to about the temperature of 180° Fahr. as quickly as possible, in order that the cookery may be completed before the water of these juices shall have had time to evaporate to any considerable extent ; therefore the meat should be placed as near to the surface of the glowing carbon as possible. But the practical housewife will say that, if placed within two or three inches, some of the fat will be melted and burn, and then the steak will be smoked.

Now, here we require a little more chemistry. There is smoking and smoking—smoking that produces a detestable flavor, and smoking that does no mischief at all beyond appearances. The flame of an ordinary coal-fire is due to the distillation and combustion of tarry vapors. If such a flame strikes a comparatively cool surface like that of the meat, it will condense and deposit thereon a film of crude coal-tar and coal-naphtha, most nauseous and rather mischievous ; but, if the flame be that which is caused by the combustion of its own fat, the deposit on a mutton-chop will be a little mutton-oil, on a beef-steak a little beef-oil, more or less blackened by mutton-carbon or beef-carbon. But these oils and carbons have no other flavor than that of cooked mutton and cooked beef ; therefore they are perfectly innocent, in spite of their guilty black appearances.

If any of my readers are skeptical, let them appeal to experiment, by putting a mutton-chop to the torture, and taking its own confession. To do this, divide the chop in equal halves, then hold one half over a flaming coal, immersing it in the flame, and cook it thus. Now cut a bit of fat off the other, throw this fat on a surface of clear, glowing, flameless coal or coke, and, when a good blaze is thus obtained, immerse this half chop recklessly and unmercifully in *this* flame; there let it splutter and fizz, drop more fat and make more flame, but hold it there, nevertheless, for a few minutes, and then taste the result.

In spite of its blackness, it will be (if just warmed through to the above-named cooking temperature) a deliciously cooked, juicy, nutritious, digestible morsel, apparently raw, but actually more completely cooked than if it had been held twice as long, at double the distance, from the surface of the fire.

For further instruction, make a third experiment by imitating the cautious unscientific cook, who, ignorant of the difference between the condensation products of coal and those from beef and mutton fat, carefully raises the gridiron directly the flame from the dropping fat threatens the object of her solicitude. The result will be an ordinary domestic chop or steak. I apply this adjective, because, in this particular effort of cookery, the grilling of chops and steaks, domestic cookery is commonly at fault. The majority of our city men find that while the joint cooked at home is better than that they usually get at restaurants and hotels, the chops and steaks are inferior.

I believe that this inferiority is due, in the first place, to the want of understanding of the difference between coal-flame and fat-flame; and in the second, to the advantage afforded to the "grill-room" cook by his specially constructed fire, where a large surface of glowing coke is surmounted by a sloping grill, whereon he can expose his chops and steaks to the radiation from a large glowing surface with a minimum of convection heat, the hot air passing in a current over the coke surface having such small depth that it barely touches the bars of the grill. (This may be seen by watching the course of flame produced by the droppings of the fat.) The same obliquity of draught prevents the serious blacking of the meat, which, although harmless, is unsightly and calculated to awaken prejudice.

The high temperature rapidly imparted by radiation to the surface of the meat forms a thin superficial crust of hardened and semi-carbonized albumen and fiber, which resists the outrush of vapor, and produces within a certain degree of high pressure, which probably acts in loosening the fibers. A well-grilled chop or steak is "puffed" out —made thicker in the middle; an ill-cooked, desiccated specimen is shriveled, collapsed, and thinned by the slow departure of its juices.

IX.

Happy little couples, living in little houses with only one little servant—or, happier still, with no servant—complain of their little joints of meat, which, when roasted, are so dry, as compared with the big, succulent joints of larger households. A little reflection on the principles applied in my last to the grilling of steaks and chops will explain the source of this little difficulty, and I think show how it may be overcome.

I will here venture upon a little of the mathematics of cookery, as well as its chemistry. While the weight or quantity of material in a joint increases with the cube of its through-measured dimensions, its surface only increases with their square—or, otherwise stated, we do not nearly double or treble the surface of a joint of given form when we double or treble its weight; and, *vice versa*, the less the weight, the greater the surface in proportion to the weight. This is obvious enough when we consider that we can not cut a single lump of anything into halves without exposing or creating two fresh surfaces where no surfaces were exposed before. As the evaporation of the juices is, under given conditions, proportionate to the surface exposed, it is evident that this process of converting the inside middle into two outside surfaces must increase the amount of evaporation that occurs in roasting.

What, then, is the remedy for this? It is twofold: First, to seal up the pores of these additional surfaces as completely as possible; and, secondly, to diminish to the utmost the time of exposure to the dry air. Logically following up these principles, I arrive at a practical formula, which will probably induce certain orthodox cooks to denounce me as a culinary paradoxer. It is this: That *the smaller the joint to be roasted the higher the temperature to which its surface should be exposed.* The roasting of a small joint should, in fact, be conducted in nearly the same manner as the grilling of a chop or steak described in my last. The surface should be crusted or browned—burned, if you please—as speedily as possible, in such wise that the juices within shall be held there under high pressure, and only allowed to escape by burst and splutters, rather than by steady evaporation.

The best way of doing this is a problem to be solved by the practical cook. I only expound the principles, and timidly suggest the mode of applying them. In a metallurgical laboratory, where I am most at home, I could roast a small joint beautifully by suspending it inside a large red-hot steel-melter's crucible, or, better still, in an apparatus called a "muffle," which is a fire-clay tunnel open in front, and so arranged in a suitable furnace as to be easily made red-hot all round. A small joint placed on a dripping-pan and run into this would be equally heated by all-round converging radiation, and exquisitely roasted in the course of about ten to thirty minutes, according to its size. Some such an apparatus has yet to be invented in order that we may learn the flavor and tenderness of a perfectly-roasted small joint of beef or mutton.

For roasting large masses of meat, a different proceeding is necessary. Here we have to contend, not with excessive surface in proportion to bulk—as in the grilling of chops and steaks and the roasting of small joints—but with the contrary—viz., excessive bulk in proportion to surface. If a baron of beef were to be treated according to my prescription for a steak, or for a single wing-rib, or other joint of three to five pounds' weight, it would be charred on its surface long before the heat could reach its center.

A considerable time is here inevitably demanded. Of course, the higher the initial outside temperature, the more rapidly the heat will penetrate ; but we can not apply this law to a lump of meat, as we may to a mass of iron. We may go on heating the outside of the iron to redness, but not so the meat. So long as the surface of the meat remains moist, we can not raise it to a higher temperature than the boiling-point of the liquid that moistens it. Above this, charring commences. A little of such charring, such as occurs to the steak or small joint during the short period of its exposure to the great heat, does no harm ; it simply "browns" the surface ; but if this were continued during the roasting of a large joint, a crust of positively black charcoal would be formed, with ruinous waste and general detriment.

As Rumford proved long ago, liquids are very bad conductors, and when their circulation is prevented by confinement between fibers, as in the meat, the rate at which heat will travel through the humid mass is very slow indeed. As few of my readers are likely to fully estimate the magnitude of this difficulty, I will state a fact that came under my own observation, and at the time surprised me.

About five-and-twenty years ago I was visiting a friend at Warwick during the "mop" or "statute fair"—the annual slave-market of the county. In accordance with the old custom, an ox was roasted whole in the open public market-place. The spitting of the carcass and starting the cookery was a disgusting sight. We are accustomed to see the neatly-cut joints ordinarily brought to the kitchen ; but the handling and impaling of the whole body of a huge beast by half a dozen rough men, while its stiffened limbs were stretching out from its trunk, presented the carnivorous character of our ordinary feeding very grossly indeed.

Nevertheless I watched the process, and dined on some of its result. The fire was lighted before midnight, the rotation of the beast on the horizontal spit before it began shortly after, and continued until the following midday, all this time being necessary for the raising of the inner parts of the flesh to the cooking temperature of about 180° Fahr.

Compare this with the grilling of a steak, which, when well done, is done in a few minutes, or the roasting of the small joint as above within thirty minutes, and you will see that I am justified in dwelling on the great differences of the two processes, and the necessity of very varied proceeding to meet these different conditions.

The difference of time is so great that the smaller relative surface is insufficient to compensate for the evaporation that must occur if the grilling principle, or the pure and simple action of radiant heat, were only made available, as in the above ideal roasting of the small joint.

What, then, is added to this? How is the desiccating difficulty overcome in the large-scale roasting? Simply by *basting*.

All night long and all the next morning men were continuously at work pouring melted fat over the surface of the slowly-rotating carcass of the Warwick ox, skillfully directing a ladleful to any part that indicated undue dryness.

By this device the meat is more or less completely enveloped in a varnish of hot melted fat, which assisted in the communication of heat while it checked the evaporation of the juices. In such roasting the heat is partially communicated by convection through the medium of a fat-bath, as in stewing it is all supplied by a water-bath.

I purpose making an experiment, whereby this principle will be fully carried out. I shall melt a sufficient quantity of mutton-fat to form a bath, in which a small joint of mutton may be immersed, or of beef-fat for beef; and then keep the melted fat at about the cooking temperature, or a little above it—say the boiling-point of water, which will be indicated by the spluttering due to the evaporation of the water in the meat. The result of this experiment will be duly reported to the readers of "Knowledge" when I reach the general subject of frying. In my next I must continue this subject of roasting, which is by no means exhausted yet. Count Rumford devotes seventy pages to it, and I quote his words for my own use. He says: "I shall, no doubt, be criticised by many for dwelling so long on a subject which to them will appear low, vulgar, and trifling; but I must not be deterred by fastidious criticisms from doing all I can do to succeed in what I have undertaken. Were I to treat my subject superficially, my writing would be of no use to anybody, and my labor would be lost; but by investigating it thoroughly I may, perhaps, engage others to pay that attention to it which, from its importance, it deserves." *—*Knowledge.*

THE GEOLOGICAL DISTRIBUTION OF NORTH AMERICAN FORESTS.

By THOMAS J. HOWELL.

THE causes which have determined the present distribution of the flora of the world have occupied the minds of some of the ablest students of natural history, but no satisfactory solution of the problem has yet appeared. If we accept the theory of Raumer, that plants are

* "Essays Political, Economical, and Philosophical," vol. iii, p. 129.

limited in their northern extension by heat alone, we shall find many anomalies difficult to reconcile, as no isothermal lines limit species. Nor will De Candolle's theory, that the limits are governed by the values of heat which are useful to a plant, assist the student; for climatic causes are not the only ones which limit vegetable species, or we should then find the same species growing in every portion of any isothermal belt of a continent, where the same conditions of heat and moisture exist, which is not the case. Some species, apparently very local in their habits and confined to a very limited area, are found many miles farther north, with no intervening stations. For example: the *Shizæa pusilla*, a little fern, was thought to be peculiar to New Jersey, where it is confined to the pine-barren district, but it has lately been found in Nova Scotia and Newfoundland, while no intervening stations have as yet been reported.

Here we have a plant, capable of propagating itself in New Jersey, which was long thought to be its only home, reappearing several degrees farther north, where the climate is colder and otherwise different, and yet unknown west of the Alleghany Mountains, where the climate is very like that of New Jersey. Neither do we find many of the plants of the western slope of the Alleghanies growing upon the eastern side.

It is well known that if a piece of coniferous forest be cleared of its timber, in Virginia or Pennsylvania, its site will soon be covered with a growth of deciduous trees, but, if then left undisturbed, the coniferous trees of the original growth will finally reassert their supremacy, and in course of time the forest again becomes exclusively coniferous. The black-walnut (*Juglans niger*), which grows naturally from North Carolina to the Great Lakes, and will grow with equal luxuriance on the Pacific coast at latitude 45°, bearing fruit which will germinate if planted, has never yet been known by the writer to grow in Northern Oregon if left to itself. I have examined the walnuts in the spring in Oregon, which fell from the trees the previous fall—they were invariably rotten. Now, as one of the necessary conditions of plant-distribution is the production of seed which will grow unaided by man upon the soil which supports the parent, it follows that there is some other cause than the requisite amount of heat that prevents the black-walnut from becoming naturalized in Oregon.

In the Smithsonian Report for 1858, page 246, is an article by Dr. J. G. Cooper on the "Forests and Trees of North America," accompanied with a map of North America north of Mexico.

This map * is divided into provinces and regions, according to the distribution of forest-trees, and the views herein maintained will be more intelligible to the reader who will refer to it, and compare it with a geological map of the same territory.

* A better map forms the frontispiece to the Agricultural Report of the Patent-Office Report for 1860.

It will perhaps be best to describe the provinces briefly :

The Lacustrine province extends from the Rocky Mountains east to the coast of Labrador, and from the northern limit of trees south to latitude 42° at or near the level of the sea. The line marking the southern boundary curves gradually from west to northwest; commencing at the west end of Lake Erie, on reaching Lake Winnipeg it pursues a northwestern direction to the base of the Rocky Mountains about latitude 60°.

The Appalachian province comprises the Atlantic States south of latitude 43° and east of the border of the prairies; the latter, commencing at the west end of Lake Erie, forms a curve nearly parallel to the Atlantic coast, and ends at the southwest corner of Louisiana.

The Campestrian province commences at latitude 60° in the Rocky Mountains; its northern boundary extends southeast to Lake Erie; its eastern boundary extends from the latter point south to the mouth of the Sabine River. The valley of the Rio Grande forms the southern boundary. The western boundary is formed by the base of the Rocky Mountains, extending northwest from longitude 104° 30′ to latitude 60°.

The Rocky Mountain province embraces the high central mountains from the Campestrian province to the foot-hills of the Cascade and Sierra Nevada Mountains.

The Caurine province begins at the northern limit of trees, on the Pacific coast, and extends east to the western boundaries of the Lacustrine and Campestrian provinces. Its southern boundary begins at latitude 48°, on a southern extension of the western boundary of the Campestrian province, extends northwest to the British line at its junction with the line between Washington and Idaho Territories, thence south to latitude 42°, and then southwest to the Pacific Ocean at latitude 38°.

The Nevadian province lies south of the Caurine, between the Rocky Mountain province and the Pacific Ocean.

The Mexican province lies south of the Rocky Mountain province, between the Campestrian on the east and the Nevadian on the west.

Now, comparing this forest-map with a geological map of the territory embraced, it will be found that the provinces and regions of the former coincide with the geological formations to a remarkable degree.

Beginning with the Lacustrine province it will be found that the formation is mostly granite, or what is popularly known as such, with some beds of Silurian and Devonian; also a few patches of tertiary rocks along the coast. Hence, the three regions comprising this province are really but one; and, accordingly, it has no trees not found south of it in the Alleghany Mountains, which are an extension of the granitic rocks. This province is characterized by its great numbers of coniferous trees; while some of the trees peculiar to the valleys west of the Alleghanies grow on the Silurian and Devonian beds.

The Appalachian province is composed of all the geological formations of North America, and its regions are very distinct.

The Alleghany region, comprising the eastern slopes of the uplands, and the lower Alleghanies, terminating in a point of latitude 34° in Georgia, is mostly granitic, but has streaks of Silurian and Triassic running through it. We find the same class of trees in it that grow in the Canadian region (Canada), with a few added which are perhaps limited by heat. These, with a few oaks and hickories, which are more prevalent on the Triassic formation than elsewhere, form the bulk of the forest-growth.

The Ohio region, embracing the eastern uplands of the Ohio Valley, east of the prairies and north of latitude 38°, is composed geologically almost wholly of Silurian, Devonian, and carboniferous beds, covered in places with drift from the north. It is marked by its large number of deciduous trees, no other country boasting of so many fine oaks, hickories, and walnuts. It is, however, very poor in coniferæ, and, but for a few stragglers, might be said to have none. Allied species are found to be plentiful in the tertiary formation nearly across the continent, indicating that this class of trees at one time reached from the Alleghanies to the Rocky Mountains, the middle of the belt having been destroyed by the more recent changes of the physical conditions of the earth's surface. As they have never returned since the glacial epoch, the inference is that the conditions of soil and climate have been so changed that the country west of the ninety-seventh degree of longitude is not capable of supporting these trees.

The Tennesseean region is a southwestern continuation of the Ohio region. It is composed of the same geological beds, with a few spurs of the granite ridges of the Alleghanies running into it, and therefore contains more coniferæ than the Ohio region. Still, the bulk of its timber is of the same class of broad-leaved trees that are found north of it, the only differences being such as climate alone makes.

The Carolinian region borders on the Atlantic coast between the Alleghany Mountains and the ocean from Middle Georgia to Long Island. It is composed of cretaceous and tertiary beds, with a strip of Triassic along the western edge. In the northern portion are some beds of drift of granite from the north. Here we have a distinct class of coniferæ on the cretaceous beds that are peculiar to this region, and another class on the drift that are also found growing farther north. Arthur Hollick,* who has made observations on the flora of Staten Island, says: "We have on Staten Island two well-marked geological formations: the *drift*, which covers about two thirds of the entire island, nearly all of the northern part, and extending as far

* "Bulletin of the Torrey Botanical Club," vol. vii, p. 14.

south as Prince's Bay; and the *cretaceous*, which occupies the remaining small area in the southern and western part. This latter is a continuation of the New Jersey clay-beds. The geological line of separation between the two formations is not always very distinct, but the limits of the different species of plants mark it in unmistakable characters. The two floras are remarkably distinct. That one belonging to the cretaceous is well represented by *Arctostaphylos, Uva-ursi, Aster concolor, Pinus inops, Quercus Phellos, Quercus nigra, Lycopodium inundatum, var. Bigelowii,* and many more of the pine-barren plants. Thus far I have never found any of these species to have crossed the line of the drift, but in their stead will be found *Pinus nigra, Quercus alba, Quercus rubra,* etc., and the majority of those plants which grow in the vicinity of New York Island and up the Hudson."

The Mississippi region embraces the lowlands bordering the Gulf of Mexico from Middle Georgia to Texas, and extending up the Mississippi and its branches to latitude 30°. It is a continuation of the Carolinian region, its characteristic trees growing from the Gulf of Mexico to the coast of Maine. It is composed of the same tertiary and cretaceous beds of the Carolinian region, with a few patches of alluvial deposit along the coast.

The Florida region is well marked and peculiar, being entirely coral alluvial. It has the peculiar flora of that formation found all over the world. Some of its plants are found farther north; but small beds of alluvial are not uncommon along the coast as far north as New Jersey.

The Campestrian province might be considered as one region, but Cooper* has divided it into five. The Saskatchewan region, embracing all north of latitude 49°, together with the basin of the Red River of the North, has some spurs of the Canadian region running into it, and consequently some of the Canadian species are found on them and on the adjacent Silurian and other formations. This region has no characteristic trees of its own. The Illinois region lies between latitudes 46° and 38°, running west to longitude 101°; on the east it is bounded by the forest provinces. It is a continuation of the Ohio region, being underlaid with the same beds of Silurian and carboniferous deposits, with cretaceous and tertiary beds on the west. But here a new feature enters into the geological characteristics. The loess or lacustrine deposits which cover the whole province from four to one hundred and fifty feet, though devoid of trees, have a peculiar flora, composed largely of compositæ, and being one of the latest of geological deposits, they furnish the most recent botanical species of the compositæ. None of the compositæ have yet been found in any of the fossil flora; hence it has clearly appeared upon the earth since the Tertiary period. Another remarkable fact is that on the eastern side of the Illinois region where

* "Patent-Office Report" (Agriculture), 1860, p. 424.

the loess-beds are not very thick, and, therefore easily cut through by streams, wherever they are thus eroded, we find dense groves of oak, walnut, hickory, and other trees characteristic of the Ohio region. With these exceptions however, the whole region is prairie; hence it would seem that the loess is not capable of sustaining forest-growths for any length of time, for it 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; not being burned, as some suppose, but disappearing because the geological formation will not retain moisture enough to sustain forest-growth.

The Texan region, lying south of the Illinois region, and extending west to 101° of longitude on the Rio Grande, is a continuation of the Mississippi region, and is underlaid with cretaceous and tertiary deposits. It is covered in many places with loess. It, therefore, has the characteristic trees of the Mississippi region wherever trees grow, and the characteristic loess flora on the prairies.

The Comanche region, lying south, and the Dakota region, north of latitude 38°, are nearly destitute of timber. The former is underlaid with triassic and the latter with cretaceous and tertiary beds; but they are covered with loess from ten to one hundred feet or more, and hence the loess flora predominates.

The mountain-region of the Rocky Mountain province is composed of granite, but has enough trachyte and other volcanic rocks to modify its flora to some extent. It also has some beds of Silurian on the eastern border, and here, strongly corroborating our views, we find some of the Eastern flora mixed with the Western and Southwestern that lie next to it. Its valleys and parks are covered with loess, and are treeless.

The Saline region, comprising the remainder of this province, is underlaid with tertiary of a different epoch from that of the Atlantic coast, but is covered with heavy beds of basalt in many places. This basalt is covered with a deposit analogous to the loess, and is treeless, but has a flora very similar to that of the Dakota region. The tertiary has a flora of its own, generally known as the sage-brush (*Artemisia*) flora, being composed of a number of shrubs peculiar to this region.

The Caurine province is composed of basaltic rocks principally, but has some tertiary beds, and the higher mountains are granitic at their tops. As the rocks are of an entirely different character from those of the Atlantic side of the continent, we should not be surprised at finding an entirely different flora. In fact, none of the Eastern trees reach this province, nor do any of its trees appear farther east than the Rocky Mountains. The geological formation of this province being mostly basaltic, the trees are characteristic of that formation, for the tertiary beds, wherever they are of sufficient size to make an impression on the flora, are all prairie, with scattered groves of oak (*Quercus gargana*), and this of but one species. The *Abies Douglasii*, *Pinus ponderosa*, and *Thuga gigantea*, are samples of this flora, for I have never seen any of them growing on any land that was not made from the disintegration of basaltic rocks.

The Nevadian province is composed of nearly all the geological formations common to North America, and, in accordance with our views, it has a flora of corresponding variety. Nearly all the genera of Eastern forests are represented, though different species are common. It has some very local trees, no doubt confined to geological formations of a peculiar character. Of these are the two *Sequoiæ*—the redwood and the "big tree." The former is confined to a narrow strip along the coast, the latter to the tops of the high mountains in isolated groves. Exact data are wanting, but it appears from the geological maps at the writer's command that the redwood is confined to the cretaceous formation which extends from about latitude 34° to 40°. As this is about the range of the redwood-groves, it will probably be proved, on close investigation, that this tree is confined to the above formation.

The *Sequoiæ* have a peculiar interest for the students of natural history, being the only living representatives of a once large and widely-distributed genus now found in the tertiary beds from British Columbia to California, and east to Nebraska. It appears to have been nearly exterminated about the glacial epoch, and is now confined to small localities that appear not to have been covered by the ice at that time.

In the foregoing pages I have made use only of trees to illustrate the affinity of plants for certain geological strata, but, should I have taken the general flora, the argument would appear still more convincing. To do this, however, it would have been necessary to divide the country into smaller regions, and to have given the geological characters more in detail than is at present practicable.

Were other proofs wanting to demonstrate the intimate relations existing between geological formations and the geographical distribution of the flora, they are close at hand in the writings of our eminent botanists. Sir Joseph D. Hooker, in a lecture on the distribution of the North American flora,* treats the subject upon the theory that all plants originated from small centers of creation and spread by slow encroachment upon the adjacent territory as fast as this was in a condition to receive them, and that climatic influences alone limit their extension. He makes four general floral regions :

"1. The great Eastern forest-region, extending over half the continent, and consisting of mixed deciduous and evergreen trees, reaches from the Atlantic to beyond the Mississippi, dwindling away as it ascends the western feeders of that river on the prairies. It is noteworthy for the number of kinds, especially of deciduous trees and

* "American Naturalist," xiii, 155.

shrubs, to be found in it. . . . 2. The prairie-region succeeds ; a grassy land, with many peculiar herbaceous American genera, including Mexican types, of which last the most conspicuous are a yucca and the cacti, which latter increase in number as the Rocky Mountains are approached, where they form a noticeable feature in the landscape. In the parks and lower valleys of the Rocky Mountains, deciduous trees are few and scattered, and the forest is an open one of conifers. . . . Higher on the mountains the coniferous forests are dense. . . . 3. Descending to the sink-region, . . . deciduous trees are very few and confined to the gullies of the mountains. . . . The hardy sage-brush (*Artemisia*) covers immense tracts of dry soil, and saline plants occupy the more humid districts. 4. The Sierra Nevada is clothed with the most gigantic coniferous forests to be found on the globe, among which a very few species of deciduous trees are scattered ; but none of these are identical with trees of the Eastern forests."

Applying the geological charts to these four general floral regions, we find corresponding to each of them respectively: 1. The great Silurian and carboniferous beds, with their large varieties of deciduous trees, the Alleghanies on the east, with their coniferous plants, and the loess-beds on the west, with their peculiar prairie flora, and a few trees along the streams. 2. The deeper loess-beds with a peculiar flora, and the Rocky Mountains with their mixed geological characters, mainly volcanic, and with a mixed flora of Eastern and Western trees, the latter predominating. 3. The tertiary beds of the saline region, which are different from those of the East, with their peculiar sage-brush and saline flora. 4. The Sierra Nevada region, with mixed geological characters of gneiss and lava, and a mixed Mexican and Northwest flora.

Thus, from more than one point of view, the North American flora is susceptible of being divided into three or more distinct floras, corresponding to the different geological formations which they inhabit.

PERRIER ON THE THEORY OF DESCENT.

By M. A. ESPINAS.

THE preface of twenty pages with which M. Edmond Perrier has introduced M. Levêque's French translation of Mr. Darwin's essay on "Earth-Worms" is a masterly work, the importance of which will escape no one. We know that this eminent naturalist, after having given a quite cool reception to the theory of descent, at last, in his "Colonies Animales," accepted it, under reserves, the tendency of which was to restrict the bearing of evolution at different points. First, he denied that that theory could explain the passage from the inorganic to the organic. Secondly, he refused to account, by it alone, that is, by the combined action of the environment and of heredity, for living forms; but had recourse, to explain some among them, to an internal *nisus*, or an original preformation analogous to final causes. Lastly, he believed that the general laws of evolution expired in some way at the threshold of the human world, and that human consciousness is formed after other laws than the organic consensus. It was the part of philosophy, now in possession of an idea of science which it owes largely to the scientific men themselves, to indicate these later reserves. For it is, after all, no small matter to know what is of science and what is not. It is imperatively necessary for us to fix our eyes on this capital point, and to decide among ourselves whether those who in their researches accord a part to final causes, and attribute an exceptional position in nature to man, are performing a work of science or of metaphysics. This is why, without losing sight of the rare merits of the work we have named, we have thought it proper to point out the ambiguous character of some parts of it.

Now, M. Perrier has resolutely canceled most of his reserves. The second part of his preface, in which he for the first time traces the geographical distribution of the species of terrestrial lumbrici, and points out the consequences of such distribution both in respect to specific characteristics and from the geological point of view, is out of our province to consider. The first part, which is devoted to a general appreciation of Darwin's work, has a high philosophical significance; and we here give a summary of the whole of it.

"Until within the last twenty years," says the author, "living beings were nearly always studied independently of the medium in which they live and of the relations which they form with each other. Each of them appeared to be a distinct entity, owing nothing except to itself, capable of abstracting itself from every modifying action on the part of external agents, created once for all in view of certain conditions of existence, marvelously adapted to these conditions, but unable to extricate itself from them except at the cost of perishing, in perfect equilibrium with the supposed unchangeable medium, but destined to disappear whenever the equilibrium was broken. This false conception of the living being has caused the failure of every essay at a philosophy of the natural sciences which has been attempted till now."

M. Perrier then shows by a small number of selected examples that each being, under the pressure of variable circumstances is, aside from any preconceived plan, adapted to its environment, even when it may not have seemed primarily destined to live in it; some fishes to a life in the air, some mammals and some birds to an aquatic life. He remarks that the living beings of the environment are the preponderant part of the medium for each species. Adaptations not less close than those which unite organisms to the physical medium, put organisms in dependence, one upon another, and provoke morphological variations which wholly change the aspect of each one of them. "The probosces of bees and of butterflies would be useless to them if there existed no flowers." The teeth of mammals tell what their regimen is. All their structure is likewise derived and by a kind of reaction from it. "The tongue of the ant-bear and its enormous salivary glands can evidently be useful only for the capture of ants, termites, and other insects living in societies. There are insects that never come out of the ant-hills; some of them are blind, and others can not eat anything but the food with which the ants gorge them." Innumerable parasites have been modified in a similar manner by the animal environment accidentally chosen by them; and all, starting from very different points, have, under the empire of analogous conditions of existence, put on similar characters. It is Darwin's glory to have established that while the physical and organic mediums are incessantly changing and endlessly producing the most varied and most unforeseen conditions, there are none among them to which organisms have not been able to bend themselves with a flexibility almost without limits.

These relations of the being with its medium furnished "the most powerful arguments for the doctrine of final causes. For this doctrine will hereafter be substituted a higher, a broader philosophy, a conception of the living world which will be wonderful only by its majestic simplicity. Every adaptation of a living being to a determined mode of existence has become no longer only a marvel to admire, but is also a problem to be resolved. This study, in fact, is that of the whole of natural history."

At this point is given a brilliant picture, in which, reviewing the great divisions of the animal kingdom, the author designates in each of the dominant forms of living beings the effect of the conditions of their existence. Every type, we may say, is thus formed by these conditions. To them must be attributed not only the variations in detail which only are commonly called adaptations, but the essential traits of the type, "due also to an anterior adaptation, the effects of which have been transmitted from more or less remote ancestors to their posterity." It results from this that the characteristics proceeding from the most ancient adaptations should be and are the most widely spread. And, as it is precisely the degree of generality of a characteristic which gives it its methodical value (the most general have been called dominant by Cuvier), their order of subordination is simply their order of antiquity. "The classifications, of which the dryness was formerly legendary, thus become all-palpitating with historical interest," for they relate to us the series of conditions of which the animal kingdom is the work and the witness.

Must man be excepted from the general operation of these laws? In no way. It is from the natural sciences thus renovated that we must demand, says M. Perrier, "an exact and scientific notion of the place of man in nature." Whatever emotion the application of the doctrine of evolution to the moral world may cause, and however grave may be the shock it inflicts on the edifice of beliefs, it should be accepted with confidence, for it is true, and the truth can not be wrong. Even if it exacts a transformation of the social order by transforming beliefs, it must be faced resolutely. The natural sciences thus impose themselves on the attention even of the statesman. "It is necessary attentively to follow their progress, to measure the bearing of their discoveries, to study their actual or possible influence on current beliefs and ideas, and to endeavor to construct a new edifice all the more quickly as the bases of the old one appear to be seriously threatened.

These declarations deserve a hearing. They have a considerable importance, not only because they come from a naturalist whose works* and position assure him one of the first places among the French scientific men of his generation, but also and especially because this naturalist is not suspected of any inconsiderate enthusiasm for the doctrine of evolution, and because he only yesterday was defending the beliefs we have spoken of against it. The honorable scruples which have kept him back seem at last to have yielded to the force of accumulated proofs: he lets fall the barriers which he seemed disposed to keep up between nature and man; he perceives that mechanism and science blend, and does not hesitate to say so. We expected nothing less from his clear-sightedness and his sincerity.—*Translated for the Popular Science Monthly from the Revue Philosophique.*

OUR INDIAN MYTHOLOGY.

By J. HENRY GEST.

THE myths of a people are the first crude embodiments of its religious feeling. They are first formulated in stories told over the fires of long winter evenings, and pass on as traditions from father to son, until written language at last makes a record of them. How carefully European students have gathered them together, seeking to extract from the scanty records the hidden image which inspired them! Any reader of this can recall some myth of Greece, or Rome, or early Europe; but how many are aware that here, among our own Indians, there exists a mythology from which not a little can be learned of the religious feeling of a rude civilization such as our own Aryan ancestors passed through long centuries ago?

Among recent German publications is a small pamphlet of seventy

* One of these works, a study of the organization of worms, has been pronounced "admirable" by Mr. Darwin.

pages, in which Mr. Karl Knortz, under the title "Mythology and Civilization of the North American Indians," gives the impression made on him during a visit among the Indians. Having read such books as we have on the subject, he has selected and briefly sketched a few of the myths, drawing some dedúctions from them. In the second part of the pamphlet he takes a rather favorable view of the prospect of civilization among the remaining tribes. It will be a pity if the book is not translated, as its pleasant style would make it popular reading among many who are not capable of taking it in the present form. We call attention to this book as an indication that the subject is receiving the attention abroad which it should have at home.

In what follows, an attempt is made to indicate a direction in which the Indian myths throw light on early religion. There is nothing new in the view taken, though it is one which has not yet received sufficient consideration.

The civilization of Europe to-day is generally accepted as the result of passing through three stages of social growth:

First, that of hunters, wandering over the country in search of animal food for daily sustenance.

Second, that of nomadic shepherds, moving about from pasture to pasture with herds of domesticated animals, which supply food and clothing more regularly and with less hardship than does the hunt.

Third, the stage of agriculture, when the plow anchors man to the spot of chosen land. Out of this has grown, after a long and tedious struggle, our complicated commercial civilization.

The Indian belongs to the first of these stages, and in attempting to civilize him we are trying to raise him to the third, without his having passed through the second. To say the least, it is extremely doubtful if even our assistance can accomplish a result which Nature has denied everywhere else. However, to return, the Indian myths are those of a hunter; and the Aryan was once, long, long ago, a hunter. This point of contact is what gives the myths their principal interest. They preserve the religious feeling of what is considered the earliest civilization, and are, therefore, valuable to a student of the progressive growth of religion; and this, however different anthropology and physiology may show the Aryan and Indian.

In all religions there are two great omnipresent relations—of man to nature, to God, and of man to man. One is the worship side, the other the moral side. Confining ourselves to the relation of man to nature, what has the study of early Aryan myths shown to be man's first conception of the nature around him? The Hindoos have probably wandered less over the face of the earth, and suffered less, than any other Aryan people. Their early religious records are consequently the clearest and the best preserved. From these it appears that the earliest religion was what is now called animisn. This is, as you choose, the soul, ghost, or spirit theory of nature; and is supposed to have had its source in dreams, the impalpable nature of whose visions suggested the presence in the dreamer of a soul distinct from the body. If the presence of a soul could explain dreams, it could equally well be made to explain such things in himself as man could not rationally comprehend. The idea of his own soul is followed by the idea of a soul in every man. From this it is but a short step to the idea of a soul or spirit in nature, to account for mysterious powers and properties. Thunder and lightning become the work of a spirit; fire, heat, and cold, the presence of others; and so on through all nature. Wherever there is something inexplainable, there is a mysterious spirit.

This is the earliest and simplest animism. Soon, however, unequal forces of nature suggest unequal spirits behind and in them, and gradually great and small spirits develop, some predominating others. Throughout, all, whether equal, great, or small, are worshiped on account of their mysterious powers. Besides the spirits in living bodies and in nature, are the souls released by death, but imagined still to wander at times about the earth, and to have some influence on living men, especially in controlling the fate of their bodily descendants. From this conception arose ancestral worship, and the many ceremonies at the grave intended to give peaceful rest beyond, that the departed spirit might thus be kindly disposed toward his offspring. A belief in a future life was necessary to a strong, active people having a tenacious love of life.

Little by little, as man becomes more self-appreciating, more confident in his superiority in the midst of surrounding nature, he gives to each great and small spirit a personality more or less like his own. Some of these will be merely exaggerated men, others a combination of man and animal. But the result of the whole will be that out of animism has grown polytheism, of which all know the congruous enormities in European mythology.

We have now gone as far as necessary in early Aryan religious growth, for a comparison of Indian religion to be made with it.

The Indian myths are a tangle of animism and polytheism, and only when we approach them with the information gained from the study of early Aryan religious worship do the hitherto senseless crudities open their hidden meanings. A few instances will show the animist or spiritual character. When the Algonquin Indian meets something he can not understand, there he fancies a *manito* present. This word has the several meanings of spirit, soul, and the first. The mysterious steel of the white man is *manito-biwabwik*, i. e., spirit-stone. The strange woven cloth is *manito-wegin*, spirit-skin. Among the Chippewas *manitowis* designates the magician. For this same idea of magic, mystery, spirit, soul, the Dakota has the word *wakan*. *Wakan-tanka* is the Great Spirit; *wakan-hdi* the lightning, literally the thing of spirit origin, *hdi* meaning *come*. Thus every mystery is *wa-*

kan. "He looks at sun, moon, and stars, but knows not who made them, or of what they are composed; he hears the winds, but, as their nature and source are to him unknown, they are *wakan.*"

To the Indian, wind and his own breath are of all nature most like his conception of the spirit force, and so these are regarded as symbols, even as embodiments, of the spirit. The principal Creek god is "the Lord of Breath"; of the Cherokees, "The oldest of the winds"; of the Choctaws, simply "storm-wind."

Like the Aryans, the Indians believe in immortality, and perform elaborate ceremonies for the benefit of departed souls.

Not content with souls and spirits in themselves and in the forces of nature, they give them also to animals; so that in the dog companion is often the guardian spirit of the Indian.

As you have already noticed, there are spirits of unequal rank and unequal powers in the Indian animism, but, though a principal spirit is at times found, yet there is no idea of a single all-powerful spirit from which all others come!

Now for some examples of the Indian polytheism. Compare the following story with some myths of early Europe. It is given in the words of Mr. Knortz: "When the world still lay in darkness, say the Mixtecas, there appeared a god, 'lion-serpent' by name, and a goddess, 'tiger-serpent.' They went to live on a high mountain, where two sons were born to them, one of whom they named 'Wind of the Nine Serpents,' and the other, 'Wind of the Nine Caves.' When the elder of these wanted amusement, he assumed the form of an eagle and flew about in the world; but the other changed himself to a winged serpent, in which shape he could fly not only through the air, but also through rocks and mountains." How nearly is this play of fancy like that which in dark Europe created dragons for the fabled knights.

The Algonquins have a hero-god, Menabuscho, whose remarkable adventures Mr. Knortz recounts at some length. Among others is an incident of the mysterious value of dragon-oil, which we have learned in the Siegfried myth: "Then he (Menabuscho) set out to war against the great chief Pearl-feather, who had slain his grandfather. He shot the serpent standing guard, and with the oil of the royal beast greased his boat, so that without stopping it ran through the fatal sea of misfortune." After death it became the privilege of Menabuscho to lead the souls of Indians into paradise.

There are numerous myths of the creation of the world and of man; others of a deluge from which only a single pair, man and woman, escaped.

These few examples give but an incomplete and very inadequate presentation of Indian mythology. But they are sufficient to show the presence of animism, and add another straw to the already accumulated evidence that animism is the first definite shape which religious feeling takes.

LOCUSTS AS FOOD FOR MAN.

By DAVID ALEXANDER LYLE, U. S. A.

THIS subject may appear to some, if not all of you, a rather peculiar one. The eating of insect-flesh is entirely repugnant to our feelings, and at once arouses all our natural and inherited antipathies. Even those who accept literally the Mosaic history of the creation as set forth in the book of Genesis, are loath to take advantage of the permissory bill of fare granted by Divine authority in the book of Leviticus. In the eleventh chapter of Leviticus, verses 1, 21, and 22, will be found these words:

1. "And the Lord spake unto Moses and to Aaron, saying unto them: . . .

21. "Yet these may ye eat, of every flying creeping thing that goeth upon all four, which have legs above their feet, to leap withal upon the earth;

22. "Even these of them ye may eat; the locust after his kind, and the bald locust after his kind, and the beetle after his kind, and the grasshopper after his kind."

Other references may be found in the Bible to the use of locusts as food. In one place in particular, in Mark i, 6, we read that "John was clothed with camel's hair, and with a girdle of a skin about his loins; and he did eat locusts and wild honey."

From these passages we learn that in olden times locusts were considered to be an article of food. And wild honey, which is an insect product, is highly prized by both aboriginal and civilized communities even to this day. In no one particular are we so much the creatures of custom and habit as in eating. That which is a delicacy to one is disgusting to another. The food relished by one nation or tribe may be spurned by another as loathsome. The inhabitants of the interior and mountains are often nauseated by the toothsome dishes of the denizens of the coast. A knowledge of the habits of certain animals (I use the term "animals" in its biological sense as distinguished from plants) often gives rise to an unconquerable abhorrence of the use of their flesh as food. To show how empirical are man's standards of edibles, it will only be necessary to cite a few instances. Beef, for example, is an almost universal article of food. But, should I place before my readers a roast of beef and tell them that this meat was taken from an animal that was accidentally drowned yesterday, my guests would very likely be indignant as well as disgusted, while at the same sitting they would eat and praise the flavor of a fish caught upon the same date and then left to *drown* in the air, if I may use the term, while it flops about and writhes with all the intensity of agony of which its low nervous organization is capable. We dote upon lobsters and lobster-salad, while a shudder of horrible disgust runs through our frames at the idea of eating a buzzard or a hyena. Yet the lobster is the scavenger of the sea as truly as the others perform the same functions upon the land.

We love the speckled beauties that haunt the mountain-streams, feeding upon insects and worms, while the Apache Mojave Indian turn in scorn from such a dish. The same Indians will regale themselves with the blood that flows from the death-wound they have just inflicted upon a deer, and will eat with relish the liver, smaller intestines, etc., while yet warm, and with little or no preparation; but we could hardly be induced to imitate their example.

Nothing can be more omnivorous and filthy in their feeding habits than chickens and swine; yet we relish the flesh of both with zest. Tripe, liver, and kidneys are esteemed by us, though a knowledge of their functions might cause a tremor of squeamishness to thrill through our bodies. As epicures we eat the diseased livers of geese, insect-eating frogs, small birds and game in an advanced stage of decomposition, and call them delicious as we discourse upon their "gamy" flavor, and at the same time we would not entertain for a moment the idea of eating a dish of freshly-roasted locusts which have fed upon the clean, juicy herbage of our fields. The Hebrews of North Africa eat boiled and fried locusts with avidity, while their co-religionists in this country turn from lobsters with scornful loathing.

The Arab relishes the savory dishes made from locusts, while he expresses his abhorrence of our habit of eating raw oysters. Our society belles shriek with horror and fright at the appearance of a cockroach, yet they sip with pleasure the sherry and madeira wines that are aged, mellowed, and flavored with these pests.

Professor Charles V. Riley, for a long time State Entomologist of Missouri, and now Entomologist at the United States Agricultural Department at Washington, undertook in 1875 a series of experiments "to demonstrate the availability of locusts as food for man, and their value as such whenever, as not infrequently happens, they deprive him of all other sources of nourishment." Professor Riley took a lot of locusts to an hotel to be cooked, but he endeavored in vain to obtain assistance from the monarchs of the gridiron. The cooks and servants retired in disgust, and left the naturalists to do their own cooking. The savory messes that the latter concocted converted the kitchen; cooks and guests alike agreeing that the soups, fricassees, and fritters, composed materially of locusts, were excellent. In regard to these experiments Professor Riley says:

"It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire which the recent locust invasions into some of the Mississippi Valley States afforded. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast majority of our people, unaccustomed to anything of the sort, and associating with the word 'insect' or 'bug,' everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was, in 1874, brought to the brink of the grave by sheer lack of food, while the St. Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing, in the spring of 1875.

"Whenever the occasion presented, I partook of locusts prepared in different ways, and one day I ate of no other kind of food, and must have consumed, in one way or another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon agreeably surprised to find that the insects were quite palatable in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insect is agreeable and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that they need no elaborate preparation or seasoning, and that they really require no disguise; and herein lies their value in exceptional emergencies, for, when people are driven to the point of starvation by these ravenous pests, it follows that all other food is scarce or unattainable. A broth, made by boiling the unfledged *caloptení* for two hours in the proper quantity of water, and seasoned with nothing but pepper and salt, is quite palatable and scarcely to be distinguished from beef-broth, though it has a slight flavor peculiar to it and not easy to be described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage, and other spices *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, they are by no means unpleasant eating, and have quite a nutty flavor. In fact, it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into soup or broth, for I found the chitinous covering and corneous parts, especially the spines on the tibiæ, dry and chippy, and somewhat irritating to the throat. This objection would not apply with the same force to the mature individuals, especially of the larger species, where the heads, legs, and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled, and afterward stewed with a few vegetables, and a little butter, pepper, salt, and vinegar, made an excellent fricassee. . . .

"I sent a bushel of scalded insects to Mr. John Bonnet, one of the oldest and best-known caterers of St. Louis. Master of the mysteries of the *cuisine*, he made a soup which was really delicious, and was so pronounced by dozens of prominent St. Louisians who tried it. Shaw, in his 'Travels in Barbary' (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like crawfish; and Mr. Bonnet declared that this locust-soup reminded him of nothing so much as crawfish *bisque*, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could only get the insects.

"His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper, and grated nutmeg, the whole being occasionally stirred. When cooked, they are pounded in a mortar with bread fried brown, or *purée* of rice. They are then replaced in the saucepan and thickened to a broth by placing on the warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few *croutons* are added. I carried a small box of fried ones to Europe, where they were tasted by numerous persons, including members of the London Entomological Society and of the Société Entomologique de France. Without exception, they were pronounced far better than was expected, and those fried in their own oil, with a little salt, remained good and fresh for several months; others fried in butter became slightly rancid, a fault of the butter. Mr. C. Horne, F.Z.S., writing to 'Science Gossip,' says: 'In the evening I had asked two gentlemen to dinner, and gave them a curry and croquette of locusts. They passed for Cabool shrimps, which in flavor they very much resembled; but the cook having inadvertently left a hind-leg in a croquette, they were found out, to the infinite disgust of one of the party and the amusement of the other.' . . .

"Locusts will hardly come into general use for food, except where they are annually abundant; and our Western farmers, who occasionally suffer from them, will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them, fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies becomes at times most offensive, they find little that is attractive in the pests.

"For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a strong and not overpleasant odor; but, rinsed and scalded, they turn a brownish red, look much more inviting, and give no disagreeable smell."

That locusts have been used as food from remote antiquity is well attested by historical writers. As stated before, they are classed among the "clean meats" in Leviticus (xi, 22), and are referred to in other parts of the Bible as human food. One of the Nineveh sculptures deposited in the British Museum represents men carrying different kinds of meat to some festival, and among them some carrying long sticks, to which locusts are tied, thus showing that they were of sufficient importance to form part of a public feast.

Locusts have been, and are yet, extensively employed as an article of food in parts of Europe, Asia, and Africa. The Romans are said to have roasted them to a bright golden yellow before eating them; and in Russia they are salted or smoked like herrings. Pliny says that locusts were highly esteemed by the Parthians; Herodotus speaks of a tribe of Ethiopians that fed on locusts; and the records of their use in ancient times as food, in both Southern Europe and Asia, are abundant. At the present day this use still continues.

Riley, in his narrative,* says: "Locusts are esteemed very good food by the Moors, Arabs, and Jews, in Barbary, who catch large numbers of them in their season, and throw them, while jumping alive, into a pan of boiling *argan* oil; here they hiss and fry until their wings are burned off, and their bodies are sufficiently cooked, when they are poured out and eaten. I have seen many thousands cooked in this manner, and have had the curiosity to taste them; they resemble, in consistence and flavor, the yolks of hard-boiled eggs."

The Riff Arabs, when they see a swarm of locusts hovering in the air and clouding the sky, watch them with anxiety, and when they descend near their habitations they receive them with shouts of gratitude to God and Mohammed, throw themselves on the ground, and collect them as fast as possible. The locusts, deprived of their heads, legs, and wings, are well boiled in butter, and served up with a substance called *alcuzcuz.* The Riff Arabs consider them delicious food. Their camels also eat them greedily. The Moors use them to this day, by first boiling and then frying them. The Moorish Jews, more provident than their Mussulman neighbors, salt them and keep them for making a dish called *dafina* which forms the Saturday's dinner of the Jewish inhabitants. This dish is made by putting meat, fish, eggs, tomatoes, locusts, "in fact, almost anything edible, into a jar, placing the latter in an oven on Friday night, and then taking it out hot on the Sabbath." In this manner the orthodox Hebrew gets a hot dinner without committing the sin of lighting a fire upon that day.

The Indians of California and the Great Basin also collect locusts for food. The Digger Indians roast them and grind or pound them into a sort of flour, which they mix with pounded acorns, the nuts of the piñon-pine, or with berries. This mixture they make into cakes and dry in the sun for future use.

Among the other uses to which locusts are applied is fish-bait for the sardine-fisheries off the coast of Spain; and similar bait might be

* Published in 1859.

prepared by the Western farmers for use upon the Atlantic and Pacific fishing-grounds. A very important chemical substance used in the arts may be extracted from locusts by the action of sulphuric acid. This is formic acid, for which many applications have been found in therapeutics and in the laboratory. By collecting, killing, and burying them in trenches, or in compost-heaps, these insects might be utilized as fertilizing agents, or they might be collected in large quantities, dried, and sent East in bales as food for poultry.

Although the writer does not profess to be an advocate of entomophagy, nor does he intend to become an acridophagist himself, unless absolutely necessary, yet he believes, with Professor Riley, that, when the devastations of the Rocky Mountain locusts lay waste our Western domain, the inhabitants of these regions need not die for want of food so long as a supply of locusts exists. Persons should not allow prejudice and squeamishness to stand in the way of self-preservation.

A NATURAL SEA-WALL.

By LOUIS BELL.

ALONG the New Hampshire sea-coast, in the towns of Rye and North Hampton, stretches a curious and massive formation, which at first sight appears as if built at enormous expenditure of time and labor. On closer examination, however, it proves to be only one of Ocean's eccentric freaks, executed in this case with almost human intelligence and care.

A sea-wall, compactly formed of water-worn pebbles of all sizes, shapes, and materials, runs along the beach for about six miles, here and there broken by rocky points and little inlets, somewhat modified by its situation, but preserving with astonishing regularity several remarkable features. In places it is so high and wide that one can hardly believe it anything but a carefully constructed dike, designed to shelter the adjoining fields. Along part of its extent, where it separates the ocean from an extensive salt-marsh, it is utilized by the farmers of the neighborhood for a cart-road. Along another stretch, a plank-walk surmounts it for half a mile.

It first appears in the form of a low wall composed of three terraces, near Little Boar's Head, in the town of North Hampton, thirty rods south of the slight projection known on the charts as Fox Hill Point. This portion of the wall is only about twenty rods in length, and seems much like a stone facing to the steep beachward slope. Some forty rods north of the point it reappears, this time in the form of a large and compact dike, and extends along the water-line in a crescent form for at least fifty rods, terminating at a small cove directly east of the well-known Farragut House. This section of the wall is by far the most symmetrical and characteristic, and is the one selected for a more detailed examination and description. Beyond this point the wall runs with occasional breaks to its northern terminus without presenting any novel features.

The annexed diagram, enlarged from measurements by the United States Coast Survey, shows that part of the wall between Fox Hill

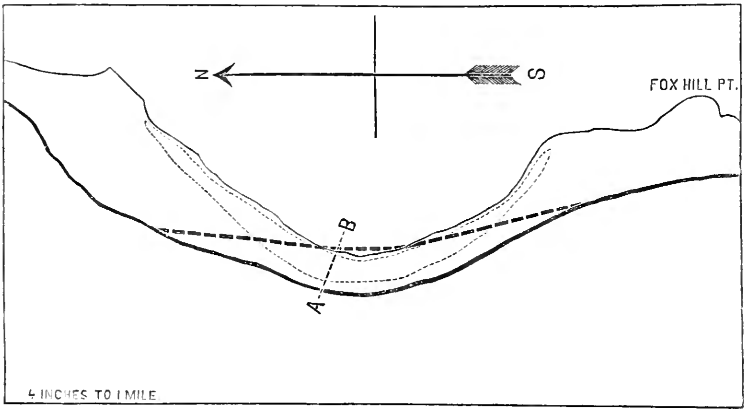

Fig. 1.

Point and the Farragut House. It has the form of a shallow crescent, and follows high-water mark quite closely, just east of the highway. It has the general peculiarities very strongly marked, but near its northern extremity is so modified by an adjacent shoal as to give an easily-followed clew to the method of its formation. It has the three neat terraces common to the whole of the wall, and, at the time of examination, had not been marred by the walk previously mentioned. This walk was built directly along the summit, which was smoothed for this purpose, thus almost obliterating the upper terrace, and lowering the whole crest. Previously, the wall has remained substantially as originally formed, for its steepness and height were such that, as a path, it was far from alluring. But now along its landward base runs the road from Little Boar's Head to Rye Beach; the situation of this road has been materially changed by the encroachments of the sea during the last fifty years, and its old location is approximately indicated on the diagram by the dotted line.

At the highest point of the crescent—near its middle—the road is about twelve feet below the summit of the wall, and only four or five feet above high-water mark. Diagram number two is a cross-section at this place, drawn to scale from personal measurements. The slope inward, it will be noticed, is comparatively gradual and quite regular, while the sea-face is formed in terraces, very regular and individually steep. The general seaward angle of inclination is fully twice as great as the landward slope, and possesses some decidedly interesting characteristics. In the first place, it is singularly regular, varying but a very few degrees throughout its entire length ; secondly, it is almost exactly the angle that such a mass of pebbles

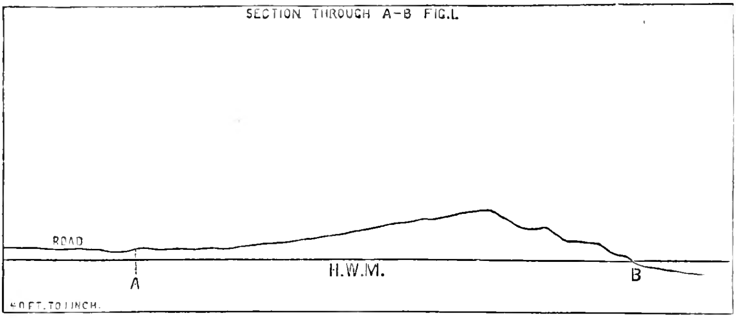

Fig. 2.

would take if uninfluenced by the action of the waves. Constant washing has adjusted it precisely as if the pile had been left to its own conditions of equilibrium.

The general angle of the upper terrace is 29°. It has undoubtedly been lessened by travel, and by the fact that it is out of reach of any but the higher waves, and the constant tendency, therefore, is toward undermining it. This terrace is composed of rather large stones, quite unmixed with sand or gravel.

The second terrace is steeper, 32° nearly. It is exposed to the high tides, and its surface is made up of rather small stones, distributed with great regularity, still unmixed with gravel, but compacted by the waves to a remarkable degree of solidity.

The lower terrace has nearly the same angle as the middle one, but its composition is very different. The pebbles are of small size, mixed with much coarse gravel and sand, and pounded by the constant washing of every tide into a hard, smooth, regular slope that effectually resists any attempt at undermining.

The general angle of the wall as a whole is within a few minutes of 30°, as nearly as could be determined. Owing to the rough instrument employed—a simple arrangement of plumb-line and semicircular protractor—the angles could only be measured to the nearest half degree, but the number of measurements taken leaves little doubt as to the accuracy of the result.

The size of the stones in some parts of the formation may give an idea of the tremendous force of the rushing waves that produced it. Stones of from twenty to thirty pounds in weight are common along the crest of the wall, fifteen feet at least above high-water mark. And not only this, but stones of the same size have been thrown completely over the wall into the road, more than a hundred feet from the water. After a severe storm the road is sometimes strewed thickly with these great pebbles, and some trouble is necessary to clear it. So, at least, says popular tradition, but it is probable that very many of the larger stones, found some rods inland, were deposited there before the wall existed in anything like its present condition. For it is almost certain, from the character of the formation and its known history, that it has been piled up in comparatively recent times.

Some of the old inhabitants assert that the terrific storm that in 1851 devastated the whole New England coast and snapped like pipe-stems the iron pillars of the Minot's Ledge light-house, is responsible, too, for the wall. While that noted storm certainly did perform some tremendous feats, and in some places permanently changed the contour of the shore, no one storm could do its work in a very systematic or regular fashion. No one storm could have formed the three terraces that compose the sea-face of our wall. The Minot's Ledge storm may have greatly augmented an existing pile and changed its shape somewhat (as there is reason to believe it did), but, powerful as it was, it did not do anything more than this.

It is said that the above-mentioned storm so blockaded the existing highway that it was moved a short distance inland, and there is evidence to show that this road once ran near the present high-water mark, on or about the line now occupied by the wall.

It is, then, probable that a double process has been going on. The sea has been encroaching on the beach, and at the same time obstructing its own course with the *débris* of former invasions. It is worthy of notice that the wall has only been thrown up along the sandy beach, where the waves had an unobstructed passage. On the ledges that are of frequent occurrence no signs of any extensive deposit are visible. The wall is absent or much modified where a shoal intervenes. These facts show that the deposit has been the result of successive storms heaping up the material, and the ordinary course of the waves and tides molding and arranging it. When the angle of the pile exceeded the natural slope of such materials, growth in that particular plane ceased, and a terrace was formed. Thus the wall, as far as its seaward side is concerned, seems to be a sort of concretion, the terraces being formed in succession, partly out of new material furnished by annual storms and partly from what was left after the first terrace had reached its present angle. Constant pounding of the waves has solidified the wall, though various storms have partially undermined it and necessitated the re-formation of its face. To these storms is due the motion landward that has from time to time taken place. The materials of the wall have been collected from a large area, as is shown by their diverse character, and why they should have been deposited at this particular point is a matter of some doubt. It may be that submarine ledges off this part of the coast have furnished a quarry for the waves. The method of formation, however, has been substantially as above recorded, and the results have been of such a curious character as to be well worth a visit from those interested in the influence of the sea in modifying and eroding the coast.

THE TELEPHONE, WITH A SKETCH OF ITS INVENTOR, PHILIPP REIS.

By WILLIAM F. CHANNING, M. D.

A BOOK of absorbing public interest is announced shortly to appear in England and this country—a history of the telephone of Johann Philipp Reis, with a biographical sketch of its inventor, by Professor Sylvanus P. Thompson.

The telephone outranks all previous discoveries in its direct enlargement of human power. The telescope and microscope are its nearest compeers. The telegraph, beside it, is a clumsy mechanism. The telephone, which makes a whispering-gallery of the round earth, may well exert an influence on civilization, comparable with that of the railroad and steamship. Already the business centers expand, and the values of city lands change, under the magic of an invention which places every man at every other man's ear. But this promise or prophecy of the telephone is not all that affects the interest of the American people. There is a menace in connection with its present history which justly awakens public concern. Rapacious hands have clutched the throat of the telephone, to extort oppressive tribute for every word which it utters.

Professor Thompson's book, which treats exhaustively the early history of the telephone, is therefore not only of scientific but of social interest and importance. It establishes beyond honest doubt or question, by historical evidence, by the reproduction of original documents and illustrations, and by the public records of scientific bodies, that Philipp Reis discovered *the electric transmission of speech* in 1860–'61; that he elaborately described and exhibited his telephone in 1861; that he invented transmitting and receiving instruments, which not only talked then and talk now, but which include the essential principles of the transmitters and receivers now in use; and that he manufactured, placed on the market, and sold his instruments in 1863, for the purpose of illustrating the electric transmission of speech and song. That an invention so important, made in the heart of Germany, should not have been instantly perfected and utilized would surprise us in this country, if history did not abundantly teach that inventions complete in themselves often lie sterile until the favorable season and soil are found for their commercial adoption and development.

The following pages are a hurried and imperfect abstract from advanced-sheets of this book, which, besides its wealth of historical matter and its affluence of illustration, contains much of scientific value contributed directly by Professor Thompson.

The biographical sketch of Reis, with which the book begins, possesses an interest independent of his connection with the telephone. Philipp Reis, as he is generally called, was born January 7, 1834, in the small provincial town of Gelnhausen in Cassel, in which his father was a master-baker and farmer. His education began with the best of all teaching—object-teaching by his father, and moral and religious inculcation by a grandmother. The German common school followed, in which his early proficiency induced plans for a higher education, which were thwarted by his father's death when Philipp was less than ten years old.

He, however, went to the institute at Friedrichsdorf, where he became specially interested in the study of English and French, and where the valuable library of the institution was a store of nourishment for his mind. At fourteen he was promoted to Hassel's Institute at Frankfort-on-the-Main. Here he learned Latin and Italian, and distinguished himself by his devotion to the natural sciences and mathematics.

Compelled at sixteen to enter as an apprentice in a color establishment, he devoted all his leisure time to his continued education. A little later he is at the institute of Dr. Poppe in Frankfort, and one of several young men who mutually instructed each other. This experience induced Reis to look forward to teaching as his future vocation.

In 1851 he became a member of the Physical Society of Frankfort, of which Professor Böttger, Professor Abbe, and Dr. Oppel were active members. In 1855 he gave his year of military service. In Frankfort again, with marvelous energy he worked in the laboratory and pursued the higher branches of education. In 1858 he accepted a position as teacher in natural science in the institute of Hofrath Garnier, in Friedrichsdorf, the same in which he had been a student; and in 1859 he married and founded his peaceful home.

In 1859 he undertook an original research "On the Radiation of Electricity," and a paper on the subject, offered to Poggendorf for his "Annalen," was declined—the rejection being felt as a serious blow by the young and sensitive teacher.

His lessons in physics in 1860 stimulated him to the construction of the first electric telephone, which, indeed, he had attempted several years before. In a little workshop behind his house he made the first telephone with his own hands, carrying the wires thence to an upper room of the dwelling, and also from the physical cabinet of Garnier's Institute across the play-ground into one of the class-rooms, for experimental telephonic communication—the boys, it is said, being afraid to make a noise in the class-room lest Herr Reis should hear them while among his instruments.

In 1861 Reis exhibited his telephone to the Physical Society of Frankfort, and his elaborate and illustrated memoir on that occasion appears in its "Annual" for 1860–'61.

In 1862 Reis sent a memoir on the telephone to Poggendorf for his "Annalen," which was again declined, despite the advocacy of Professor Böttger and Professor Müller of Freiburg—Poggendorf "treating the transmission of speech by electricity as a myth." Reis felt this rejection very keenly, ascribing it to his inferior position as a poor schoolmaster.

Between 1861 and 1864 Reis gave public exhibitions of his telephone before various scientific bodies, and it became widely known. In addition to his own lectures and papers on the telephone, it was the subject of lectures and reports by prominent men in various parts of Germany, and in 1863 it was exhibited to the Emperor of Austria and King Max of Bavaria, then on a visit to Frankfort. Telephones, also, were sent to various parts of the world, and were manufactured for Reis by Albert, of Frankfort, and sold for scientific illustrative use in 1863. It is related that, in September, 1864, after a successful exhibition before the Association of German Naturalists at Giessen, he received at last an invitation from Poggendorf to prepare an account of the telephone for the "Annalen." Reis replied, thanking him, and telling him that it was too late, that he should not send it, and that his apparatus would become known without description in the "Annalen."

If this offer had not been refused by Reis, the diffusion of the telephone would probably have taken place at a much earlier day. It did not, however, pass out of sight. It was figured and described in encyclopædias and text-books in different languages. Reis's telephone in England was the subject of experiment and improvement; and it is even rumored with a good deal of probability that his instruments were so far improved in a German neighborhood in Pennsylvania that fluent talking was obtained some years before the revival of the telephone in this country by Gray and Bell.

The year 1864 was probably the culminating point of Reis's career in connection with the telephone, though his labors continued. He proclaimed the invention of the speaking telephone as an accomplished scientific fact, and confidently predicted its practical commercial application. The indifference with which his discovery was often received, and the rebuffs which he encountered, told on a sensitive temperament, and still more on a body struggling with a fatal disease in the early prime of life. For several years he discharged his professional duties only by great effort. We can see the poor schoolmaster of Friedrichsdorf, who had created the telephone, striving at disadvantage to earn the necessaries of life for his wife and children, though we have no precise information of his family. Disabled finally by hæmorrhage of the lungs and loss of voice, he disposed of all his instruments to Garnier's Institute, and died of consumption, January 14, 1874, at forty years of age.

Four years later, in 1878, the Physical Society of Frankfort erected an obelisk of red sandstone over his grave in Friedrichsdorf bearing upon it a medallion of the great inventor.

The description of Reis's telephone is divided naturally into two sections. Here, fully illustrated in Professor Thompson's book, we have ten forms of transmitter, all imitating the mechanism of the ear, and applying the vibrations of an artificial tympanum to vary or modulate a current of electricity, by varying the degree of contact at a loose joint in the circuit, one or both of the members at this point of contact having an elastic bearing. This is the essential principle and method, leaving out certain adjuncts, of the most approved modern transmitters. In the very first transmitter made by Reis, in 1860 or 1861, a little curved lever is attached by one end to the center of an elastic tympanum, while the other end makes varying contact with a delicate spring, regulated by an adjusting screw—the surfaces of contact being of platinum—and the lever and spring included in a telephonic circuit equipped with a galvanic battery and receiver.

Of the receivers four forms are given. The first receiver made by Reis consisted of a knitting-needle wound with a helix of silk-covered copper wire, one end of which knitting-needle was thrust into the bridge of a violin, which served as a sounding box. This instrument was given to Reis for the purpose by Herr Peter, the music-teacher of Garnier Institute, and it is now preserved with other relics in the museum of that institution. In the second form the helix was laid horizontally upon a sounding-box (a cigar-box), and the knitting-needle, passed through it without contact, was supported by a "bridge" at each end. The third form was the electro-magnetic which will be described in connection with Fig. 1. Of this class of receivers Reis himself writes, "Electro-magnetism affords the possibility of calling into life, at any given distance, vibrations similar to the vibrations that have been produced (in the transmitter), and in this way to give out again in one place tones (sounds) that have been produced in another place." In the fourth form of receiver Reis recurred to the "knitting needle," more elaborately arranged. This is shown in Fig. 2.

Among these instruments of Reis are two noteworthy types of transmitter and two of receiver. They all happen to be grouped in two very early illustrations, published in the proceedings of learned bodies, and therefore of the highest authenticity. The first of these is contained in the report by Wilhelm von Legat to the Austro-German Telegraph Verein in 1862, printed in the journal of that society, and reprinted verbatim in Dingler's "Polytechnisches Journal" for 1863. This is shown in Fig. 1.

The transmitter in Fig. 1 consists of a conical tube, *a*, closed at the smaller end by a collodion membrane, *o*, on the center of which rests the end of a very light bent lever, *c d*, supported at *e*, and thrown

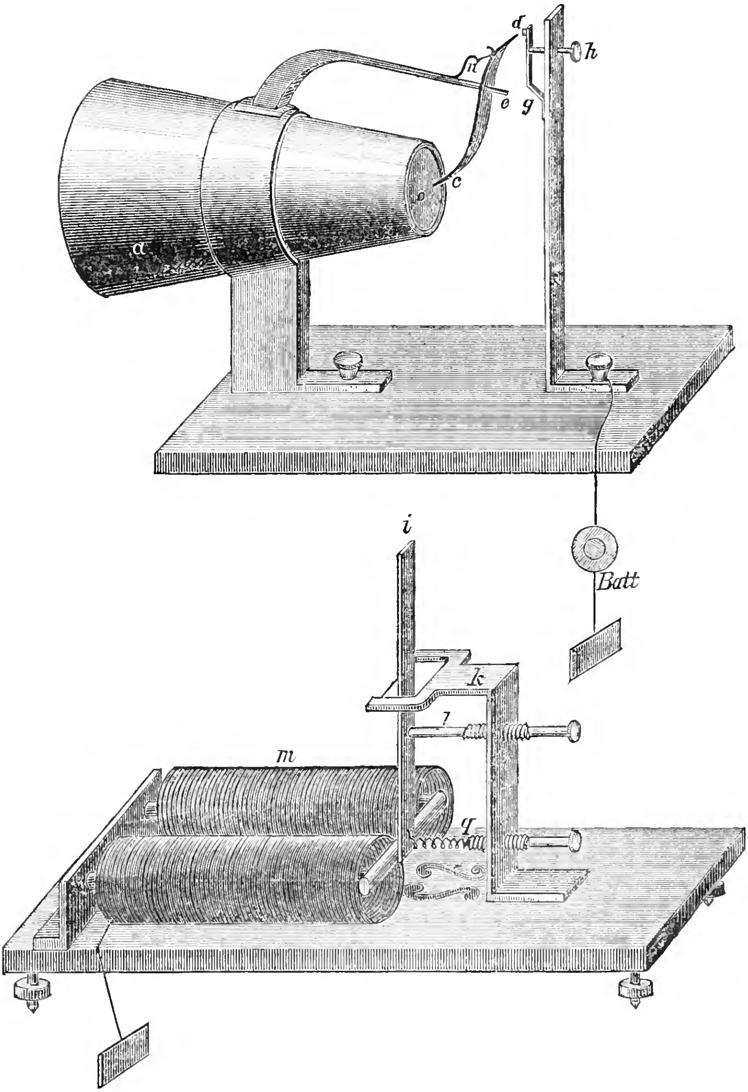

Fig. 1.

forward into contact with the spring *g* by the delicate spring *n*. The spring *g* is adjustable by the screw *h*. The electric connections will be easily traced. In the description, *g* is explicitly described as *a spring*; and the essential feature to be observed in this type is the current regulator, or loose-contact mechanism, consisting of the spring *g* bearing on the lever *c d*, actuated by the elastic membrane *o*.

The receiver in this figure consists of an electro-magnet, *m*, on a sounding-board, with an armature, regulated by an adjustable spring, *g*, pendulum-mounted, and "connected with a lever, *i*, which is as long as possible, but light and broad." This expansion of the armature is for the purpose of increasing its superficial contact with the air for the propagation of sound-waves. The Reis armature, so equipped, is the equivalent of the "diaphragm" in what is commonly called "the Bell receiver," a form, however, which appears to have originated with Elisha Gray. In the "Bell receiver" the diaphragm is an elastic, expanded, circular armature. The Reis electro-magnetic receiver is thus a complete and perfect anticipation of that of Yeates, of Dublin, in 1865, and of the later receiver of Gray or Bell. The function of all is to move an elastically supported armature backward and forward, and so throw it into vibrations corresponding to those imparted by the sound-waves to the transmitting apparatus.

Fig. 2 is copied from the "Prospectus" of Reis, dated August, 1863, containing instructions to accompany the telephones constructed for him, and sold by W. Albert, of Frankfort. The transmitter here shown has been usually called the "box-instrument." In this type, instead of a spring adjustment of the current-regulator or loose-contact mechanism, as in Fig. 1, we have the angle-shaped "Hämmerchen," as Reis called it, or little hammer, poised on the supports *a b*,

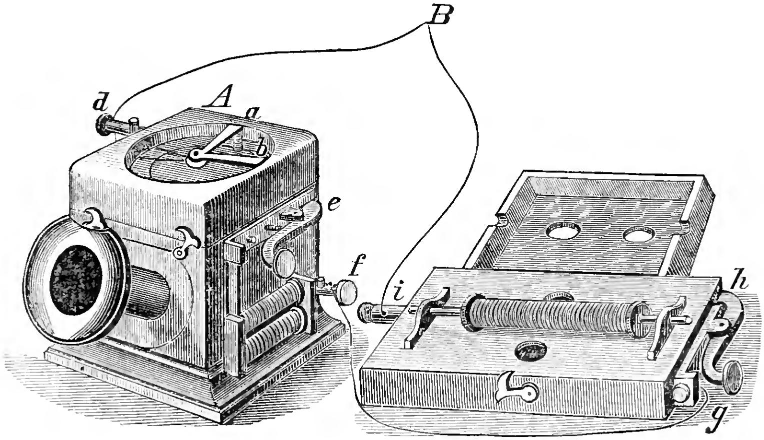

FIG. 2.

and resting *by gravity* on the strip of platinum-foil at the center of the tympanum seen below. A little drop of mercury at *b* makes perfect electric communication between the little hammer and neighboring screw-cup. The elastic feature of this loose-contact arrangement is confined to the animal or other membrane of the tympanum itself.

The mouth-tube communicates with the inside of the box or air-chamber, and the sound-waves act upon the tympanum from below. On the side of the box are seen a telegraph key, *e*, and sounder, for signalizing between the transmitting and receiving stations. This is the transmitter successfully used, as will be seen, by Yeates, in Dublin, in 1865. So sensitive was this transmitter that it was found unnecessary, in its early use, to speak directly into the mouth-piece; and in practice the speaker talked and sang at a little distance from it. In the reports of experiments with this instrument the rattling noises which were sometimes complained of as heard in the receiver were undoubtedly due to the complete breaking of the circuit by too loud talking or singing in the mouth-piece. The Berliner and Blake transmitters are liable, unless specially guarded, to the same misadventure from the same cause.

The receiver in Fig. 2 is Reis's latest form of the "knitting-needle" instrument. A helix of insulated wire is attached horizontally to a sounding-box. Through the helix a steel wire or knitting-needle is passed without contact, and supported at each end by a bridge. The vibrations of this knitting-needle magnet, corresponding exactly to the vibrations of the tympanum of the transmitter, are converted into sound-waves by the extended surface of the box acting upon the air. On the side of the box is a telegraph-key to communicate back to the transmitter. The code of signals suggested in the accompanying "Prospectus" contains the following:

"One tap = sing.
Two taps = speak."

An original telegraphic letter alphabet is also suggested, showing how slight was Reis's acquaintance with ordinary telegraphing.

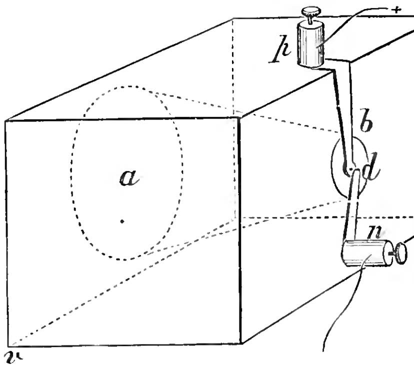

FIG. 3.

Fig. 3 represents the form of transmitter, figured and described by Reis in his first memoir of 1861. I present it, out of chronological order, on account of its simplicity and close resemblance to the modern transmitters. A conical chamber, *a b*, is bored through a cubical block and is closed at *d* by a membrane. A platinum strip, *b*, extends from the screw-cup *p*, to the center of the membrane *d*, to which it is attached. From the screw-cup *n* a spring, *n d*, carrying a platinum style, makes contact at *d* with the platinum strip *p d*. This original instrument, presented by Reis to Professor Böttger, is now in the possession of Professor Thompson. It has an adjusting screw in the course of the spring *n d*.

Reis's claim as an inventor is discussed by Professor Thompson and fully substantiated under the three following heads: "1. Reis's telephone *was expressly intended to transmit speech.* 2. Reis's telephone, *in the hands of Reis and his contemporaries, did transmit speech.* 3. Reis's telephone *will transmit speech.*" Before bringing forward evidence on these points, Professor Thompson disposes of a current prejudice against Reis's telephone, which has been not altogether innocently created. It has been called a "tone-telephone," or musical telephone, by those interested in relegating it to the category of harmonic instruments. Reis called it neither an articulating nor tone telephone, but simply "Das Telephon." He spoke habitually of reproducing any and all sounds through its agency, the German word used being *Ton*, plural *Töne*, which is nearly the equivalent of our English word "sound." By transferring the German word (untranslated) to the English it has been attempted to narrow the scope of his discovery as stated in his own words. It is in place here to say that Reis was no musician, and could hardly distinguish one tune from another.

Reis's first memoir on the telephone, delivered before the Physical Society of Frankfort-on-the-Main, in 1861, and printed in their "Annual" for the same year, begins thus: "The surprising results in the domain of telegraphy have often already suggested the question whether it may not be possible to communicate the very 'tones' [sounds] of speech direct to a distance." He says that "the cardinal question" always was "how could a single instrument reproduce at once the total action of all the organs operated by human speech." Could the expression of intention be plainer? He says, again: "Until now [1861], it has not been possible to reproduce the 'tones' [sounds] of human speech with a distinctness to satisfy everybody. *The consonants are for the most part tolerably distinctly reproduced, but the vowels not yet in an equal degree.*" Was this only a "tone-telephone"? He proceeds to show the cause of the difficulty in the case of vowels by diagrams of the undulating curves representing consonant and vowel sounds. The memoir concludes thus: "There may probably remain much to be done toward making the telephone *of practical commercial value.* For physics, however, it has already sufficient interest in that it has opened out a new field of labor. . . . Philipp Reis, December, 1861." It will be observed that this date precedes the improved forms of Reis's telephone, by which the somewhat better practical articulation, hereafter testified to, was obtained. But, even on this showing, what can be plainer than that Reis was the originator of the new art of the electrical transmission of speech? Granting that the articulation at this time, and even in 1864, was poor—poorer even than Gray's in 1875, and Bell's in the spring of 1876—it was still articulation, understood where the words were not foreknown by the listener.

With regard to the present capability of Reis's instruments, Professor Thompson says that he has found the Reis transmitters competent to transmit both vowels and consonants with perfect distinctness; and from Reis's "knitting-needle receiver he has obtained articulation, exceeding, in perfection of definition of vowels and consonants, the articulation of *any other telephone receiver he has ever listened to.*"

Among other contemporary documents, the important report of Legat on Reis's telephone to the Austro-German Telegraph Society in 1862 is reproduced in full. From this report we have taken one of the illustrations in this paper. The report is not only a description of Reis's instruments, but an elaborate discussion of the problems connected with the telephonic reproduction of sounds, including the transmission of speech. The documents of this date show that the subject of telephony was usually studied in connection with vocal song rather than simple speech, and that the transmission of musical sounds, which was generally successful, was preferred for illustration to the more difficult, but also much more important, transmission of words and sentences. But the fact of articulation continually appears.

In a chapter containing the testimony of contemporary witnesses, Professor G. Quincke, Professor of Physics in the University of Heidelberg, writes, under date of March 10, 1883, that he was present at Reis's exhibition before the Naturforscher Versamlung, at Giessen, 1864. He says: "I heard distinctly both singing and talking. I distinctly remember having heard the words of the German poem:

"'Ach, du lieber Augustin,
Alles ist hin,'" etc.

Ernst Horkeimer, a pupil of Reis, writes that he assisted him in most of his experiments prior to the spring of 1862; that the transmission of speech was Reis's chief aim; "the transmitting of musical tones being only an after-thought, worked out for the convenience of public exhibition," and that some words were successfully transmitted without previous arrangement, but not (at that date) whole sentences. He states that Reis anticipated the use of thin metallic tympanums, and tried one, varnished with shellac on both sides, except the central point of contact.

Léon Garnier, proprietor and principal of the institute of which Reis was a teacher, states that he often talked with Reis through his telephone for an hour at a time, the distance of the stations from each other being about one hundred and fifty feet. He says: "I remember especially that—Mr. Reis speaking through his instrument—I distinctly heard the words, 'Guten Morgen, Herr Fischer'; 'Ich komme gleich'; 'Passe auf'; 'Wie viel Uhr ist es?' 'Wie heisst du?'" Heinrich Hold, a colleague of Reis in the same institute, gives detailed testimony of talking successfully through the telephone. Heinrich F. Peter, the musical teacher, then and still at Garnier's Institute, says, "Philipp Schmidt read long sentences from Spiess's 'Turnbuch,' which sentences Philipp Reis, who was listening, understood perfectly, and repeated to us." Being incredulous, and to further test it, Herr Peter spoke some impromptu nonsensical sentences through the telephone, such as "Die Sonne ist von Kupfer," which Reis understood as "Die Sonne ist von Zucker."

Mr. S. M. Yeates, instrument-maker of Dublin, writes that in 1865 he exhibited Reis's telephone to the Dublin Philosophical Society, substituting an improved electro-magnetic receiver for the knitting-needle receiver (shown in Fig. 2), the transmitter being the same as in that figure. Yeates's receiver was an electro-magnet with a vibrating armature, mounted on a spring attached to a sounding-box. William Frazer, M. D., member of the Council of the Royal Irish Academy, writes, March 13, 1883, that he was present on this occasion, that various questions were asked and answered, and that "the separate words were most distinct, the singing less so." The individual who spoke was easily recognized by his voice. (It has been stated elsewhere that Yeates improved the Reis transmitter by placing a drop of water between the platinum surfaces of loose contact.)

In an appendix, which is not really separable from nor less important than the rest of the work, Professor Thompson discusses the relation of Reis's instruments to those now in use, and also Reis's development and use of the variable or "undulatory" electric current, corresponding to the undulatory curves of sound-pressure, which he graphically represents, and to which he often refers.

In the first section, Professor Thompson points out that Reis's transmitters preserve throughout, first, the tympanum to collect the voice-waves, and, second, two or more electric elements in loose or imperfect contact with each other, so combined with the tympanum that the motions of the latter correspondingly alter the current of electricity flowing between the contact-pieces. Reis's apparatus is not, therefore, an "interruptor," but a "current-regulator." The contact-pieces, one or both, were mounted with adjustable springs, or held together by gravity, so as to vary the current without completely breaking contact, in the same way, and for the same purpose, as in the Berliner, Blake, and other modern transmitters. Disregarding induction-coils and other accessories, the fundamental principle of these later instruments is the combination of a tympanum with a current-regulator, identical with the combination used by Reis. Too loud shouting in either the Reis or Blake transmitters spoils the articulation by breaking the circuit.

Reis's transmitters have been called make- and break-circuit instruments. If so, the Berliner and Blake transmitters, operating on the same principle, are also make- and break-circuit instruments. If, on the other hand, the Berliner and Blake transmitters, by their current-regulators, determine undulatory electric currents, in correspondence with the sound-waves, the Reis transmitters, by the same mechanism, necessarily do the same.

The identity of the mechanism of the current-regulators in four of Reis's transmitters with the mechanism in six modern forms of transmitter is strikingly exhibited by Professor Thompson in a comparative plate.

In connection with the Reis current-regulator, now in almost universal use, it has been in later times found generally advisable to use an induction-coil. It is an interesting fact in the evolution of the telephone, though it may not be stated in the book before us, that Ferguson's chemistry, published in 1868, states that Dr. Wright in England used a Reis transmitter in the primary circuit of an induction-coil. The combination of current-regulator and induction-coil in the modern transmitters is therefore old.

In the third section of the appendix, Reis's receivers are compared with recent instruments. The examination in this case, also, is much aided by a comparative plate. Reis's electro-magnetic receiver is shown to combine the three following essential elements, which enter into the Yeates, Gray, Bell, Edison, and other receivers: 1. An armature acted on by an electro-magnet; 2. An armature elastically mounted; 3. An armature of sufficiently extended surface to set in motion aërial sound-waves. This discussion has been anticipated in previous pages. Professor Thompson, in summing up his close analysis, points to Reis as the genius by whom the essential principles of all the electro-magnetic receivers now in use were discovered and combined so as to reproduce articulate speech.

A section in the appendix is devoted to the "undulatory" current in Reis's telephone. We have already seen that the function of the Reis transmitter was to vary the strength of the electric current, and not to break it. Reis was accustomed to speak of opening and closing the circuit in describing these instruments, not in the technical sense of modern telegraphy, nor with the idea of sending intermittent signals, but in the sense of increasing or diminishing the current, without going so far as absolutely to break it. This is abundantly proved by the context in his descriptions, and by the operation of his instruments. He states, in his first memoir, that, to reproduce any sound, or combination of sounds, all that is necessary is to set up in the receiver vibrations whose curves are identical with those of the sounds, or combination of sounds, in the transmitter. And he represents graphically the undulatory curves of consonant and vowel sounds, by way of illustration. Between the transmitter and receiver, on whose necessary identity of vibrations he constantly insists, he employs an electric current as the intermediate, to take on, in its wave-motions or polarizations, all the possible variations of the sound-waves striking on the transmitter, and to give them up again to the receiver. Reis, without talking about "undulatory" currents, makes them the staple of his telephone.

Professor Thompson, without the least imputation of plagiarism, shows, in parallel columns, the identity of expression between Reis and Bell, in their statement of the essential principles of the telephone. The impression of the identity of Reis's and Bell's discovery grows, page by page, during the perusal of this book.

The conclusion reached by Professor Thompson, from the survey of the whole field—a conclusion which seems to be fully borne out by the facts adduced—is the following: "There is not, in the telephone exchanges of England to-day, any single telephone to be found in which the fundamental principles of Reis's telephone are not the essential and indispensable features."

This conclusion makes the speaking telephone, in its elementary form, free to the whole world. It opens wide the door for the future development of the telephone; and it should assure to all those who, by their genius and industry, in our day and generation, have improved or may improve the telephone, an ample pecuniary reward. The recompense due to the family of Philipp Reis should take the form hereafter not of a tax, but a free gift from the world's gratitude.

This book comes, then, as a charter of freedom of speech in a larger sphere than ever before known.

In the light of historic facts which this book establishes, the decision of the courts of the United States that Professor Bell is the discoverer of a new and useful art (the electric transmission of speech), to which he has exclusive title, must be reversed as speedily as possible, that our courts may retain the respect of the people of the United States.

CORRESPONDENCE.

DEVELOPING A NEW INSTINCT.

Messrs. Editors:

A COW (half Jersey) ran with others in an orchard, and showed herself exceedingly fond of green, sour apples. So persistently did she "go for them," that it was suggested she would climb the trees yet. But she did not take to climbing; she invented another method: she took to shaking the limbs.

At first she reached directly for the fruit and foliage, but at the same time, no doubt, observed that, when the limb sprang back, apples fell to the ground. This left an impression known as memory; and, at length, keeping hold of the limb with her teeth, she shook it precisely as a man would, jerking it downward a number of times in quick succession, and then letting go her hold to pick up the apples. I once drove her away from a tree which she was relieving of its fruit rather successfully, when she went to another tree, apparently intent on business, seeming to have forgotten that she had previously shaken off all the apples within reach; but, when there, she either observed that there was no fruit to shake off, or else recollected that she had already harvested all that was to be had; at any rate, she did no shaking.

To protect the fruit against her fertile genius, I tied her head to a fore-leg, with about twenty inches interval between them. She would then support herself on three legs, lift up the fourth one and seize with her teeth limbs as much as five feet from the ground, and shake them as skillfully as before.

In this case there is no mistake about the fact. I have witnessed the novel performance many times; and, when not looking, I have heard the peculiar sound of the shaking limb and falling apples, and realized how strikingly suggestive it was of a human presence. The animal is now four years old, and has given exhibitions of her skill the last two summers.

This trick was not learned by witnessing a like act of man or animal. It was independently invented through suggestion, as a human being would independently invent a mechanical process. The animal in question is not any wiser than her comrades in other respects; but, though she invented limb-shaking for herself, they have not taken the first step toward imitating her. Still it would be plausible to suppose that other cattle, especially her own offspring, would come to follow her example by-and-by, and that if they ran constantly in apple-orchards they might become permanently endowed with the limb-shaking instinct—not of miraculous but of purely utilitarian origin.

J. S. Patterson.

Berlin Heights, Ohio, *April*, 1883.

THE AGE OF TREES.

Messrs. Editors:

In the December number of "The Popular Science Monthly" I observe an article by A. L. Childs, M. D., stating that the old notion that a person could tell the age of a tree by the number of the concentric rings shown on a cross-section of the timber was a fallacy, and giving some facts to sustain the theory advanced. As the "Monthly" is searching for the truth only on scientific questions, permit me to give a few facts, which tend to support the old theory that Dr. Childs attacks.

When Virginia ceded to the United States the territory northwest of the river Ohio, she reserved all the lands lying between the Scioto and Little Miami Rivers, in order to satisfy the bounty lands given by her to her soldiers who had served in the Revolutionary War. The State of Virginia had given lands varying in quantity from one hundred acres to a private soldier, five thousand acres to a colonel, to fifteen thousand acres to a major-general, to all those who had served as such soldiers and officers during the war, and issued what were termed "land-warrants" to such soldiers and officers for the land to which each was entitled. These parties took the "land-warrants" thus issued to them, and made their own entries of the lands called for on any vacant land in the district, describing the same on the "Book of Entries," and then had these entries surveyed by the surveyor of the district, who marked the boundaries and corners of the several surveys on the growing timber, by hacking the same that happened to be standing along the lines of the surveys or near the corners thereof; and on these surveys being returned by the holder to the General Land-Office, at Washington city, the Government issued a patent for the land thus surveyed to the holder of the warrant, his heirs and assigns. Some of these surveys were made before General Anthony Wayne defeated the Indian tribes in 1794, and others were made as late as 1857. From the fact that parties made their own entries, there were many overlapping and interfering entries and surveys, and very frequently junior entries and surveys obtained the first patent. (Some of the entries are not yet surveyed, and some of the surveys not yet patented.) Out of this system endless confusion and litigation arose in settling the disputed lines and overlapping entries and surveys.

This litigation was not wholly settled until long after I came to the bar, in 1847, and it was my fortune to be engaged in many of these cases. In the trial of these cases it very frequently became important to show the date of the surveys These dates were shown by the indorsement on the survey itself, and corroborated by an examination of the hacks on the line and corner trees of the survey. These hacks invariably left a scar, which, to the practical surveyor, was readily detected, even after a lapse of sixty years. By "blocking" the tree, as it was called, and taking the block and counting the concentric rings, from the hack made by the surveyor to the outside of the tree, it invariably corresponded with the dates as they appeared upon the returns made by the surveyor, showing as many rings as years had elapsed from the date of the survey, thus proving that for each year of the life of the tree au additional concentric ring had been added.

The prevailing timber was oak, in its many varieties, and they were rarely marked unless they were at least four inches and upward in diameter. 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.

Judge N. H. Swayne, late of the Supreme Court of the United States, but now residing in New York city, practiced for many years, before he was called to a seat on the bench, in the Virginia military district, and is familiar with these facts. If you will drop a note to him, he will corroborate me. P. C. Smith.

Circleville, Ohio, *January* 3, 1883.

WÖHLER AND "VITAL ENERGY."

Messrs. Editors:

In the June issue of your magazine (vol. xxiii, No. II), in the opening paragraph of an article entitled "Darwin and Copernicus," reference is made to Wöhler as the "chemist who by the first organic synthesis helped to dispel the illusion of vital energy." Have the artificial production of urea by synthesis and subsequent achievements in that line satisfied scientists that vital energy is an *illusion*, or does Du Bois-Reymond so characterize it upon the basis of his own *speculations* and the *conjecture* of a school of physicists? If the non-existence of vital energy has not been demonstrated beyond question, does he not violate "scientific candor" in his assertion? A well-known chemist, for several years pupil and assistant of Wöhler, familiar with his work, and conversant with later chemical research, has told me that in his judgment the expression referred to above is unwarrantable.

Very respectfully,

Austin B. Bassett,

Department of Physics, Massachusetts Agricultural College.

Amherst, *June* 5, 1883.

TEACHING ENGLISH.

Messrs. Editors:

Not long since the Board of Education in this city decided to employ a teacher of *English* and *Elocution* for their high-school, one of the largest for places of equal size in the country. But, although the University of Michigan, with its fourteen hundred students, is situated here, no one could be found among its graduates competent to teach how to write the most important and forcible of all languages, our own mother-tongue, and at the same time speak it with ease, grace, and the most artistic expression. Hundreds are prepared to teach dead languages, none to write and speak the English, and hence a teacher had to be imported. Herbert Spencer's question, "What knowledge is of most worth?" is very pertinent here. Why so much time on dead languages, and none on speaking our own?

X.

Ann Arbor, Mich., *June* 26, 1883.

THE CASE OF THE DOG PLUTO.

Messrs. Editors:

In your issue of the present month appears the article of Mr. Eugene N. S. Ringueberg, describing the strange actions of his pointer Pluto. It seems to me a strained explanation which attributes the conduct of this dog, as described, to *superstition* or the fear of ghosts, etc.

In your number of April last was a paper on "Perceptional Insanities," by Dr. W. A. Hammond, and any person who has read that article, or who is otherwise at all familiar with the subject of illusions and hallucinations, must recognize the fact that all which is related by Mr. Ringueberg is more reasonably to be accounted for by supposing Pluto to have been a victim of *perceptional insanity*.

The animals, sharing much with man even as to mental or spiritual qualities, are, like him, subject to madness and insanity, and there is no reason for supposing that they do not occasionally suffer from deception of the senses. In the case of Pluto, the first noticed attack followed immediately upon hearing the noise caused by the falling of a stick of wood in the stove behind which the dog was sleeping. It seems probable that the sudden clatter impressed the startled animal as being the sound uttered by some dangerous enemy. If such were the case, it was natural for the beast to search for the thing itself that terrified him, which in fact was done, for he immediately fastened his gaze upon the leaf that lay on the floor and commenced against it his timid hostilities. This conduct upon his part justifies the inference that the noise of the falling stick suggested a visible enemy, possibly a serpent; and so, the withdrawing of his paw accompanied by the licking of it would seem to tell us that the illusion or hallucination affected the sense of touch as well as those of hearing and sight.

Having once passed through this experience as following the hearing of the noise made by the falling stick, it was natural that there should be an association within him between sudden noises in general and the thing of terror, and hence, as Mr. Ringueberg tells us, he was apt to be thrown by such noises into paroxysms; and so, the sound which caused the first trouble having arisen in the kitchen, noises coming subsequently from that quarter were the most disturbing to him, just as stated. Proceeding one step further, as the first attack came upon Pluto in the kitchen, it was natural for him to regard that spot as the abiding-place of this enemy, and to show signs of terror, as he did, at all times when passing through that apartment. And, when particularly disposed to a violent attack, the association of ideas connected with the kitchen was most likely to there bring upon him the climax of his trouble.

Mr. Ringueberg speaks always of these paroxysms as accompanied by a fixed staring at some particular object, whether a spot upon the ceiling, a hanging towel, or something else, and a terrified retreat therefrom; all of which suggests a false sight, bringing up the image of some *material* enemy, and it is rather imaginative, under all the circumstances, to suppose that it was ghosts, or *things spiritual*, which he had before him, in imagination.

Respectfully yours,

FRANK McGLOIN.

NEW ORLEANS, *May* 18, 1883.

EDITOR'S TABLE.

HERBERT SPENCER AND THE FRENCH ACADEMY.

MR. HERBERT SPENCER has been chosen a member of the Institute of France. We learn that he was elected in May by a nearly unanimous vote as a Foreign Correspondent of the Academy of Moral and Political Sciences, to fill a vacancy caused by the death of Henry P. Tappan, of Detroit. These academical distinctions are so often unworthily bestowed, that Mr. Spencer does not hold them in much esteem as indications of genuine merit; but, as it may be assumed that he is not indifferent to the good opinion of his eminent contemporaries, he will, no doubt, appreciate at its true worth this well-intended compliment, and make his acknowledgments accordingly.

But there is an interest in the transaction not confined to the immediate parties to it. When an institution, standing highest in the world as a dispenser of the titles to intellectual eminence, and which has become a kind of authoritative arbiter in such matters, undertakes to assign the position of a man like Spencer, there are many who will desire to know with what discrimination, and what rectitude of judgment, the award has been made. The honors of the Institute are not all of equal dignity: that of Foreign Associate is highest, while that of Foreign Correspondent is of secondary rank. The French academicians, after having certainly taken abundant time for deliberation, now decide that Mr. Spencer's claims are not such as to entitle him to the highest rank among the intellectual leaders of the time. We think the Academy has here made a considerable mistake, which it is important should be corrected.*

* It may be as well to say that we are not to expect too much from the French Academy. Its predominant historic spirit has been time-serving, and it is declared by high authority that, instead of fostering originality, it has rather been its policy to hamper and crush it. We should not, therefore, look to it for a very liberal appreciation of Herbert Spencer; his qualities, in fact, are very much those which it has not been its policy to honor. The following estimate of its influence, by M. Langfrey, is

By the theory of all such institutions, the relative rank of great men is a determinable thing. The supreme object of the Institute of France, through the organization of its five great Academies, is the extension and improvement of human knowledge in all its comprehensive departments; while, subsidiary to this object, it assumes the function of honoring the men in foreign countries who have contributed in eminent ways to this advance of knowledge. Mr. Spencer is, therefore, to be estimated by the import of his contributions to the progress of thought. The tests of pre-eminence here are not doubtful. To produce any wide or profound impression upon the state of knowledge at the present day requires the rarest order of mind. There must be a thorough mastery of many departments, comprehensive insight, great capacity of generalization and of organization, and the fertility of creative conception, the independence and the originality of ideas that belong to genius. It will not be difficult to show that Herbert Spencer possesses these traits in so marked a degree as to have made him a leading power in the greatest intellectual movement of modern times.

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probably but too correct. He says, in his "History of Napoleon": "Founded by the monarchy and for the monarchy, eminently favorable to the spirit of intrigue and favoritism, . . . wasting all its energies in childish tournaments, in which the flatteries that it showers on others are only the foretaste of the compliments it expects in return for itself, the French Academy seems to have received from its founders the special mission to transform genius into *bel-esprit*, and it would be hard to produce a man with talent whom it has not demoralized. . . . If we examine its influence on the national genius, we shall see that it has given it a flexibility, a brilliancy, a polish, which it never possessed before; but it has done so at the expense of its masculine qualities, its originality, its spontaneity, its vigor, its natural grace. It has disciplined it, but it has emasculated, impoverished, and rigidified it. It sees in taste not a sense of the beautiful, but a certain type of correctness, an elegant form of mediocrity. It has substituted pomp for grandeur, school-routine for individual inspiration, elaborateness for simplicity, *fadeur* and the monotony of literary orthodoxy for variety—the source and spring of literary life; and, in the works produced under its auspices, we discover the rhetorician and the writer, never the man. By all its traditions, the Academy was made to be the natural ornament of a monarchical society. Richelieu conceived and created it as a sort of superior centralization applied to intellect, as a high literary court to maintain intellectual unity and protest against innovation."

Mr. Spencer published in 1855 a philosophical treatise entitled "The Principles of Psychology," an original and powerful work, putting the science of mind upon a new basis, and which the best judge in England, John Stuart Mill, pronounced "the finest example we possess of the psychological method in its full power." This work anticipated and reduced to valid application in the highest phenomenal sphere those fundamental doctrines of nature and life which have since become firmly established in the scientific world. Holding the principle of evolution to be a fundamental truth while yet it was generally held to be a baseless speculation, he founded upon it a systematic exposition of the laws of mental phenomena. The constitution of mind was investigated by the genetic method, and the development of the mental elements, organic and psychical, was traced from their simplest to their most complex relations in correspondence with the phenomenal relations of environing nature, by intercourse with which all mind is unfolded. The book was greatly in advance of the age, and its significance was at first comprehended by only a few; but these were so powerfully affected by it that a new direction was given to psychological study, and its influence was soon widely recognized in the ablest literature of the subject.

A single illustration of its insight and originality may be here instanced. From early times down to the present, philosophers have been split into two parties over the question of the genesis of ideas, one maintaining that they are innate, and the other that they originate in experience. From Plato to Kant on the one side, and from Aristotle to Locke on the other side, the representatives of these schools have battled over the problem in thousands of futile books, which left the question as unsettled as they found it. Herbert Spencer solved the problem and reconciled the antagonism through the basal idea of evolution in the organic sphere—the principle of heredity. He showed that there is an element of truth in both views, and that, while on the one hand all ideas are derived from experience, it is not alone the experience of the individual, but the experience of the race and of ancestral races, by which the mental elements become organized, transmitted, and augmented in vast time, so that each individual is born with a heritage of innate and *a priori* aptitudes and capacities—the products of evolution. Thus the philosophical conflict of ages was harmonized in our own time, and the brilliancy of the solution is already tempting some of our ablest thinkers to venture the assertion of rival claims to the honor of having independently reached this great result. But the priority of Herbert Spencer is here impregnable, as is unreservedly conceded by the most competent authorities. We quote the last that comes to hand. Dr. Edmund Montgomery, in a masterly series of articles on "Causation and its Organic Conditions," recently contributed to "Mind," thus refers to Spencer's enunciation of the principle:

"Until quite recently I can not detect any movement in philosophy containing a germ of sufficient power to be capable of effecting by development the deliverance from the constant and almost fruitless see-sawing of the two schools. . . .

"Suddenly, however, light began to pierce the hitherto immovable darkness. It was Mr. Herbert Spencer who caught one of those rare revealing glimpses that initiate a new epoch in the history of thought. He saw that the evolution hypothesis 'furnishes a solution of the controversy between the disciples of Locke and Kant.' To us younger thinkers, into whose serious meditations Darwinism entered from the beginning as a potent solvent of many an ancient mystery, this reconciliation of transcendentalism and experientialism may have consistently presented itself as an evident corollary from the laws of heredity. But what an achievement for a solitary thinker, aided by no other light than the penetration of his own genius, before Darwinism was current, to discover this deeply-hidden secret of nature which with one stroke disclosed the true relation of innate and acquired faculties, an enigma over which so many generations of philosophers had pondered in vain!"

We speak far within bounds in saying that the book embodying these and kindred views, and recasting the most subtile and complex of the sciences, must be classed with the few great works of the century, the value of which, as a contribution to progressive thought, it is hard to overestimate.

Had Mr. Spencer done nothing more than to make his powerful contribution to the regeneration of mental philosophy, this capital service to the advance of thought should have been honorably signalized by the French Academy a quarter of a century ago. But this research only prepared the way for labors of greater magnitude. His system of Psychology, matured in thought in 1853, and written in 1854, shows how early and how firmly he had grasped the principle of evolution at that early time. That he should have been enchained by the new view was inevitable. The sciences were full of the raw materials of the inquiry, and evidence rapidly accumulated that a common process of unfolding transformation may be traced through all orders of phenomena. It was while writing the "Psychology" that Mr. Spencer first reached the conviction that evolution is a universal law of the course of nature. So vast and so pregnant an idea could not fail to have an all-determining influence upon his future course of thought. He saw that the scientific elucidation of this grand generalization, the discovery of the causes and conditions of the universal process, and the comprehensive application of the principle to the reorganization of knowledge, must be the next great step in the progress of modern ideas. The import of the new view could hardly be exaggerated. Hitherto the unity of nature had been a speculative conception favored by the tendencies of science, but not resulting in any valid unification of knowledge. An epoch was now reached by the recognition of a demonstrable, all-unifying, objective law, capable of bringing the great divisions of science into closer co-ordination, and a more intimate mutual dependence. This made possible a philosophy of nature based upon the sciences, and to the working out of such a scheme of thought Mr. Spencer devoted all the powers of his mind. His qualifications for the task were eminent. His encyclopedic acquisitions, his remarkable power of analysis, his capacity of organization and generalization, declared by the "Saturday Review" to have been unequaled in England since Newton, prepared him to engage upon a great intellectual undertaking which he was himself the first to conceive and to project, and he resolved to work out a philosophical system of thought constructive and synthetic in its predominant character, and embodying the principle of evolution as its central and controlling conception.

Mr. Spencer entered upon this extensive project in 1858 by drawing up a scheme designed to occupy seven volumes and to contain a fundamental exposition of the proofs and principles of the theory of evolution, a broad application of it to the laws of life, of mind, and of human society, and finally to ethical science by showing the bearing of evolutionary doctrine upon the regulation of human conduct—the whole to constitute a systematic philosophy of evolution. His method was then mature, but upon further consideration the scheme was amplified in 1859 to ten volumes, and embodied in a prospectus for publication, which presented the course of the elucidation in detailed order of logical dependence under thirty-three consecutive divisions, and which referred to various extended tracts of the general investigation already written and published. This prospectus was printed in March, 1860, and has been adhered to, with no essential deviation, in the subsequent carrying out of the undertaking.

Now, in any critical estimate of Mr. Spencer's original contributions to the progress of knowledge, it is of the first importance to bear distinctly in mind the time at which they were matured. For this purpose we are closely concerned with his *status* as a thinker in 1858, as recognized by men of the highest ability while yet the general public knew nothing of him. There is evidence upon this point that must not be overlooked. When Mr. Spencer had elaborated the first programme, and resolved to execute it, he had at once to meet the primary difficulties of self-support and of publication. Thinking there might be some Government place of light duty and small emolument which he could consistently fill, and still have leisure for his labors, a few friends were consulted, and they gave him letters designed to be published and to favor his application. But Mr. Spencer gave up the plan and never printed them, and the use now made of them is by no consent of his. These letters were from John Tyndall, J. S. Mill, George Grote, T. H. Huxley, R. G. Latham, J. D. Hooker, and A. C. Fraser. Their joint import was that Mr. Spencer was a man of remarkable endowments, eminently qualified to do a great intellectual work, which would be an honor to the nation and a lasting service to mankind—a work like that of Bacon, although more arduous and difficult, owing to the vast accumulation of knowledge in modern times. One of the most distinguished of the writers said:

"I am glad to have an opportunity

of expressing my sense of the value which attaches to the writings of my friend Mr. Herbert Spencer, and of the high estimation in which I, as a practical man of science, hold his speculative labors.

"Founded as it is upon the accurate observation of facts, science would soon stagnate if the co-ordination of its data did not accompany their accumulation; and I can conceive nothing that would give a more vigorous impulse to the progress of science than the promulgation of a modern Novum Organon adapted to the state of knowledge in these days, and showing the unity of method of all science, and the mutual connection and interdependence of all forms of acquisition.

"I can not testify more strongly to my estimation of Mr. Spencer's abilities than by expressing my belief that, if health and moderate leisure be granted him, he will very satisfactorily perform this necessary piece of work for us. And I base my conviction not so much upon a knowledge of Mr. Spencer's works (though I could amply justify it from them), as upon that intimate acquaintance with himself which it has, for some years past, been my privilege to enjoy."

The eminent and responsible pledges thus tendered twenty-five years ago of Mr. Spencer's preparation to enter upon a great intellectual undertaking for the advancement of human knowledge have now been amply redeemed. Seven volumes of the "Synthetic Philosophy" have been given to the public, have been translated into various languages, and are recognized by the best minds as authoritatively representing a new epoch of thought, and as taking rank among the monumental works of the century. Though it may seem useless to quote authorities in confirmation of this statement, yet they have so important a bearing upon our present purpose that we must be excused for citing a few expressions testifying to the position of the man as shown by the character of his accomplished work.

Dr. Masson, of the Edinburgh University, spoke several years ago, in one of his books, of Spencer as the rising power in British philosophy; and G. H. Lewes, in his "History of Philosophy," declared "that no thinker of finer caliber had appeared in England." Professor Jevons, in his "Principles of Science," ranks the works of Spencer as in their influence among the most important that have appeared since the "Principia" of Newton. Dr. J. D. Morell, author of the "History of Philosophy," testified to Spencer's "extraordinary power of analysis and generalization," and Dr. Fairbairn recently declared that to conceive such a system as Spencer's "is in itself an education to an age." Professor Huxley remarked before the Royal Institution that "the only complete and systematic statement of the doctrine (evolution) with which I am acquainted, is that contained in Mr. Herbert Spencer's 'System of Philosophy.'" Mr. J. S. Mill has referred to his "encyclopedic knowledge"; Mr. Darwin spoke of him as "our great philosopher"; H. W. Beecher as "king of the thinkers of this age"; President McCosh recognized his "giant mind," and President Barnard speaks of him as "not only the profoundest thinker of our time, but the most capacious and the most powerful intellect of all time."

These emphatic declarations regarding Spencer's genius and position as evinced by the greatness of his work must be construed as applying to what he had really achieved in 1858–'59. It is not that his works stand to-day confessed in their supereminence, but that he was before all other men in arriving at the views they contain. Evolution has now become a commonplace of thought; it was the guiding principle of Herbert Spencer's intellectual labor thirty years ago. While yet the doctrine was scouted as a chimera by one half the world, and execrated as an abomination by the other half, there was with Mr. Spencer no slightest question of its truth, the evidence for it being to him overwhelming and irresistible on every hand. While a few scientific men were giving to it a reserved adhesion, or testing it in special directions, Mr. Spencer was reconstructing the sciences by its guidance, and building a philosophy out of its principles. In any attempt to appraise his intellectual rank, we are bound to remember the originality and the priority of the labors it is now so easy to applaud. When it is a question of grading the searcher after truth, it makes a profound difference whether he is a pioneer or a follower; and it is but naked justice to Mr. Spencer to recognize that he had worked out the grand doctrine of evolution in systematic completeness as now formulated and accepted before Mr. Darwin had published a word of his important contributions to the subject.

Clearly, then, the action taken by the French Academy is discreditable to its intelligence and to its impartiality. By all the equities that should control it in the discharge of its self-assumed office of rating the intellectual services of eminent men, the name of Herbert Spencer ought long since to have been enrolled among the first in honor. By its culpable tardiness its belated verdict is alike superfluous to the recipient and to the world which long ago formed its judgment of the rank of this philosophical thinker. And when at last the decision comes, it betrays a misconception of the case, which may be fitly characterized as a blunder, while only the following sorry apology can be offered for it. It is well known that the French are behind the world in their appreciation of the doctrine of evolution. The French mind has never recovered from the warp it received half a century ago in getting committed on the wrong side by the overshadowing genius of Cuvier, whose brilliant rhetorical triumph over Geoffroy Saint-Hilaire, in the walls of the Academy itself, strongly biased the national thought in relation to this subject. The *savants* of France may therefore be not very competent judges of the foreign contributions to the knowledge of it. But surely they should have known better than to offer Herbert Spencer the successorship to "Tappan, of Detroit!" In what way this gentleman ever got into the French Academy, let those explain who can; but certainly, if the place was suited to him, it is not such as should have been proffered as an honor to the most commanding intellect of the age.

LITERARY NOTICES.

Notes of Talks on Teaching. Given by Francis W. Parker, at the Martha's Vineyard Summer Institute, July 17 to August 19, 1882. Reported by Lelia E. Patridge. New York: E. L. Kellogg & Co.

The normal schools all over the land have for the past twenty-five years been sending out graduates whose mission it has been to replace the old rote-system of lesson-learning by methods better adapted to the minds of children. We commend this book to that great body of earnest teachers. It contains a series of twenty-five full, clear, and much-needed expositions of the principles that underlie primary and grammar school teaching. The first half of the volume is devoted to lectures, or "talks," as they are called, upon teaching children to read, to spell, and to write. There are nine further "talks" upon teaching composition, numbers, arithmetic, geography, and history. Then follow a chapter upon examinations, another upon school government, and another upon moral training.

It is said, by some of our leading teachers, that the noise about Colonel Parker and the "Quincy System" is largely due to the prominence of his trumpeters—the Adamses. And, no doubt, many willing learners will ask: "Is there really anything new in Colonel Parker's teaching? Have we not, for a generation, been using identical methods?" We reply that this book certainly contains a great deal that we have not before seen in the literature of school-reform. Candid readers, familiar with current school ideals and practices, will see, we think, that Colonel Parker is working from a stand-point of his own, and that his view of the situation is not the generally recognized one.

The fashion of modern educational reformers has been to exalt "method" above all other things. Normal pupils have been trained early and late in *methods* of teaching. To the acquirement of method they have given long practice, under sharp criticism. And the practical issue of all this drill has too often been a kind of teaching which has at once fallen to the level of dead routine. The method, mechanically acquired, has been mechanically applied. Colonel Parker evidently sees this. With him methods are nothing without competent teachers; and competent teachers evolve their own methods. The "talks" in this volume are mostly of the underlying psychological principles that should shape methods, and rarely of special practices. He reiterates his warning to teachers against *imitation*. Teaching, with him, is a vital intercourse between the *mind* of the teacher and the *mind* of the scholar. It is in his greater reliance upon the guidance of principles, and the personal activity of the teacher, working on his own hook independently of anybody's method, that Colonel Parker's claim seems to us to consist.

He has unusual insight into mental phenomena. He is a student of psychology, with an intuitive tendency to seek the causes of things. Further than this, he has strong sympathy with childhood, and these combined traits give originality to his work as a teacher. They make him a reformer of the reformers. He sees through the barren formulas and absurdities that have frequently replaced the old-fashioned school routine.

His sense of the inanity of prevailing practices is often seen in these pages. For instance, in speaking of so-called analytical teaching, he gives the following familiar example of recitation in arithmetic:

Teacher.—"If one apple costs three cents, what will four apples cost?"

Child.—"If one apple costs three cents, four apples will cost four times as many cents as one apple will cost. Therefore, four apples will cost four times three cents. Four times three cents are twelve cents. Therefore, if one apple costs three cents, four apples will cost twelve cents."

Colonel Parker adds: "I think I have not put in all the words that can be put into this complex and useless explanation. If the previous work has been correct, all the child needs to say is, 'twelve cents,' and go on performing a dozen examples, instead of agonizing over this one."

By "previous work" Colonel Parker means the early study of numbers, which should be "by bringing the mind to bear directly upon the relations of things. . . . As well might we try to teach the facts in botany without plants, in zoölogy without animals, form without form, and color without colors, as to teach number without numbers of objects. All primary ideas of numbers and their relations must be obtained immediately through the senses, and by their repeated limitations as numbers of things, as to how many. . . . From repeated tests, given by myself and by teachers under my supervision, the average child of five or six years of age does not know three when he enters the school-room. . . . Ability to count," says Colonel Parker, "must not be confounded with the knowledge of numbers. Knowing a number is, first, knowing the equal numbers that make it up; second, the equal parts of a number; and, third, any two unequal numbers in a number and any two unequal numbers that make it up. This applies to numbers from one to twenty, and is learned by experiments with things. I have tried during the last eleven years to teach numbers to little folks, and I have never succeeded in teaching, nor have I seen ten really taught, during the first year. By using language without regard to what it expresses, fifty or one hundred may be taught; i. e., the child, by unceasing drill, may repeat gibberish that seems to be knowledge to the casual observer. Ask him to verify his statement by showing the real relations among things, and you find he has been repeating an unknown language."

Colonel Parker's criticisms upon much that goes as object-teaching are equally trenchant and thorough-going. With him, education is idea-growth. He understands the conditions of this growth, and he knows that the first business of a teacher should be to learn these conditions. So far as we know, the subject of mental growth is not put on this footing in our training-schools, nor are our teachers tested by any such standard. But the circulation of such books as this will hasten the time when the teachers of children will be required to know something of the laws that govern their mental development.

An Address on the Fiftieth Anniversary of the Class of 1832, parts of which were read at a Class-Meeting at Union College, June 27, 1882. By Charles E. West. Brooklyn, N. Y.: Tremlett & Co.

This is a volume of unusual interest of its kind. There is of course much in it of local and personal import that will be chiefly prized by the parties in most intimate relation with the scene of the history, but we have found even this portion of Dr. West's monograph very entertaining. We call attention to it here, however, on account of the admirably executed survey of scientific progress in its main departments which has taken place during the fifty years which have elapsed since the organization of the "class of '32." From his wide familiarity with the labors of scientific men, and his clear appreciation of the great drifts of modern thought, Dr. West was well prepared to perform the duty that devolved upon him in sketching the great changes of the last half-century, and he has done it in a most able and attractive manner.

The Life of James Clerk Maxwell, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science. By Lewis Campbell, M. A., LL. D., and William Garnett, M. A. London: Macmillan & Co. Pp. 662. Price, $6.

No stronger individuality has appeared in recent English science than that illustrated by the present biography. Clerk Maxwell was a man of undoubted genius, as a mathematical physicist among the very ablest, and withal original, versatile, and eccentric. He had a strong sense of humor, and mixed wit, fun, pictures, and poetry, with much of his speculation in science. He was affectionate and interesting as well as adventuresome and refractory as a boy, and was always unconventional, quaint, and simple in his ways. He dipped deeply into logic and metaphysics when in college, and the tendency to subtile speculation is exemplified in all his scientific works. His life furnished much material for the pen of the biographer, and the volume is graphic, spicy, and very readable. Much of it consists of his correspondence and previously unpublished notes, while the course of his mental development is well delineated, and the importance of his researches is clearly presented. He had a very profound admiration for the genius of Faraday, and perhaps his own most important work consists in the mathematical development of physical ideas concerning the constitution of matter, the germs of which are found in the insight of the great electrician. Professor Maxwell's character is thus summed up by the writers of the present volume:

> Great as was the range and depth of Maxwell's powers, that which is still more remarkable is the unity of his nature and of his life. This unity came not from circumstance, for there were breaks in his outward career, but from the native strength of the spirit that was in him. In the eyes of those who knew him best, the whole man gained in beauty year by year, as son, friend, lover, husband; in science, in society, in religion; whether buried in retirement or immersed in business, he is absolutely single-hearted. This is true of his mental as well as of his emotional being, for indeed they were inseparably blended. And the fixity of his devotion, both to persons and ideas, was compatible with all but universal sympathies and the most fearless openness of thought. . . . That marvelous interpenetration of scientific industry, philosophic insight, poetic feeling and imagination, and overflowing humor, was closely related to the profound *sincerity* which, after all is said, is the truest sign alike of his genius and of his inmost nature, and is most apt to make his life instructive beyond the limits of the scientific world.

Oliver Wendell Holmes, Poet, Littérateur, Scientist. By William Sloane Kennedy. Boston: S. E. Cassino & Co. Pp. 356.

No doubt the rampage for personal gossip, displayed alike by our newspapers and magazines, is largely shared also by biographical writers who enter upon the delineation of many lives before the life has ceased. As to the gossip, it is of course but an index of the public appetite, and, as to its untimeliness, that must be held as timely which is sufficiently wanted. That we should have a virtual life of Holmes while he is yet among us and busy as ever, seems to us as far as possible from being objectionable.

And certainly no man ever had a greater temptation for working up a personal career to the edification of all contemporaries than the writer of this book. His materials are abundant and attractive, to many they will be fresh, and to all entertaining. The account of the early life of Dr. Holmes we have found very pleasant and satisfactory, and the information about his various publications interesting; the eulogy is of course inevitable, and the criticism more or less passable. For Mr. Kennedy must also favor us with his estimates of the genius, performances, and opinions of the author he has taken in hand. But his judgments, if not very valuable, can not be much misleading, because everybody has read these fascinating books, and each one can make up his own mind as to their merits. On the whole, however, we confess ourselves much obliged to Mr. Kennedy for his agreeable volume.

Methods of Social Reform, and other Papers. By W. Stanley Jevons, F. R. S. New York: Macmillan & Co. Pp. 383. Price, $3.

This volume consists of various articles contributed within the last few years by Dr. Jevons to the reviews on a variety of social subjects, and which have been collected by his wife for those who desire to possess them in a permanent form. It was the intention of Dr. Jevons to reissue them himself, and before his untimely and lamented death he had already revised two of them, "Experimental Legislation and the Drink-Traffic," and "Amusements of the People." The remainder are reprinted just as they were originally written.

It is unnecessary to commend the work of this able writer. His several treatises on philosophical subjects are of excellent repute. But the present volume, while quite miscellaneous in its topics, probably represents his latest views on important practical questions of a social character. They are marked by clearness and moderation, and will be found full of sober reflection upon questions too frequently treated by extremists in visionary and extravagant ways. Much of Dr. Jevons's criticism deals with the social condition of things in England, and is designed to bear upon special practical reforms, but the discussions are always carried on with reference to principles that are not without application in other countries.

Inquiries into Human Faculty and its Development. By Francis Galton, F. R. S., author of "Hereditary Genius." New York: Macmillan & Co. Pp. 387. Price, $3.

Mr. Galton, as is very well known, has taken up the systematic study of human character from the most modern point of view, and, pursuing it in the light of the doctrine of evolution, has carried out a course of experimental inquiries ingenious in conception and fruitful of many new conclusions. With his numerous papers contributed to learned societies and to the periodical press, scientific readers are familiar; these, which are of a varied character, he has now revised, extended, reduced to considerable unity of method, and published in the volume before us. Mr. Galton's researches are characterized by great subtilty of perception, a remarkable insight into the elements of human character, and a surprising skill in pursuing his fertile suggestions to verification by experimental tests. He has done much, more indeed than any other investigator, to bring the elements of research respecting individual characteristics into quantitative and statistical form, so as to favor accuracy of inductions. If a more technical title had been admissible, the present work might have been called a treatise on anthropometry—the measurement of the traits of human nature. It is through the bodily correlations of intellectual and emotional effects that this experimental method becomes possible, and all Mr. Galton's studies, although they deal largely with psychical phenomena, are made upon the basis of organic conditions and physical characteristics. The subject of composite portraiture, to which Mr. Galton has given much attention, and which, indeed, he has created as an important branch of investigation, is fully treated in this volume, the result of his latest methods being given and pictorially illustrated, while graphic and diagrammatic resources are extended to other subjects of inquiry. The book is most interesting throughout, full of novel and acute suggestions and practical conclusions of varied applicability. The chapters upon "Variety of Human Nature," "Anthropomorphic Registers," "Mental Imagery," "Enthusiasm," "Influence of Man upon Race," "Early and Late Marriages," and "The History of Twins," may be mentioned as of especial interest, although the whole work richly deserves the critical attention of all the scientific students of human nature.

Wealth-Creation. By Augustus Mongredien. With an Introduction, by Simon Sterne. New York: Cassell, Petter, Galpin & Co. Pp. 308. Price, $1.25.

The author is well known as a writer of unusual clearness on questions of political economy; as a practical business man possessing the happy faculty, which does not always exist in men engaged in trade, of considering these questions by reference to their fundamental principles, and in the light of a strictly correct reasoning. The predominant ideas of his work are that the abolition of war and the establishment of unrestricted freedom of trade are the essential conditions to the creation and even diffusion of the largest wealth and prosperity among nations. In Mr. Sterne's introduction is given a review of the history of tariff legislation in the United States, with facts showing that our manufacturing industries and other interests have enjoyed the greatest degree of relative prosperity during the life of tariffs laid for revenue only; that while from 1850 to 1860, with such a tariff, the capital invested in manufactures and the product of the manufactories doubled, from 1860 to 1870, under the war tariff, they did no more; and from 1870 to 1880, under the same tariff, they increased only twenty-five per cent.

Alcoholic Inebriety, from a Medical Stand-point, with Cases from Clinical Records. By Joseph Parrish, M. D. Philadelphia: Blakiston, Son & Co. Pp. 185. Price, $1.25.

Dr. Parrish has performed an excellent and much-needed service in the preparation of this volume. That both the moral and political agencies have failed to do what was expected from them, in putting an end to the evils of intemperance, is now but too well known. Henceforth less sanguine expectations must be entertained as to what can be really accomplished, and different means resorted to for the purpose—chief among which will be the diffusion of sound scientific information in regard to the subject of which this volume on alcoholic inebriety is an example.

The point of view from which the work is written is thus stated by the author: "From the ordinary and popular outlook, inebriety corrupts a wide range of both public and private morals, and is so interwoven with the affairs of life, both domestic and civil, that it is looked upon as the chief factor of crime, of insanity and many other diseases, and as a general disturber of all that should be cherished as valuable in the life of individuals and of the community. Efforts have been put forth to arrest its progress, if not to apply a radical remedy for its evils, to which the pulpit, the press, the platform, and the ballot, have all contributed a share of influence, till the land is covered with organizations having for their standard the doctrine of abstinence and prohibition. Taking half a century ago as a starting-point, the growth of the temperance sentiment of the country has been marvelous, and to-day, *simply as a sentiment*, it holds a prominent and commanding position; and yet we are confronted with the discouraging statement that dram-drinking and drunkenness are on the increase."

"From another outlook, not so popular, because not so familiar, another view may be had, which, though more limited in its scope, is none the less important, because it reveals the causal beginnings from which flow the results that are recognized as intoxication. As yet this new field has not been explored as it might have been, and as the gravity of the subject demands, notwithstanding it discloses the remote causes of inebriety, and indicates the remedial course to be followed in dealing with it. This is doubtless partly due to the fact that the new line of research is, in a degree, technical and scientific, and the people are not disposed to go behind what they see in the inebriate and his surroundings, to attempt to penetrate tissues, and search after forces with which they are not familiar."

It has been the purpose of Dr. Parrish to treat the principles of his subject from the foregoing point of view as a physician interested first of all in the nature, causes, and treatment of disease. If alcoholism is a disease involving organic perversion and morbid physical action that has become chronic, it is of but little use either to exhort or pledge men against its effects, or even to invoke the law for the suppression of intemperance. Diseases must be treated in conformity with natural laws, and by men who understand what they are. Dr. Parrish takes up the subject of inebriety in its aspects of vice and crime, and with reference to the various abnormal manifestations of conduct in inebriates. The subject of heredity in alcoholic intemperance, and the relations of inebriety and insanity, with the questions of asylums for these classes, are considered. The chapters on "The Inebriate's View," "How to deal with Inebriates," "The Psychology of Inebriety," and "The Effects of Different Alcohols," are practical discussions of the subject which ought to be widely disseminated. It should be stated that a large number of cases are cited in the work, illustrative of the phenomena and varied effects of intemperance, under its several aspects of vice, crime, and disease.

Catalogue of Publications of the Smithsonian Institution, 1846 to 1882. By William J. Rhees. Washington: Smithsonian Institution. Pp. 328.

The series of "Smithsonian Contributions to Knowledge" was begun in 1848, and now comprises twenty-three volumes in 4to, with 119 articles. The "Smithsonian Miscellaneous Collections," begun in 1862, embraces twenty-three volumes in 8vo, with 122 papers. The annual reports are represented by thirty-five volumes, which include much general matter of interest. Other series are the "Bulletins of the National Museum," of which twenty, aggregating 3,103 pages, have been published; the "Proceedings of the National Museum," which are sent out by the sheetful of 16 pages, and are at present represented by four volumes of 2,221 pages; and the volume of the "Reports of the Bureau of Ethnology," 638 pages imperial 8vo. The whole number of publications is 478. The names of the articles and the names of the authors are given alphabetically in the catalogue. No copyright is taken out by the Institution on its works, but acknowledgment is expected to be made of the use of them. All works that are in print can be obtained at cost price; and a price-list is printed in connection with the catalogue.

The Leading Men of Japan. With an Historical Summary of the Empire. By Charles Lanman. Boston: D. Lothrop & Co. Pp. 421. Price, $2.

The first part of this volume is devoted to biographical sketches of modern Japanese statesmen, authors, and scholars, largely those who have contributed in a greater or less degree to the bringing about of the late reforms in the empire. The materials for the sketches are, of course, derived from native sources, and much of the matter appears to be also; for it has a terseness, a richness, and a home flavor like those of the works of Japanese art that an American writer working up the sketches in his own way could never have given. All the more credit to Mr. Lanman for preserving this flavor, for it is one of the most attractive and delightful features of the book. In the second part are given excellent accounts, historical and descriptive, of the Japanese Empire, and of Corea—so lately the forbidden land; to all of which is added a bibliography of works on Japan.

The Builder's Guide, and Estimator's Price-Book. By Frederick T. Hodgson. New York: The Industrial Publication Company. Pp. 331. Price, $2.

This work is chiefly intended to assist the builder or contractor in making estimates of the cost of work he is about to undertake, by bringing before him the details he must look after, and their approximate cost. It is also useful to the person about to employ a builder or contractor, or who intends to execute his own plans. It includes a compilation of the current prices of all kinds of building materials in their details, of worked materials, and of labor, with building rules, data, tables, and useful memoranda, and a glossary of architectural and building terms.

First-Year Arithmetic-Teacher's Manual, and First-Year Text-Book. By James H. Hoose, A. M., Ph. D. Syracuse, New York: C. W. Bardeen. Pp. 156. Price, 35 cents.

This work is based upon Pestalozzi's system of teaching elementary numbers, and is designed for pupils in the first grade, or first year of public schools. It appears to have grown out of work that was accomplished by teachers with pupils of the grade for which it is designed, and to be in effect simply a transcription of the record of that work as kept by the teachers from day to day, for application to other classes. By it, it is claimed, pupils may learn to compute numbers with accuracy and readiness, without a slate; to express themselves with facility and intelligence in the forms of arithmetical language; and to think patiently, vigorously, and accurately, and have a becoming confidence in their own powers.

Astronomy corrected. By H B. Philbrook, Counselor-at-Law. New York: John Polhemus. Pp. 55.

This little volume, says the author, "is respectfully submitted to the reading world, in order to remove the errors that have so long deluded mankind in reference to astronomical problems." These "errors" relate to the creation and the causes of the motions of the solar system, to Laplace's nebular hypothesis, and Newton's gravitation. It is not new to have the law of gravitation assailed, nor is it entirely novel to have the portion in regulating the universe that has been assigned to it referred to the interstellar ether. Mr. Philbrook is, we believe, the first to tell us precisely how the ether acts.

Lowest Forms of Water Animals. By N. d'Anvers. New York: G. P. Putnam's Sons. Pp. 59. Price, 50 cents.

This is one of the "Science Ladders" series of illustrated natural history readers, the special purpose of which is to teach the great laws of the animal kingdom in language simple enough to be intelligible to every child who can read. It teaches what an animal is and what protoplasm is, and describes the rhizopoda, sponges, infusoria, hydras, medusæ, sea-anemones, coral, polyps, polyzoa, and "some tiny creatures with water-works."

Compendium of the Tenth Census, June 1, 1880. Washington: Government Printing-Office. Part I, pp. 924; Part II, pp. 847.

The scope of the census of 1880 was greatly enlarged, and its machinery was much changed from that under which the previous censuses were taken. The information collected by it has been much more extensive, more varied, and presumably more accurate than has been gathered for any other decade in the history of our country. Opportunity was given to begin the inquiries in departments admitting such anticipation, several months before the first of June, and thus to give a more careful and exhaustive character to the investigation; and the work of making the enumerations was given to persons especially appointed for it, and not to officers who already had other duties. Except as to churches, libraries, and private schools, the statistics of which have been delayed in compilation, the tables embraced in the "Compendium" touch all the general classes of statistics which will be embraced in a more detailed form in the more extended publication of the series of quarto volumes. Part I contains the statistics of population and agriculture; Part II, those of manufactures; power used in manufactures; mining, railroads, steam-craft, canals, telegraphs, and telephones; occupations; fisheries; foreign parentage; areas, dwellings, and families; Alaska; life-insurance; fire and marine insurance; valuation and taxation; public indebtedness; newspapers and periodicals; public schools; illiteracy; defective, dependent, and delinquent classes; and mortality.

Geological Survey of New Jersey. Annual Report of the State Geologist for 1882. By George H. Cook. Camden, New Jersey: F. F. Patterson. Pp. 191, with Map.

The topographical survey has been continued over 480 square miles, chiefly in the highland country of the northern part of the State. The whole area covered by this survey up to the present time is 1,740 square miles. Progress is also reported of the United States Coast and Geodetic Survey, which, when completed, it is hoped in the next season, will cover 5,326 of the 7,576 square miles of the State. The report of "Geological Work in Progress" includes an extensive notice of the Red Sandstone district with its trap ridges, which is a marked local feature, with accounts of the eruptive rocks of Sussex County, iron-mines and mining industries, plastic clays and their uses, and shore-changes. The plastic clays are worthy of especial attention, for they have been found capable of extensive application, particularly for furnishing terra-cotta building material and architectural ornaments, and promise to become most important elements in the resources of New Jersey. The "sea-side developments," or growth of summer resorts now in course of rapid expansion, are also noticed, with some account of climatic peculiarities and of agricultural development in Southern New Jersey. A chapter on drainage is illustrated with a convenient map of the water-sheds. The resources for water-supply and the character of the water are considered, whether the supply is derived from lakes and rivers or wells, dug, driven, and bored; and the water-supplies of the larger towns and several important wells are described. The map accompanying the report has been corrected up to date.

Annual Report of the Chief Signal-Officer to the Secretary of War, for the Year 1880. Washington: Government Printing-Office. Pp. 1,120, with 119 Charts.

The organization and objects of the Signal-Service department have been often set forth. Its chief purpose is to train a corps of officers competent to correspond by signal and give speedy and effective service in times of war and in emergencies. For that purpose primarily the training-school is kept up at Fort Whipple, Virginia, where officers are drilled for Signal-Service work. Incidentally, the service makes its value known in a variety of ways, and is the agency employed by the Government to secure the reports and forecasts of the weather. It had in operation, during the year of the present report, in the United States, 247 stations, and was receiving daily telegraphic reports from 189 stations in the United States and other countries. The net-work of its stations extends to the Atlantic and Pacific coasts and over the intervening territory. "Sunset stations" have been established at a number of places, where meteorological indications are gathered from the appearances at sunset, and with the aid of the spectroscope; and the officers at these stations have acquired an accuracy in forecasting the local weather twenty-four hours in advance, the degree of which is represented by a maximum percentage of $89\frac{2}{10}$ for the regions west of the Mississippi Valley, and $82\frac{6}{10}$ for the region east of the eastern bounds of that valley. The report is filled with masses of detail and station reports.

The Jewelers' Circular and Horological Review, March, 1883. D. H. Hopkinson, Editor and Proprietor. New York. Pp. 32–lxxxviii. Price, $2 a year.

A most pleasing and flattering illustration of the prosperity and the artistic taste of the fraternity of jewelers and silversmiths in the United States. The literary department comprises thirty-two of the finely printed, large quarto pages, and is occupied with articles of special interest to the fraternity and of general interest to many others; among them we notice a part of a series on the elaboration of gold and silver, and a kind of "Notes and Queries," under the title of "Proceedings of the Horological Club." The other pages are occupied with the cards of manufacturers and cuts of their designs, many of which, it is hardly necessary to say, are exceedingly handsome.

The Physiology of Protoplasmic Motion. By Th. W. Englemann, M. D., of the University of Utrecht. Translated by Charles S. Dolley, M. D. Rochester, N. Y.: Davis & Leyden. Pp. 40. Price, 50 cents.

Living protoplasm, says the author of this treatise, possesses, in many cases at least, as it appears to the assisted eye, the power of independent, rapid movement. The motion expresses itself in a change of form and arrangement of the protoplasmic mass, the volume of which apparently remains the same. It may also be produced artificially. The present paper records the results of continued, careful, and minute studies of the manifestations of protoplasmic motion in its various forms.

Lectures delivered to the Employés of the Baltimore and Ohio Railroad Company. By Professor H. Newell Martin and Drs. Henry Sewell, William T. Sedgwick, and William K. Brooks, of Johns Hopkins University. Baltimore: Baltimore & Ohio Railroad Company. Pp. 98.

The Baltimore and Ohio Railroad Company maintains two reading-rooms for the men in its employ, but it had been observed that only a part of those for whom the rooms were intended availed themselves of them. Professor Martin suggested to President Garrett that the men who were not readers might be induced to attend free popular scientific lectures, and proffered the services of himself and his biological colleagues in the Johns Hopkins University. The lectures were delivered in February, 1882, before audiences of twice as many deeply interested hearers as were expected. They were on "How Skulls and Backbones are built," by Professor Martin; "How we move," by Dr. Sewall; "Fermentation," by Dr. Sedgwick; and "Some Curious Kinds of Animal Locomotion," by Dr. Brooks. They are popular in character and are published in their present form by the railroad company for free distribution among the men who heard them, and among others in its employ who were not able to attend them.

The Unending Genesis; or, Creation ever present. By H. M. Simmons. Chicago: The Colegrove Book Company. Pp. 111.

A pleasantly conceived and pleasant-tempered essay on the phenomena of nature in the light of the Biblical story of the creation, the purpose of which is to show that creation is not and is not to be a completed process, but one that is ever recurring, the object of continual renewals, and still as fresh and living in its repetitions of to-day as when it first began to operate.

Proceedings of the Davenport Academy of Natural Sciences. Vol. III, Part III. 1879-1881. Davenport, Iowa: Published by the Academy. Pp. 130, with Four Plates.

The volume which is completed by the publication of this part contains a large number of contributions on subjects of geography, geology, natural history, and antiquities, which speak well for the activity and intelligent zeal with which the members of the Academy perform their self-imposed work. Most of the papers record the results of local investigations around Davenport, which seems to be situated in a district of much scientific interest. Other papers concern the larger field of investigations opened by our rapidly developing Western Territories. The whole of the third part of the volume is occupied with the memorials and writings of the late youthful but devoted President of the Academy, Joseph Duncan Putnam, in whose death science evidently has suffered a great loss. Besides the memorial addresses and biographical sketches, its principal feature is the publication in full of Mr. Putnam's notes on the *Solpugidæ*—a family between the scorpions and the spiders—of North America.

Proposed Ordinance and Rules and Regulations for Plumbing, House-Drainage, etc., in the City of Philadelphia. As reported by the Committee of Twenty-one. Philadelphia: P. Blakiston, Son & Co. Pp. 13. Price, 20 cents.

The "Committee of Twenty-one" consisted of plumbers, architects, physicians, and citizens, interested in sanitary matters. The plumbers, as a body, submitted their suggestions, and the architects did the same. The committee, guided by these aids and their discussions, elaborated the ordinance which, in the shape in which it is here presented, constitutes a valuable epitome of the essentials of sanitary plumbing and engineering.

"Appalachia," April, 1883. Vol. III, No. 2. Appalachian Mountain Club. Boston: W. B. Clarke & Carruth. Pp. 104. Price, 50 cents.

The present number of this interesting journal contains an article on "Mountain Observatories," by Professor Pickering; a paper by Mrs. John Tatlock, Jr., on the "Variations of Barometric Measurements of Altitude with the Season"; descriptive accounts, from explorations, of the Twin Mountain Range, the Blue Hills (of Norfolk County, Massachusetts), the Mountains of Eastern Cuba, and Roan Mountain, North Carolina; reports of officers, and of the work of the Club; and proceedings of meetings. In the course of the past three years, the names of forty-seven mountains, of which no published accounts existed, while many of them were wholly unexplored, and several even unnamed, have appeared in the lists of the club. Of these there now remain but thirteen of which no description has as yet appeared in "Appalachia." Prominent features of the work described in the present number are the exploration of the Twin Mountains, the construction of new paths to the summits of Mounts Madison and Adams, the expedition up the Wild River Valley and the east branch of the Pemigewasset to the summit of Mount Lafayette, and more restricted but hardly less interesting investigations.

An Outline of Qualitative Analysis for Beginners. By John T. Stoddard, Ph. D., Professor of Chemistry in Smith College. A. G. Carley, Northampton, Mass. Pp. 54. Price, 75 cents.

Students in a well-equipped qualitative laboratory, who have the time of a competent instructor at their disposal, need little help from a text-book. Some small book containing the tests by which the several bases and acids may be detected, and the succesive steps of the system of analysis which the instructor deems the best, is a necessity. Professor Stoddard's book belongs to this class, and probably leaves more for the student to work out under the guidance of the instructor than any similar book yet published. Thus, no equations are given, it being a part of his method to require the student to write these, and to draw up analytical tables for himself. He also requires the devising of new methods of separation, thus introducing an element of original work.

The Advanced Question-Book. By Albert P. Southwick. Syracuse, N. Y.: C. W. Bardeen. Pp. 366. Price, $1.50.

This work includes in one volume the "Dime" question-books on general literature, general history, astronomy, mythology, rhetoric, botany, zoölogy, chemistry, geology, and physics, with complete answers, notes, queries, etc. While we should never think of using such books in recitation, or of encouraging a teacher who used them there, we can conceive that they are admirable as manuals for ready reference.

Johns Hopkins University Studies in Historical and Political Science. Herbert B. Adams, Editor. VI. Parish Institutions in Maryland. By Edward Ingle, A. B. Pp. 48. Price, 40 cents. VII. Old Maryland Manors. By John Johnson, A. B. Pp. 38. Price, 30 cents. Baltimore: Johns Hopkins University. Price of the series, $3 for twelve numbers.

The idea of this series is to bring together, in numbered monographs, kindred contributions to historical and political science, so that individual efforts may gain strength by combination, and become more useful as well as more accessible to students. The Studies will be published at monthly intervals, but not necessarily in separate form. The present essays relate to peculiar features in the political and social organization of the Maryland colony, quite different from those which distinguished the New England organization, a correct understanding of which may help to explain some things in the history and present condition of the State.

PUBLICATIONS RECEIVED.

Van Loan's Catskill Mountain Guide, 1883. Catskill, N. Y.: Walton Van Loan. Pp. 122, with Maps. 40 cents.

"The Medico-Legal Journal," Vol. I. No. I. Published at 55 Broadway, N. Y. Pp. 115. $3 a year.

Woman's Medical College of Baltimore. Announcement and Catalogue. Baltimore. Pp. 12.

Small-pox and Vaccination. By Professor S. E. Chaillé. New Orleans: New Orleans Auxiliary Sanitary Association. Pp. 28.

Record for the Sick-Room. Philadelphia: P. Blakiston, Son & Co. 25 cents.

The Upper University: A Syllabus of the Scheme and of the Sources of its Revenue. By Thales Lindsley. Pp. 25.

The Human Consciousness: A Syllabus of its Data and Inductions. By Thales Lindsley. Pp. 17.

Relief of Local and State Taxation through Distribution of the National Surplus. By Wharton Barker. Philadelphia: Edward Stern & Co. Pp. 28.

The Ores of Leadville. By Louis D. Ricketts, B. S. Princeton, N. J. Pp. 68, with Plates.

School Books on Physiology and Hygiene. By Stanford E. Chaillé. New Orleans. Pp. 10.

Hero-Worship: Sermon by M. J. Savage. Boston: George H. Ellis. Pp. 11.

Saylor's Portland Cement. New York: Johnson & Wilson.

Legal Provisions respecting the Examination and Licensing of Teachers. Washington: Government Printing-Office. Pp. 48.

Edison Electric-Light Company, Eighteenth Bulletin. Pp. 40.

Resuscitated: A Dream of Existence after Death, etc. Sacramento, Cal.: Lewis & Johnston. Pp. 123. 75 cents.

A Revision of the Genus Clematis of the United States. By Joseph F. James. Cincinnati. Pp. 19.

Manifesto of the Communists. By Karl Marx and Frederick Engels. New York: Schaerr & Frantz. Pp. 28. 5 cents.

The American Trotting-Horse. By Professor William H. Brewer. Pp. 28.

The Evolution of the American Trotting-Horse. By William H. Brewer. Pp. 6.

The Natural Cure of Consumption, Constipation, Bright's Disease, Neuralgia, Rheumatism, Colds, Fevers, etc. By C. E. Page, M. D. New York: Fowler & Wells. Pp. 274. $1.

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

Conflict in Nature and Life. New York: D. Appleton & Co. Pp. 488. $2.

Bacteria and the Germ Theory of Disease. By Dr. H. Gradle. Chicago, Ill.: W. T. Keener. Pp. 219.

A Treatise on Insanity in its Medical Relations. By William A. Hammond, M. D. New York: D. Appleton & Co. Pp. 767. $5.

Life and Language of William Cobbett, with his Grammar. By Robert Waters. New York: James W. Pratt. Pp. 272. $1.75.

A Tragedy in the Imperial Harem at Constantinople. By Leila-Hanoum. Translated from the French by General R. E. Colster. New York: W. S. Gottsberger. Pp. 299.

Atomic Creation and other Poems. By Cornelius P. Schermerhorn. New York. Pp. 200.

God Out and Man In. Replies to Robert G. Ingersoll. By W. H. Platt, D. D., LL. D. Rochester, N. Y.: Steele & Avery. Pp. 320. $1.50.

Hand-Saws, their Use, Care, and Abuse. By Frederick T. Hodgson. New York: The Industrial Publication Company. Pp. 96. $1.

Plant-Life. By Edward Step. New York: Henry Holt & Co. Pp. 218. $1.25.

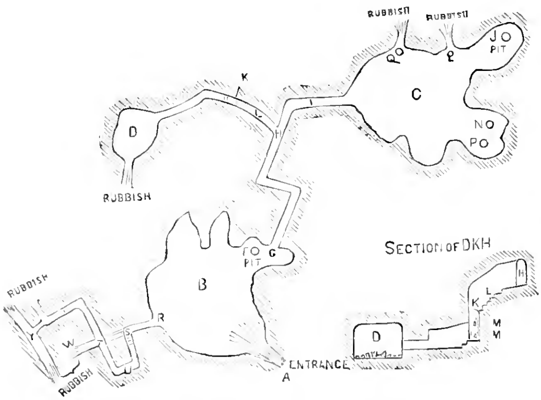
Manual of Taxidermy. By C. J. Maynard. Boston: S. E. Cassino & Co. Pp. 111.

Report of the Chief Signal-Officer, 1881. Washington: Government Printing-Office. Pp. 1296, with 69 Charts.

POPULAR MISCELLANY.

Nationalities in New York City.—"The Impress of Nationalities on the City of New York" is the subject of a paper recently read by Mr. James W. Gerard before the New York Historical Society. The subject is a difficult one, for the impress is multiple and the population of the city is exceedingly heterogeneous. The characteristics of the old population were derived from the Dutch and the English. The Dutch brought with them the same spirit of independence that had characterized their forefathers and made them in Europe the pioneers of civil rights, and which had become national instincts. They also brought the spirit of toleration. During the English period the descendants of the Dutch settlers kept equal in the race with their English brethren in all matters of political and military action and enterprise. Their thrift and plodding industry and business sagacity have left their marks to this day. The French Huguenots, who came over during the period of the French persecutions, brought an improved cookery and a national gayety and courtesy that tended much to modify the habits and manners of our people. When we consider the principles and origin of the population thus formed, we can well imagine that the men were not afraid of the Revolution. "These were the descendants of the Dutch patriots, of Independents of the English fighting-stock under Cromwell, of French Huguenots, of banished Covenanters from Scotland, of soldiers of Monmouth's rebellion, and of men who had fought under the banner of both of the Pretenders." The Anglo-Saxon has, however, been the dominant type here, with which the Dutch and French have been absorbed by intermarriage; and the conditions of settlement and acclimatization, acting on the combined type, have produced a new, deviating race. To this may be added the infusion of the blood of the New-Englander, who is more conservative in character, more grave in temperament, and at the same time more enterprising and more persistent in action than the descendants of the Dutch and English settlers. This element, though Anglo-Saxon and formed into the local life, has still distinctive features. The deviation of the new race is apparent in its physical, mental, and perhaps in its moral attributes, and also in its lingual expression. Under the conditions of the new life, nerve-force and energy have been called upon, and have developed rapidly. The Irish and German nationalities, more recent acquisitions, have exercised great influence upon the city and its inhabitants. New York endures most of the evils and gets least of the advantages of immigration. The Irish, from their knowledge of our language, have exerted a stronger influence upon the city than the Germans, who keep more apart, and a greater proportion of whom travel westward or settle in districts of the city where they are separated from the rest of the population. But while the Dutch and the French have flowed into the general result, the Irish and Germans have been of too late introduction to have become factors in the formation of the general local character.

Prehistoric Underground Chambers.—The subterranean works called by the people of Poitou "gueriments" are little known, though the tradition of the country assigns their origin to prehistoric times. I purpose to describe one of these which I visited, with my brother, in 1878, and which may be regarded as a type of the whole series. The chalk of Beaumont, stretching south of Châtellerault, resembles a vast ants'-nest, so numerous are the galleries with which it is honeycombed. The one that I am about to describe is at a place called La Fuye, and is only a few hundred yards from the old Roman road between Colombiers and Jaulnay. We went down into a hole, A, overgrown with bushes, that looked very much like a fox's hole, and came upon a large hall, B, on which abutted the passages G and R. The passages are of about the height of a common-sized man, but less than two feet wide. They appear to have once been tightly closed by doors and fortified by beams. After going in about a hundred metres, and making a number of turns, I came to a sudden descent, and fell into the hole K (see the section D K H). When I came to myself, and was able to examine the place, I found that the narrow passage led to a steep ladder of five steps, L, at the end of which was the hole into which I had fallen, about six feet deep. Hence led another narrow gallery, which we explored with great difficulty, but at the end of which we came to the spacious chamber D, where we found a quantity of large bones, charcoal, and blocks of flint, and, by digging, a badly decayed piece of coarse pottery. Gallery E opened out from this passage, but it had become choked up. Returning, we climbed up the passage K with the aid of the foot-holes M M in the wall, and went through the gallery I, into the chamber C, which contained a number of circular pits, J, N, P, suggesting the form of a cistern, but they could not have been used to hold water. The galleries O and Q were choked up. Returning to the first chamber, and passing the half-filled pit F, we went by the corridor R into the galleries *s*, *u*, *t*, *v*, *y*, in which we remarked two tubes, pierced at *t* and *s*, so as to form a direct communication between W and B. The construction of all the "gueriments" is analogous to that of this one. They are cut in the rock itself, and consist of large chambers connected by narrow galleries, and present a striking similarity of aspect to those dwellings which insects hollow out in the trunks of trees. The openings of descending passages had been closed by trap-doors and fastened by wooden cross-beams. Niches in which lights could be placed were cut at convenient distances. Many "gueriments" communicated with a well; and, as some of the galleries have been wholly stopped up, at some more or less remote period in the past, the only entrance now is by the well. I have only visited three caves of this kind, but I know of a considerable number of them that can not be explored because of the presence of an excess of carbonic acid in them.—*Translated for the Popular Science Monthly from La Nature.*



[Note by the Editor of Popular Science Monthly.—Strabo, in his accounts of the Siculi around Lake Avernus in Central Italy, says: "Ephorus assigns the place to the Kimmerioi, and says they lived in underground dwellings which they called *argillai*, and through certain excavated passages passed about to each other, and conveyed strangers to the oracle, which was constructed deep in the ground."]

Musical Fishes.—Cases of peculiar sounds being heard at sea and ascribed to fishes are not rare. Lieutenant White, of our navy, relates that, when at the mouth of a river in Cambodia in 1824, he and the crew of his vessel were struck by hearing extraordinary sounds, like a mixture of the bass of an organ, the ringing of bells, the guttural cries of a large frog, and the tones of an enormous harp, which they heard around the bottom of their vessel. The interpreter said they were produced by a troop of a kind of fish. Dr. Buist, in 1847, told of a party in a boat near Bombay, who heard sounds not unlike the others, which the boatmen said were produced by fish. Similar sounds were reported two years afterward as having been heard from beneath the water at Vizagapatam. Sir J. Emerson Tennent heard like sounds from the Lake of Batticaloa, in Ceylon, and the natives said that a shell made them. A correspondent of the "Field," in 1867, alleged that the vessel in which he was at Greytown, Nicaragua, was haunted at night by these sounds. A similar account, probably of the same occurrence, is given by Mr. Dennely, in "Nature" of May 12, 1870. Another correspondent of the "Field" told of sounds "produced by fishes" which he heard in the Tavoy River. A review of all the accounts shows that the sounds were nearly always heard in ships at sea, though Canon Kingsley once heard them at Trinidad from the shore; that they are most commonly heard in tropical regions, but sometimes in the temperate zone; that they have been noticed along an extensive line of coasts, American, European, and Asiatic, northern and southern; that they are invariably heard at night; and that they are most generally heard near the mouths of rivers. Dr. Dufossé, who has made the production of sound by fishes a special study, says that, while many fishes can make themselves heard, there is a great variety in the manner in which the noises are evolved. Sometimes they proceed from the movements or friction of the pharyngeal bones, or the vibration of the muscles of the swimming-bladder. In the latter way a gurnard produces nearly an octave of notes. The males of the genus *Ophidium* are provided with a drumming apparatus, consisting of bones and muscles developed in relation to the swimming-bladder. The sounds made by the *Umbrinas* of the Mediterranean have been heard from a depth of twenty fathoms.

Action of Acids on Tin-Ware.—Mr. Francis P. Hall reports the results of experiments on the action of vegetable acids—acetic, tartaric, and citric acids—on lead and tin. The results were rather negative in their tendency, and seem hardly to bear out the assertions that are made respecting the danger of lead-poisoning from tinned goods. The most danger is from the solder, and from the action of the acids on the tin itself. The corrosion does not appear to increase as regularly as is supposed with the strength of these acids; but it was found that corrosion, in the case of canned fruits, takes place very rapidly after the can is opened, so that a can when opened should be emptied at once. Mr. Hall's analyses of bright tin-plate failed in every case to show enough lead impurity to justify the charge of intended adulteration, even in the worst-looking ware from the five-cent stores. Terne plate, used for roofing, is known to contain large quantities of lead, but no one with his eyes open is ever likely to buy it for genuine tin. Tin-foil, which is used for enveloping various kinds of food, is in some cases pure tin, in other cases heavily adulterated. Specimens used for wrapping different kinds of compressed yeast were pure. The worst specimen (89·87 per cent lead) was embossed, and on a very fashionable cake of chocolate.

German Explorations in Africa.—The Germans claim the honor of having done the most after the English for the exploration of the interior of Africa. The trading posts of the Hamburg merchants on the east coast have long exercised a civilizing influence there. To German missionaries are due the first important discoveries that were made in that region, viz., the discovery of Mount Kilimanjaro by the missionary Rebmann, in 1848; that of Mount Kenia by the missionary Krapf, in 1849; and the execution of a map of the country, showing the Ukerewe Lake, by Rebmann and Erhardt, a work which provoked the English expeditions of Burton, and of Grant and Speke. Dr. Albert Roscher planned the ascent of

Kilimanjaro in 1859, but gave it up to seek for Lake Nyanza, and died in that attempt. Baron Claus von Decken, in the next year, climbed Kilimanjaro to the height of 8,360 feet, and ascertained the total height of the mountain (18,710 feet). Again, in 1862, he, with Dr. Otto Kersten, climbed the mountain to 14,160 feet, and determined its volcanic nature and its situation. Von der Decken was finally murdered by Somaulis, in his fourth expedition up the Juba River. Richard Brenner followed this adventurous traveler, and retraced his last journey. In 1875 J. M. Hildebrandt was sent out by the Karl Ritter *Stiftung* and the Berlin Academy of Sciences on an expedition to the mountain-region, which was fruitful in scientific results. Other important expeditions were made by Clemens Denhardt, in 1878, by Dr. Schweinfurth, and, more recently, by Gerhard Rolfs and Dr. Nachtigal. Lastly, Dr. G. A. Fischer, who took part in Denhardt's expedition, has gone out under the auspices of the Geographical Society of Hamburg for an exploration of Somauli-land and the Galla country.

Brain-Health.—In a lecture at Edinburgh, on "The Establishment and Maintenance of Brain-Health," Dr. J. Batty Tuke pointed out a certain class of influences acting for good or evil on the brain over which the individual had no control. They were those connected with his antecedents and bringing up. A man might be handicapped for life by the mistakes or faults of his ancestors; and, differently from the race-horse, he had to carry weight in the race of life according to his imperfections, not according to his advantages. In respect to this point, every child's future history depends upon the food it gets and on its surroundings, and much upon the mother, whether she be well and vigorous or the contrary. Of other food than mother's milk, the Scotch oatmeal-porridge and milk is a "typical" food, and the best. Tea should be condemned. In education, home influence should never be spared. To send a child away from the family influence into an atmosphere of necessarily strict discipline and routine should be the last resource of misfortune. The life of a child so placed is artificial, its individuality is endangered, and its experience circumscribed. Therefore, at all hazards, keep the child in the family, and send him no farther than to the day-school. One of the great causes of overstraining in early youth is the vicious system of offering prizes for competition. It deflects the mind of the child from the main aim and object of its study, and often defeats them. Our whole educational system tends too much in the direction of abstract facts and theories, and to produce a sort of brain-dyspepsia or indigestion; for the child's brain is not given time to assimilate the food it gets. Among women, idleness and ignorance are much more prolific causes of disease than overwork. It is not work, but worry, that kills the brain. The most highly educated and hard-working women the lecturer knew were eminently healthy. Breakdown from overwork does, however, occasionally take place, and the first really important symptom is sleeplessness. When that sets in there is cause for alarm. Headache also comes on; and, as soon as a child or young person develops continuous headache, work should be discontinued at once. Most men working in this department of medicine recognize that, if there is a hope of diminishing the amount of brain-disease, it is to be effected by preventive measures. The lecturer had therefore directed attention more especially to the transgressions of the father than to those of the son.

Deformities due to School-Life.—Dr. Dally read a paper at the Geneva Hygienic Congress on the "Deformation of the Body during School-Life." The researches of Dr. Chaussier, who found that only 122 out of 23,200 newly-born infants examined by him possessed abnormal peculiarities of any kind, indicate that children are, as a rule, straight when they start to school. The deformities which they exhibit at a later period may therefore be attributed to the enforced maintenance of one attitude for a considerable length of time. The various parts of the organism of youth are easily displaced, and, if the cause operates continuously, the displacement is liable to become permanent. Doctors were exhorted to pay more attention to the medical aspects of school-life.

Some Peculiarities of Color-Blindness.—Mr. R. Brudenel Carter defines color-blindness, in his Cantor Lectures on that subject, as incapacity on the part of the nerves of vision to respond to the stimulus which one of the three kinds of light is calculated to produce. It will help us to realize the nature of the defect to assume, which is not quite the case, that white light is composed of red, green, and violet in equal proportions and of equal luminosity; then to eyes which are incapable of seeing one of the colors, one third of the illumination of natural objects is extinguished, and the appearance the objects present is not that of their real color, but only of that fraction of their real color in which the two visible colors are combined in them. White is not white to the color-blind, but a mixture of green and violet to the red-blind, of red and violet to the green-blind, and so through the other shades and the other varieties of color-blindness. It is impossible to obtain an exact idea of what the color-blind see, except a person be examined who has one eye normal-sighted while the other eye is defective. Professor Holmgren has examined two such persons, one of whom was red-blind, the other violet-blind in one eye, with results tending to confirm what had been predicted on the subject in accordance with the Young-Helmholtz theory. The mistakes made by the color-blind in daily life are much less numerous and less remarkable than might have been supposed; so much so, that the recently acquired knowledge of the great prevalence of the condition has come as a great surprise to most of the world; and persons may live for years having the defect without knowing it till the fact is revealed by some unexpected test being applied in an unusual manner. The color-blind are seldom fully insensible to differences in the colors between which they can not distinguish critically. They learn by habit to perceive differences in the appearance of objects which are called by different color-names—difference it may be in shade, or in intensity of light—which they learn to associate with the color-names, and will so escape being caught. Men on railroads may thus learn to distinguish red from green lights by one of them being bright and the other dim, and may go for a long time without being found out. Their defect, however, will some day expose them, probably when they are least suspicious of its influence. It has been remarked that color-blind men regularly eliminate themselves from railway-service in the course of a few years, by a kind of unintelligent selection, so that they are never found among the old servants of any company. They get discharged for carelessness, or for drunkenness, for accidents which were really owing to color-blindness. It is evident from these considerations that no test of the color-sense can be wholly satisfactory that depends on calling the colors by their right names, for that becomes a matter of habit—not one that depends on the exhibition of differently colored lights, for the blindest know a difference, although not *the* difference, between them. Holmgren's variously colored worsteds, of about a hundred and fifty shades, which candidates are required to assort and match, afford the most satisfactory and a nearly perfect test.

Cat-Lore.—The origin of domestic cats is obscure, but seems by all accounts to fall somewhere within historic times. All the histories of ancient nations seem to go back to a time when they had no cats. M. Lenormant says that a wild cat was hunted and eaten by the Swiss lake-dwellers in the age of stone; but Africa, south of Egypt, appears to have been the cradle of the cat as a domesticated animal. Pussy appears in the middle-empire Egyptian monuments in the character of a retriever seated in the boat of the wild-fowl hunter, a circumstance indicating that those people had a strain that did not have as unconquerable an aversion to the water as our cats; and there have been cats, even in modern times, that could bring themselves up to diving after fish. The cat, like everything else, whether agreeable or horrible, was raised to the odor of sanctity in Egypt and became the emblem of the goddess Pasht, the Egyptian Diana. M. Lenormant believes, however, that this worship was comparatively late, and finds no trace of the animal among the monuments of the ancient empire. Under the earlier dynasties, Pasht was a lioness-goddess, and not till the twelfth dynasty, and the conquests in the land of Cush, did the cat come to the front. We may therefore regard the cat as a Cushite animal, derived from the *Felis maniculata*, which was found wild in upper Nubia and the Soodan. The Egyptians carried their reverence for cats to what seems to us a ridiculous excess. If any of them voluntarily slew one of the sacred animals, he was punished with death; and Diodorus relates that a Roman soldier who had killed a cat could hardly escape the fury of the people. When a cat died in a house, the people shaved their eyebrows; and dead cats were embalmed and buried in the city of Bubastis, which was sacred to Pasht. According to M. Lenormant, the Egyptians still respect cats, and in Cairo serve up a copious banquet every day to the cats of each quarter, "in the court of the house of the cadi." The late introduction of domesticated cats among Semitic peoples seems to be proved by the absence of mention of them in the Bible. The Assyrians and Babylonians are said to have been equally ignorant of the animal. A lively discussion between Mr. A. S. Murray and Professor Mahaffy a few years ago, as to whether the Greeks had cats, seems to have resulted in an understanding that they had not. Their cat was a polecat or something else, and the Byzantine writers of later days seem to have been the first who gave its name to the modern cat. No Greek or Roman pictures or representations of the *mau* or "mew-cat" of the Egyptians are known, except one that M. Longpérier has found on a Tarentine coin struck shortly before the wars of Pyrrhus, and one on a lost post-Christian tombstone. The Indo-Aryans of the Vedic age seem to have lived and died ignorant of cats. The Sanskrit names of the animal mean "the animal of the house," "the house-wolf," "the rat-eater," "the enemy of mice." M. Pictet thinks that none of the European names for the cat belong to the old Aryan tongue. The Roman name, *catus*, signifies sly, cunning, crafty, but is traced by him back to the Syriac *gatô* and the Arabic *gitt*, and thence back to African words of which the Nubian *kadiska* is an example. This gives more evidence, such as it is, of the African origin of the animal. Some of the names, such as the Persian *puschak* and its variants, appear related to our *puss*, and are connected by M. Pictet with the Sanskrit *putchha*, tail—the creature with the waving tail. Our cat is supposed to be derived from the wild-cat—an animal which gave the name to the clan Chattan, and a title to the Duchess of Sutherland, which is said to mean "the Great Lady of the Cat." Finally, the "Saturday Review," from which we derive this gossip, expresses its admiration at the sagacity with which the cat passes a double life—"a sleek domestic favorite all day, a wild animal of unbridled impulse in the darkness of night."

Bedouin Weddings.—Dr. Siegfried Langer pleasantly describes in "Das Ausland" the marriage customs of the Bedouins of Es Salt, Palestine. First, as is the usage among all Semitic peoples, the bride is bought. The purchase-money is paid, half to her parents in compensation for bringing her up and supporting her, whence it is called milk-money; the other half in the form of dresses and ornaments for the bride, or of a provision for a settlement in case of divorce: and all must be paid in cash. As the time of the marriage approaches, the groom's associates collect around his house some evening and perform a wild symbolical dance with a great noise. The bride's friends, in the mean while are making her dress, which, when it is done, is paraded at the head of a procession singing praises of the beauty and accomplishments of the bride and the manly virtues of the groom. On the wedding-day the bride, if she lives in another town, is brought to her future home unveiled and on horseback, with an escort of a dozen armed men. She finds the friends of the bridegroom awaiting her, and they engage in a contest to gain the right by seizing to become her host for dinner. These contests sometimes become real fights. If, however, the bride lives in the same town with the groom, her friends serve her at the bath, and the putting on of her wedding-clothes, after which she takes her seat of honor to wait for the groom. He, in the mean time, has ridden to the nearest well for a bath, followed to the gate of the town by a procession of women bearing a figure adorned with pieces of the bride's outfit. Having performed his ablutions, he rides back, and on the way strikes with his riding-whip the bridal doll, which is held up for the purpose. That is his part of the marriage ceremony. He then goes to his house, and the bride is brought up on horseback, thickly veiled, with much shouting. As she steps upon the threshold, she must cut in two with her whip an olive-branch which is put over the door; if she does not succeed, it is a bad sign. As she enters the room, a number of young fellows armed with switches rush upon the couple and try to give them a good thrashing. Then they all prepare for the feast. Abundant supplies of provisions are sent down to the *madari*, or Arab inn. The poor and travelers are admitted; and the bridegroom takes the seat of honor amid the congratulations of the crowd. After the feast the couple take a seat together and spend the whole evening and sometimes the next day silently receiving the presents and greetings of their acquaintances. On the third day they are permitted to begin their regular married life.

Microscopy as a Science.—The proper scientific position of microscopy is well set forth by Mr. Albert H. Tuttle in his address as Vice-President of the Section of Histology and Microscopy of the Montreal meeting of the American Association. The claim of microscopy to scientific consideration does not rest on anything in the perfection of its instruments and accessories or the delicacy of its manipulations, for they are mere technics, and, however important in their scientific bearing, are not science; nor on the fact that it is engaged with objects too small to be seen without the aid of the instrument, for many of those objects have their proper place in well-defined fields of science; but on the fact that there is a department, investigations in which must be carried on wholly by the aid of the microscope. This department is that of the study of cell-life, in all its bearings, in plant and animal alike. It embraces all matters relating to the protozoa and the protophyta, including particularly the ferment-organisms. To it belong all studies dealing with cell-life in the higher organisms; on the morphology of cells and the higher morphological questions treated by histological method; and on the development of cells and the structure and significance of embryonic layers and tissues.

Two Vital Phenomena explained.—Speaking of the paucity of births and the decrease of marriages shown in the French census returns for 1881, M. Levasseur remarked in the French Association that they ought not to occasion too much alarm, for they might be only temporary. Men married at thirty or thirty-five, and the men who were now of that age belonged to the class who served in the defense of the country in 1870 and 1871, which was decimated. If the decrease should be continuous for three or four years, it would be grave, and a new fact. Poverty had nothing to do with the decrease of births, for that was conspicuous in the richest departments, as in Normandy. M. Passy said that the same was the case in Switzerland. When a canton reached a certain degree of wealth, the births were fewer. A kind of indolence, mingled with a care for the future, set in, and the desire began to prevail to secure an easy position with a small expenditure, and without running any risks.

NOTES.

Dr. C. C. Abbott reports as among many interesting "finds" which he discovered in the Trenton gravels, after the heavy rains of last September, a wisdom-tooth of a man, which lay in the undisturbed gravel within a dozen feet of the spot where a mastodon's tusk, described in Professor Cook's "Geology of New Jersey," was found some years ago, buried almost as deeply as the tusk, and in a similar situation and among similar surroundings. This, he believes, proves the contemporaneity of man and the mastodon. He also describes some argillite spear-heads found in the gravels, more finished than the palæolithic, ruder than the polished implements, which he is disposed to class as the handiwork of the direct, post-glacial descendants of palæolithic man.

Dr. Th. Fuchs, of Vienna, has undertaken to show that the distribution of life at the different depths of the sea is influenced more by the differences in the quantity of light than by differences in temperature. He reasons that all the known facts of the distribution of sea-life are consistent with his view, and that some of the facts favor it more than the other one. Thus, if temperature is the controlling influence, the shore-animals of northern regions should seek the deep sea when they find themselves in warmer climates, but they are still found near the shore. Genera which live in Arctic seas at a temperature below the freezing-point, find themselves at home in British seas at a temperature several degrees higher, and continue to be found in still warmer seas, till near the Island of Zebu, where they occur at 70° of temperature. Dr. Fuchs does not deny that heat has an influence in controlling the distribution, but he contends that it is very much less than that of light.

The death of William Spottiswoode, President of the Royal Society, was announced by cable from London, June 27th. Dr. Spottiswoode was born in 1825, and was graduated at Oxford in 1845, as first class in mathematics. By inheritance he became Queen's printer, and managed that business through his life, but at the same time continued his studies, and became famous in mathematics, languages, and philosophy, and was active in educational matters. He contributed much that is of value to scientific journals. He was President of the Dublin Meeting of the British Association in 1878, and in that capacity delivered an address of remarkable qualities. A portrait of him and a short sketch were given in the "Monthly" for November, 1878.

Mr. F. W. Putnam has described, in a paper before the American Antiquarian Society, a number of interesting copper implements from Mexico. These articles are now rare, because most of them have been sent to the melting-pot. The implements described by Mr. Putnam include a shapely axe from San Luis Potosi; axes from Tlacolula, Oaxaca; "hoes," with semi-lunar blades, from Teotitlan del Valle and Oaxaca; and scrapers of a little different shape, which are now in Dr. Valentini's collection and in the Peabody Museum. The exact character of many of these implements is not yet determined.

Another French expedition has started, in the steamer Talisman, to explore the depths of the Atlantic. It will begin with the coast of Morocco and the vicinity of the Canary Islands, and will go thence to the Cape Verd Islands, the red-coral fisheries of San Jago, and the desert islands of Branco and Raza, which are frequented by saurians that are found nowhere else, and will pay particular attention to the Sargasso Sea and its fauna.

Dr. H. Leffmann has observed, in bottoms of some of the silicious geyser-waters of the Yellowstone National Park, deposits of gelatinous matter, which an analysis has proved to be nearly pure silica. It is structureless, but becomes a white opaque mass when heated and dried. Confined for some weeks with strong sulphuric acid, it shrank to about one tenth its former volume.

The Rev. J. L. Zabriskie, of Nyack, New York, records the discovery, from observations of pods which he was keeping in his room, that the Wistaria-pod has the faculty of exploding with a very audible noise, and throwing its beans with force to a considerable distance. Two of the pods in his room thus exploded in succession. One of the beans was thrown to a distance of sixteen feet, and rebounded four feet. If it had been ejected with the same force from the position in which it grew on its native vine, it would have flown for a distance of at least thirty feet.

Professor W. P. Blake has found native lead and minium occurring in galena, near Bellevue, Idaho. The native lead is in small, rounded masses or grains of an eighth or a quarter of an inch in diameter, and sometimes in reniform bunches weighing an ounce or more. The minium is generally found incrusting it.

The efficiency of oil to temper the rage of the waves in storms at sea is now generally recognized, and it is becoming the practice for vessels to take oil with them to be used in this way in cases of extremity. The ship Glamorganshire was recently saved in a tempest by the timely use of oil; while a powerful steamer, the Navarre, neglecting it, was swept by the waves and went down in the North Sea, on the 6th of March, with those on board. The oil operates by preventing the waves around the vessel from breaking, and converting them into a heavy swell. "Chambers's Journal" remarks that "ships that leave port unfurnished with oil, in case of emergency, are defrauded of one of their chief elements of safety."

M. Richet, Professor of Clinical Surgery at Paris, has been chosen to the seat in the French Academy of Sciences made vacant by the death of M. Sedillot.

The greenhouses of the Dutch gardeners have been recently infested by a myriapod, heretofore unknown, called the *Fontaria gracilis*, which has the singular faculty of emitting a strong odor of prussic acid when attacked. A chemist of the country, M. Guldensteeden-Egeling, has ascertained that the animal really fabricates and secretes hydrocyanic acid. This substance has hitherto been regarded as exclusively of vegetable origin.

M. Margis, of Paris, has succeeded in obtaining oxygen directly from the atmosphere by dialysis. By forcing air through a series of membranous bags prepared by immersing taffeta in ether, sulphide of carbon, or alcohol, and covering with a fine layer of caoutchouc, he has secured an increase of the percentage of oxygen in respect to nitrogen till the fourth bag gives ninety-five per cent of pure oxygen.

SIR WILLIAM E. LOGAN.

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THE GERM-THEORY OF DISEASE.*

By Professor H. GRADLE, M. D.

SCOURGES of the human race and diseases are attributed by savages to the influence of evil spirits. Extremes often meet. What human intelligence suspected in its first dawn has been verified by human intelligence in its highest development. Again, we have come to the belief of evil spirits in disease, but these destroyers have now assumed a tangible shape. Instead of the mere passive, unwitting efforts with which we have hitherto resisted them, we now begin to fight them in their own domain with all the resources of our intellect. For they are no longer invisible creatures of our own imagination, but with that omnipotent instrument, the microscope, we can see and identify them as living beings, of dimensions on the present verge of visibility. The study of these minute foes constitutes the germ-theory.

This germ-theory of disease is rising to such importance in medical discussions that it can not be ignored by that part of the laity who aspire to a fair general information. For it has substituted a tangible reality for idle speculation and superstition so current formerly in the branch of medical science treating of the causes of disease. Formerly—that is, within a period scarcely over now—the first cause invoked to explain the origin of many diseases was the vague and much-abused bugbear "cold." When that failed, obscure chemical changes, of which no one knew anything definitely, or "impurities of the blood," a term of similar accuracy and convenience, were accused, while with regard to contagious diseases medical ignorance concealed itself by the invocation of a "genus epidemicus." The germ-theory, as far as it is applicable, does away with all these obscurities. It points out the way to investigate the causes of disease with the same spirit of in-

* A lecture delivered before the Chicago Philosophical Society, November 4, 1882.

quiry with which we investigate all other occurrences in nature. In the light of the germ-theory, disease is a *struggle for existence between the parts of the organism and some parasite invading it.* From this point of view, diseases become a part of the Darwinian programme of nature.

The animal body may be compared to a vast colony, consisting as it does of a mass of cells the ultimate elements of life. Each tissue, be it bone, muscle, liver, or brain, is made up of cells of its own kind, peculiar to and characteristic of the tissue. Each cell represents an element living by itself, but capable of continuing its life only by the aid it gets from other cells. By means of the blood-vessels and the nervous system, the different cells of the body are put into a state of mutual connection and dependence. The animal system resembles in this way a republic, in which each citizen depends upon others for protection, subsistence, and the supply of the requisites of daily life. Accustomed as each citizen is to this mutual interdependence, he could not exist without it. Each citizen of this animal colony, each cell, can thrive only as long as the conditions persist to which it is adapted. These conditions comprise the proper supply of food and oxygen, the necessary removal of the waste products formed by the chemical activity of all parts of the body, the protection against external mechanical forces and temperature, as well as a number of minor details. Any interference with these conditions of life impairs the normal activity of the entire body, or, as the case may be, of the individual cells concerned. But the animal system possesses the means of resisting damaging influences. Death or inactivity of one or a few citizens does not disable the state. The body is not such a rigid piece of mechanism that the breakage of one wheel can arrest the action of the whole. Within certain limits, any damage done to individual groups of cells can be repaired by the compensating powers of the organism. It is only when this compensating faculty fails, when the body can not successfully resist an unfavorable influence, that a disturbance arises which we call disease. This definition enables us to understand how external violence, improper or insufficient food, poisons, and other unaccustomed influences, can produce disease. But modern research has rendered it likely that the diseases due to such causes are not so numerous as the affections produced by invasion of the body by parasites.

Of these a few are known to be animals—for instance, the trichina, and some worms found in the blood in certain rare diseases. But the bulk of the hosts we have to contend with is of vegetable nature, and belongs to the lowest order of fungi—commonly termed *bacteria.*

Special names have been given to the different subdivisions of this class of microscopic beings—the rod-shaped bacteria being termed *bacilli;* the granular specimens, *micrococci;* while the rarer forms, of the shape of a screw, are known as *spirilla.*

Bacteria surround us from all quarters. The surface of the earth teems with them. No terrestrial waters are free from them. They form a part of the atmospheric dust, and are deposited upon all objects exposed to the air. It is difficult to demonstrate this truth directly with the microscope, for in the dry state bacteria are not readily recognized, especially when few in number. But we can easily detect their presence by their power of multiplication. We need but provide a suitable soil. An infusion of almost any animal or vegetable substance will suffice—meat-broth, for instance—though not all bacteria will grow in the same soil. Such a fluid when freshly prepared and filtered, is clear as crystal, and remains so if well boiled and kept in a closed vessel, for boiling destroys any germs that may be present, while the access of others is prevented by closure of the flask. But as soon as we sow in this fluid a single bacterium, it multiplies to such an extent that within a day the fluid is turbid from the presence of myriads of microscopic forms. For this purpose we can throw in any terrestrial object which has not been heated previously, or we can expose the fluid to the dust of the air. Air which has lost its dust by subsidence or filtration through cotton has *not* the power of starting bacterial life in a soil devoid of germs. Of course, the most certain way of filling our flask with bacteria is to introduce into it a drop from another fluid previously teeming with them.

In a suitable soil each bacterium grows and then divides into two young bacteria, it may be within less than an hour, which progeny continue the work of their ancestor. At this rate a single germ, if not stinted for food, can produce over fifteen million of its kind within twenty-four hours! More astounding even seems the calculation that *one* microscopic being, some forty billion of which can not weigh over one grain, might grow to the terrific mass of eight hundred tons within three days, were there but room and food for this growth!

During their growth the bacteria live upon the fluid, as all other plants do upon their soil. Characteristic, however, of bacteria-growth is the decomposition of any complex organic substances in the fluid to an extent entirely disproportionate to the weight of the bacteria themselves. This destructive action occurs wherever bacteria exist, be it in the experimental fluid, or in the solid animal or vegetable refuse where they are ordinarily found. It constitutes, in fact, rotting or putrefaction. The processes of decomposition of organic substances coming under the head of putrefaction are entirely the effect of bacterial life. Any influence, like heat, which kills the bacteria, arrests the putrefaction, and the latter does not set in again until other living bacteria gain access to the substance in question. Without bacteria, no putrefaction can occur, though bacteria can exist without putrefaction, in case there is no substance on hand which they can decompose.

No error has retarded more the progress of the germ-theory than the false belief that the bacteria of putrefaction are identical with the germs of disease. The most contradictory results were obtained in experiments made to demonstrate on animals either the poisonous nature, or, on the other hand, the harmlessness, of the fungi commonly found in rotting refuse. But real contradictions do not exist in science; they are only apparent, because the results in any opposite cases were not obtained under identical conditions. The explanation of the variable effects of common putrefaction-germs upon animals is self-evident as soon as we admit *that each parasitic disease is due to a separate species of bacteria, characteristic of the disease*, producing only this form and no other affection; while, on the other hand, the same disease can not be caused by any other but its special parasite. It can be affirmed, on the basis of decisive experiments, that the bacteria characteristic of various diseases float in the air, in many localities at least. Hence rotting material, teeming with bacterial life, may or may not contain disease-producing germs, according to whether the latter have settled upon it by accident or not. Even if these disease-producing species were as numerous in the dust as the common bacteria of putrefaction, which we do not know, they would be at a disadvantage, as far as their increase is concerned. For experience has shown that the germs of most diseases require a special soil for their growth, and can not live, like the agents of putrefaction, upon any organic refuse. In some cases, indeed, these microscopic parasites are so fastidious in their demands that they can not grow at all outside of the animal body which they are adapted to invade. Hence, if a decomposing fluid does contain them, they form at least a minority of the inhabitants, being crowded out by the more energetically growing forms. In the microscopic world there occurs as bitter a struggle for existence as is ever witnessed between the most highly organized beings. The species best adapted to the soil crowds out all its competitors.

Though the putrefaction-bacteria, or, as Dumas calls them, the agents of corruption, are not identical with disease-producing germs, they are yet not harmless by themselves. Putrid fluids cause grave sickness when introduced into the blood of animals in *any quantity*. But this is not a bacterial disease proper; it is an instance of poisoning by certain substances produced by the life-agency of the bacteria while decomposing their soil. The latter themselves do not increase in the blood of the animal; they are killed in their struggle with the living animal cells. The putrefaction-bacteria need not be further present in the putrid solution to produce the poisonous effect on animals. They may be killed by boiling, if only the poisonous substances there formed remain.

In order to prove the bacterial origin of a disease two requirements are necessary: First, we must detect the characteristic bacteria in every case of that disease; secondly, we must reproduce a disease in other individuals by means of the isolated bacteria of that disease. Both these demonstrations may be very difficult. Some species of bacteria are so small and so transparent that they can not be easily, if at all, seen in the midst of animal tissues. This difficulty may be lessened by the use of staining agents, which color the bacteria differently from the animal cells. But it often requires long and tedious trials to find the right dye. The obstacles in the way of the second part of the proposition mentioned are no less appalling. Having found a suspected parasite in the blood or flesh of a patient, we can not accuse the parasite with certainty of being the cause of the disease, unless we can separate it entirely from the fluids and cells of the diseased body without depriving it of its virulence. In some cases it is not easy, if possible, to cultivate the parasite outside of the body; in other instances it can be readily accomplished. Of course, all such attempts require scrupulous care to prevent contamination from other germs that might accidentally be introduced into the same soil. If we can now reproduce the original disease in other animals by infection with these isolated bacteria, the chain of evidence is complete beyond cavil and doubt. But this last step may not be the least difficult, as many diseases of mankind can not be transferred to animals, or only to some few species.

If we apply these rigid requirements, there are not many diseases of man whose bacterial origin is beyond doubt. As the most unequivocal instance, we can mention splenic fever, or anthrax, a disease of domestic animals, which sometimes attacks man, and is then known as malignant pustule. The existence of a parasite in this affection in the form of minute rods and its power of reproducing the disease are among the best-established facts in medicine. It is also known that these rods form seeds, or spores, as they are termed, in their interior, after the death of the patient, which germinate again in proper soil. These spores are the most durable and resisting objects known in animated nature. If kept in the state of spores they possess an absolute immortality; no temperature short of prolonged boiling can destroy them, while they can resist the action of most poisons, even corrosive acids, to a scarcely credible extent.

Another disease, of vastly greater importance to man, has lately been added to the list of scourges of unquestionable bacterial origin. I refer to tuberculosis, or consumption. It is true, this claim is based upon the work of but one investigator—Robert Koch. But whoever reads his original description must admit that no dart of criticism can assail his impenetrable position. Here also a rod-shaped bacillus, extremely minute and delicate, has been found the inevitable companion of the disease. With marvelous patience Koch has succeeded in getting the parasite to grow in pure blood, and freeing it from all associated matter. It must have been a rare emotion that filled the soul of that indefatigable man, when he beheld for the first time, in its isolated state, the fell destroyer of over one eighth of all mankind! None of the animals experimented upon could withstand the concentrated virulence of the isolated parasite. This bacillus likewise produces spores of a persistent nature, which every consumptive patient spits broadcast into the world.

Relapsing fever is another disease of definitely proved origin. If we mention, furthermore, abscesses, the dependence of which on bacteria has lately been established, we have about exhausted the list of human afflictions about the cause of which there is no longer any doubt. Some diseases peculiar to lower animals belong also to this category. The classical researches of Pasteur have assigned the silk-worm disease and chicken-cholera to the same rank. Several forms of septicæmia and pyæmia have also been studied satisfactorily in animals. Indeed, the analogy between these and the kindred forms of blood-poisoning in man is so close that there can be no reasonable doubt as to the similarity of cause. This assumption, next door to certainty, applies equally to the fevers of childbirth. The experimental demonstration of the parasitic nature of leprosy, erysipelas, and diphtheria is not yet complete, though nearly so. Malarial fever also is claimed to belong to the category of known bacterial diseases, but the proofs do not seem as irreproachable to others as they do to their authors.

The entire class of contagious diseases of man can be suspected on just grounds of being of bacterial origin. All analogies, and not a few separate observations, are in favor of this view, while against it no valid argument can be adduced; but it must be admitted that the absolute proof is as yet wanting. Many diseases also, not known to be contagious, like pneumonia, rheumatism, and Bright's disease, have been found associated with parasites, the *rôle* of which is yet uncertain. It is not sophistry to look forward to an application of the germ-theory to all such diseases, if only for *the* reason that we know absolutely no other assignable cause, while the changes found in them resemble those known to be due to parasites. In the expectation of all who are not blinded by prejudice, the field is a vast one, which the germ-theory is to cover some day, though progress can only continue if we accept nothing as proved until it is proved.

There can be little doubt that in many, perhaps in most instances, the disease-producing germs enter the body with the air we breathe. At any rate, the organism presents no other gate so accessible to germs as the lungs. Moreover, it has been shown that an air artificially impregnated with living germs can infect animals through the lungs. How far drinking-water can be accused of causing sickness as the vehicle of parasites can not be stated with certainty. There is, as yet, very little evidence to the point, and what there is is ambiguous. Thus, exposed from all quarters to the attacks of these merciless invaders, it seems almost strange that we can resist their attacks to the extent that we do. In fact, one of the arguments used against the germ-theory—a weak one, it is true—is, that, while it explains why some fall victims to the germs, it does not explain why all others do not share their fate. If all of us are threatened alike by the invisible enemies in the air we breathe, how is it that so many escape? If we expose a hundred flasks of meat-broth to the same atmosphere, they will all become tainted alike, and in the same time. But the animal body is not a dead soil in which bacteria can vegetate without disturbance. Though our blood and juices are the most perfect food the parasites require, though the animal temperature gives them the best conditions of life, they must still struggle for their existence with the cells of the animal body. We do not know yet in what way our tissues defend themselves, but that they do resist, and often successfully, is an inevitable conclusion. We can show this resistance experimentally in some cases. The ordinary putrefaction-bacteria can thrive excellently in dead blood, but if injected into the living blood-vessels they speedily perish. Disease-producing germs, however, are better adapted to the conditions they meet with in the body they invade, and hence they can the longer battle with their host, even though they succumb in the end.

The resistance or want of resistance which the body opposes to its invaders is medically referred to as the predisposition to the disease. What the real conditions of this predisposition are, we do not know. Experience has simply shown that different individuals have not an equal power to cope with the parasites. Here, as throughout all nature, the battle ends with the survival of the fittest. The invaders, if they gain a foothold at all, soon secure an advantage by reason of their terrific rate of increase. In some instances they carry on the war by producing poisonous substances, in others they rob the animal cells of food and oxygen. If the organism can withstand these assaults, can keep up its nutrition during the long siege, can ultimately destroy its assailants, it wins the battle. Fortunately for us, victory for once means victory forever, at least in many cases. Most contagious diseases attack an individual but once in his lifetime. The nature of this lucky immunity is unknown. The popular notion, that the disease has taken an alleged "poison" out of the body, has just as little substantial basis as the contrary assumption that the parasites have left in the body a substance destructive to themselves. It is not likely, indeed, that an explanation will ever be given on a purely chemical basis, but in what way the cells have been altered so as to baffle their assailants in a second attempt at invasion is as yet a matter of speculation. Unfortunately for us, there are other diseases of probable bacterial origin, which do not protect against, but directly invite, future attacks.

A question now much agitated is, whether each kind of disease-germs amounts to a distinct and separate species, or whether the parasite of one disease can be so changed as to produce other affections as well. When investigations on bacteria were first begun, it was taken for granted that all bacterial forms, yeast-cells, and mold-fungus, were but different stages of one and the same plant. This view has long since been recognized as false. But even yet some botanists claim that all bacteria are but one species, appearing under different forms according to their surroundings, and that these forms are mutually convertible. The question is a difficult one to answer, since bacteria of widely differing powers may resemble each other in form. Hence, if a species cultivated in a flask be contaminated by other germs accidentally introduced, which is very likely to happen, the gravest errors may arise. But the more our methods gain in precision, and the more positive our experience becomes, the more do we drift toward the view that each variety of bacteria represents a species as distinct and characteristic as the separate species among the higher animals. From a medical stand-point this view, indeed, is the only acceptable one.

A disease remains the same in essence, no matter whom it attacks or what its severity be in the individual case. Each contagious disease breeds only its own kind, and no other. When we experiment with an isolated disease-producing, germ it causes always one and the same affection, if it takes hold at all.

But evidence is beginning to accumulate that, though we can not change one species into another, we can modify the power and activity, in short, the virulence, of parasites. Pasteur has shown that when the bacteria of chicken cholera are kept in an open vessel, exposed to the air for many months, their power to struggle with the animal cells is gradually enfeebled. Taken at any stage during their decline of virulence, and placed in a fresh soil in which they can grow, be it in the body of an animal or outside, they multiply as before. But the new breed has only the modified virulence of its parents, and transmits the same to its progeny. Though the form of the parasite has been unaltered, its physiological activity has been modified: it produces no longer the fatal form of chicken-cholera, but only a light attack, from which the animal recovers. By further enfeeblement of the parasite, the disease it gives to its host can be reduced in severity to almost any extent. These mild attacks, however, *protect the animal against repetitions.* By passing through the modified disease, the chicken obtains immunity from the fatal form. In the words of Pasteur, the parasite can be transformed into a "vaccine virus" by cultivation under conditions which enfeeble its power. The splendid view is thus opened to us of vaccinating, some day, against all diseases—in which one attack grants immunity against another. Pasteur has succeeded in the same way in another disease of much greater importance, namely, splenic fever. The parasite of this affection has also been modified by him, by special modes of cultivation, so as to produce a mild attack, protecting against the graver form of the disease. Pasteur's own accounts of his results, in vaccinating, against anthrax, the stock on French farms, are dazzling. But a repetition of his experiments in other countries, by his own assistants, has been less conclusive. In Hungary the immunity obtained by vaccination was not absolute, while the protective vaccination itself destroyed some fourteen per cent of the herds.

Yet, though much of the enthusiasm generated by Pasteur's researches may proceed further than the facts warrant, he has at least opened a new path which promises to lead to results of the highest importance to mankind.

The ideal treatment of any parasitic disease would be to administer drugs which have a specific destructive influence upon the parasites, but spare their host, i. e., the cells of the animal body. But no substance of such virtue is known to us. All so-called antiseptics, i. e., chemicals arresting bacterial life, injure the body as much as if not more than the bacteria. For the latter of all living beings are characterized by their resistance to poisons. Some attempts, indeed, have been made to cure bacterial (if not all) diseases by the internal use of carbolic acid, but they display such innocent *naïveté* as not to merit serious consideration. More promising than this search after a new philosopher's stone is the hope of arresting bacterial invasion of the human body by rendering the conditions unsuitable for the development of the germs, and thus affording the organism a better chance to struggle with them. Let me illustrate this by an instance described by Pasteur. The chicken is almost proof against splenic fever. This protection Pasteur attributes to the high normal temperature of that animal, viz., 42° Cent. At that degree of warmth the anthrax-bacillus can yet develop, but it is enfeebled. The cells of the bird's body, thriving best at their own temperature, can hence overcome the enfeebled invader. Reduction of the animal's temperature, however, by means of cold baths, makes it succumb to the disease, though recovery will occur if the normal temperature be restored in due time. In the treatment of human diseases, we have not yet realized any practice of that nature, but research in that direction is steadily continuing.

The most direct outcome of the germ-theory, as far as immediate benefits are concerned, is our ability to act more intelligently in limiting the spread of contagious diseases. Knowing the nature of the poison emanated by such patients, and studying the mode of its distribution through nature, we can prevent it from reaching others, and thus spare them the personal struggle with the parasite. In no instance has the benefit derived from a knowledge of the germ-theory been more brilliantly exemplified than in the principles of antiseptic surgery inaugurated by Lister. This benefactor of mankind recognized that *the* great disturbing influence in the healing of wounds is the admission of germs. It had been well known, prior to his day, that wounds heal kindly if undisturbed, and that the fever and other dangers to life are an accidental, *not* an inevitable, consequence of wounds. But Lister was the first to point out that these accidents were due to the entrance of germs into the wound, and that this dangerous complication could be prevented. By excluding the parasites from the wound, the surgeon spares his patient the unnecessary and risky struggle, giving the wound the chance to heal in the most perfect manner. Only he who has compared the uncertainty of the surgery prior to the antiseptic period, and the misery it was incompetent to prevent, with the ideal results of the modern surgeon, can appreciate what the world owes to Mr. Lister. The amount of suffering avoided and the number of lives annually saved by antiseptic surgery constitute the first practical gain derived from the application of the germ-theory in medicine.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

X.

AS stated in my last, the subject of roasting occupied a large amount of Count Rumford's attention, especially while he was in England residing in Brompton Road, and founding the Royal Institution. His efforts were directed not merely to cooking the meat effectively, but to doing so economically. Like all others who have contemplated thoughtfully the habits of Englishmen, he was shocked at the barbaric waste of fuel that everywhere prevailed in this country, even to a greater extent then than now.

The first fact that necessarily presented itself to his mind was the great amount of heat that is wasted, when an ordinary joint of meat is suspended in front of an ordinary coal-fire to intercept and utilize only a small fraction of its total radiation.

As far as I am aware, there is no other country in Europe where such a process is indigenous. I say "indigenous" because there certainly are hotels where this or any other English extravagance is perpetrated to please Englishmen who choose to pay for it. What is usually called roast meat in countries not inhabited by English-speaking people is what we should call "baked meat," the very name of which sets all the gastronomic bristles of an orthodox Englishman in a position of perpendicularity.

I have a theory of my own respecting the origin of this prejudice. Within the recollection of many still living, the great middle class of Englishmen lived in town; their sitting-rooms were back parlors behind their shops, or factories, or warehouses, their drawing-rooms were on the first-floor, and kitchens in the basement.

They kept one general servant of the "Marchioness" type. The corresponding class now live in suburban villas, keep cook, house-maid, and parlor-maid, besides the gardener and his boy, and they dine at supper-time.

In the days of the one marchioness and the basement kitchen, these citizens "of credit and renown" dined at dinner-time, and were in the habit of placing a three-legged open iron triangle in a brown earthenware dish; then spreading a stratum of peeled potatoes on said dish, and a joint of meat above, on the open triangular support. The combination was carried by the marchioness to the bakehouse round the corner at about 11 A. M., and brought back steaming and savory at 1 P. M.

This was not done always, but at other times, as when the condition of the mistress's wardrobe offered no particular motive for going to church, she staid at home and roasted the Sunday dinner. The experience thus obtained demonstrated a material difference between the flavor of the roasted and the baked meat very decidedly in favor of the home-roasted. Why?

The principal reason was, I believe, that the baker's large bread-oven contained at dinner-time a curious medley of meats—mutton, beef, pork, geese, veal, etc., including stuffing with sage and onions, besides the possibility of a joint or two that had been hung longer than was necessary for procuring tenderness. The vapors of these would induce a confusion of flavors in the milder meats, fully accounting for the observed superiority of the home-roasted joints.

A little reflection on the principles already expounded will show that, theoretically regarded, a given piece of meat would be better roasted in a closed chamber radiating heat *from all sides* toward the meat than it could be when suspended in front of a fire and heated only on one side, while the other side was turned away to cool more or less, according to the rate of rotation.

If I agreed with the popular belief in the advantage of open-air exposure to direct radiation from glowing coal, I should suggest that for large joints a special roasting fire be constructed, by building an upright cylinder of fire-brick, and erecting within this a smaller cylinder or grating of iron bars, so that the fuel should be placed between these, and thus form an upright cylindrical ring or shirt of fire, inclosed outside by the bricks, but open and glowing toward the inside of the hollow cylinder, in the midst of which the meat should be suspended to receive the radiation from all sides.

The whole apparatus might stand under a dome, terminating in an ordinary chimney, like a glass-house or a steel-maker's cementing furnace; or, in this respect, like those wondrous kitchens of the old seraglio, to which I have already alluded, where each apartment is a huge chimney, outspreading downward, so that the cooks and their materials and apparatus, as well as the huge fires themselves, are all under the great central chimney-shaft.

I do not, however, recommend such an apparatus, even to the most wealthy and luxurious epicure, because I am convinced, not merely from theoretical considerations, but also from practical experiments, that all kinds of meat may be not merely as well roasted in a close oven as before an open fire, but that the close chamber, properly managed, produces *better results in every respect* than can possibly be obtained by roasting in the open air.

To obtain such results there must be no compromise, no concession to any false theory respecting a necessity for ventilation.

Many modern kitchen-ranges are fitted with such compromises in the shape of a ventilated roasting-oven, the action of which ventilation is purely and simply mischievous, excepting in the case of semi-putrid game or venison, which require to be carbonized and disinfected as well as cooked, and, of course, also demand the speedy removal of their noxious vapors.

Not so with fresh meats. There is nothing in the vapor of beef that can injure the flavor of beef, nor in the vapor of mutton that is damaging to mutton, and so on with the rest. But there is much that can, and does, actually improve them ; or, more strictly speaking, prevents the deterioration to which they are liable when roasted before an open fire. I will endeavor to explain this.

Carefully-conducted experiments have demonstrated the general law that atmospheric air is a vacuum to the vapor of water and other similar vapors, while each particular vapor is a plenum to itself, though not to other vapors ; or, otherwise stated, if a given space, at a given temperature, be filled with air, the quantity of aqueous vapor that it is capable of holding is the same as though this space contained no air at all, nor anything else. But this same space may contain a much smaller quantity of aqueous vapor, and yet be absolutely impenetrable to aqueous vapor, provided its temperature is unaltered.

Thus, if a bell-glass, filled with air under ordinary pressure, at the temperature of 100° Fahr., be placed over a dish of water at same temperature, a quantity of vapor, equal to one thirtieth (in round numbers) of the weight of the air, will rise into the bell-glass, and there remain diffused throughout. If there were less air, or no air at all (temperature remaining the same), the bell-glass would obtain and hold the same quantity of vapor.

If, instead of being filled with air, it contained at the outset only this one thirtieth of aqueous vapor, it would now be an impenetrable plenum, behaving like a solid to aqueous vapor—no more can be forced into it without raising its temperature.

But while thus charged with aqueous vapor, there would still be room for vapor of alcohol, or turpentine, or ether, or chloroform, etc. It would be a vacuum to these, though a plenum to itself. On the other hand, if the alcohol, turpentine, ether, or chloroform were allowed to evaporate into the bell-glass, a certain quantity of either of these vapors would presently enter it, and then this vapor would act like a solid mass in resisting the entry of any more of its own kind, while it would be freely pervious to the vapor of water or that of the other liquids.

A practical example will further illustrate this. Some years ago I was engaged in the distillation of paraffin-oil, and had a few thousand gallons of the crude liquid in a still with a tall head and a rising condenser. In spite of severe firing, the distillation proceeded very slowly. Then I threw into the still, just above the surface of the oil, a jet of steam. The rate of distillation immediately increased with the same firing, although the steam was of much lower temperature than the boiling oil, and therefore wasted much heat. The *rationale* of this was that at first an atmosphere of oil-vapor stood over the oil, and this was impervious to more oil-vapor, but, on sweeping this out and replacing it by steam, the atmosphere above the liquid oil was permeable by oil-vapor. This principle is largely applied in similar distillations.

But I am exceeding my limits, and must, therefore, defer the direct application of these principles to my next, though doubtless most of my readers will anticipate, or, in vulgar but expressive phrase, "see what I am driving at."

XI.

Always keeping in view that the primary problem in roasting is to raise the temperature throughout to the cooking heat with the smallest possible degree of desiccation of the natural juices of the meat, and applying to this problem the laws of vapor diffusion expounded in my last, it is easy enough to understand the theoretical advantages of roasting in a closed oven, the space within which speedily becomes saturated with those particular vapors that resist further vaporization of these juices.

I say "theoretical," because I despair of practically convincing any thorough-bred Englishman that baked meat is better than roasted meat by any reasoning whatever. If, however, he is sufficiently "un-English" to test the question experimentally, he may possibly convince himself. To do this fairly, a large joint of meat should be equally divided, one half roasted in front of the fire, the other in a non-ventilated oven over a little water by a cook who knows how to heat the latter. This condition is essential, as some intelligence is demanded in regulating the temperature of an oven, while any barbarian can carry out the modern modification of the ordinary device of the savage, who skewers a bit of meat, and holds this near enough to a fire to make it frizzle.

Having settled this question to my own satisfaction more than twenty years ago, I now amuse myself occasionally by experimenting upon others, and continually find that the most uncompromising theoretical haters of baked meat practically prefer it to orthodox roasted meat, provided always that they eat it in ignorance.

Part II of Count Rumford's "Tenth Essay" is devoted to his roaster and roasting generally, and occupies ninety-four pages, including the special preface. This preface is curious now, as it contains the following apology for delay of publication: "During several months, almost the whole of my time was taken up with the business of the Royal Institution; and those who are acquainted with the objects of that noble establishment will, no doubt, think that I judged wisely in preferring its interest to every other concern." To those who have attended the fashionable gatherings held on Friday evenings in "that noble establishment" during the London season, it is almost comical to read what its founder says concerning the object for which it was instituted, viz., the noble purpose of DIFFUSING THE KNOWLEDGE AND FACILITATING THE GENERAL INTRODUCTION OF NEW AND USEFUL INVENTIONS AND IMPROVEMENTS." The capitals are Rumford's, and he illustrates their meaning by reference to "the repository of this new establishment," where specimens of pots and kettles, ovens, roasters, fireplaces, gridirons, tea-kettles, kitchen-boilers, etc., might be inspected.

Some years ago, when I was sufficiently imprudent to accept an invitation to describe Rumford's scientific researches in *one* Friday evening lecture, rigidly limited to fifty-seven minutes (and consequently muddled my subject in the vain struggle to condense it), I tried to find the original roaster, but failed; all that remained of the original "repository" being a few models put out of the way as though they were empty wine-bottles. I am not finding fault, as the noble work that has been done there by Davy, Faraday, and Tyndall must have profoundly gladdened the supervising soul of Rumford (supposing that it does such spiritual supervision), in spite of his neglected roaster, which I must now describe without further digression.

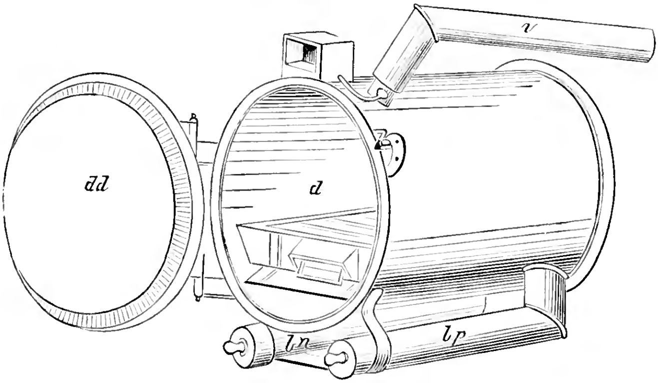

Fig. 1.

It is shown open and out of its setting in Fig. 1, and there seen as a hollow cylinder of sheet-iron, which for ordinary use may be about eighteen inches in diameter and twenty-four inches long, closed permanently at one end, and by a hinged double door of sheet-iron (*d d*) at the other. The doubling of the door is for the purpose of retaining the heat by means of an intervening lining of ill-conducting material. Or a single door of sheet-iron, with a panel of wood outside, may be used. The whole to be set horizontally in brickwork, as shown in Fig. 4, the door-front being flush with the front of the brickwork. The flame of the small fire below plays freely all round it by filling the enveloping flue-space indicated by the dotted lines on Fig. 4. Inside the cylinder is a shelf to support the dripping-pan (*d*), Fig. 1, which is separately shown in Figs. 2 and 3.

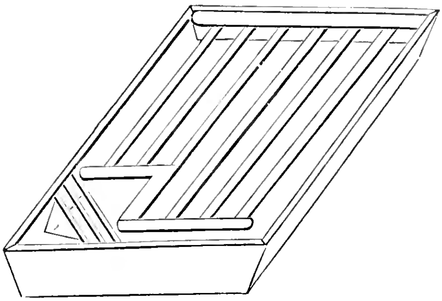

FIG. 2.

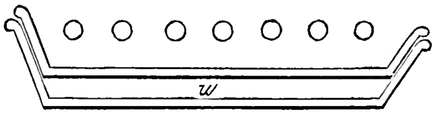

FIG. 3.

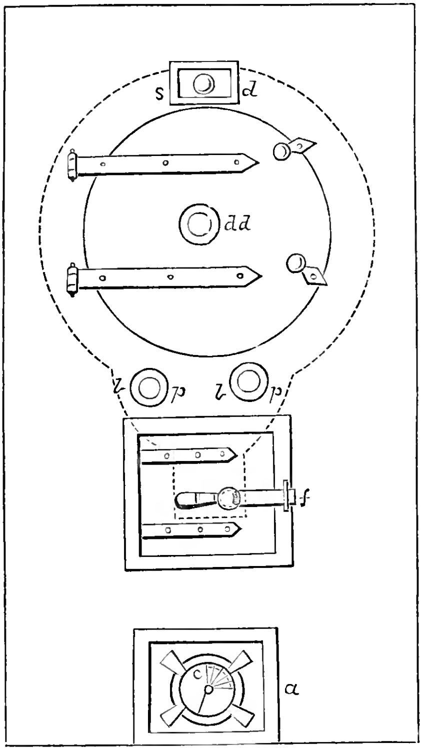

FIG. 4.

This dripping-pan is an important element of the apparatus. Fig. 3 shows it in cross-section, made up of two tin-plate dishes, one above the other, arranged to leave a space (*w*) between. This space contains water, half to three quarters of an inch in depth. Above is a gridiron, shown in plan, Fig. 2, on which the meat rests; the bars of this are shown in section in Fig. 3. The object of this arrangement is to prevent the fat which drips from the meat from being overheated and filling the roaster with the fumes of "burnt," i. e., partially decomposed, fat and gravy, to the tainting influence of which Rumford attributed the English prejudice against baked meat. So long as any water remains, the dripping can not be raised more than two or three degrees above 212°.

The tube *v*, Fig. 1, is for carrying away vapor, if necessary. This tube may be opened or closed by means of a damper moved by the little handle shown on the right. The *heat* of the roaster is regulated by means of the register *c* in the ash-pit door of the fireplace, its *dryness* by the above-named damper of the steam-tube *v*, and also by the blow-pipes, *b p*.

These are iron tubes, about two and a half inches in diameter, placed underneath, so as to be in the midst of the flame as it ascends from the fire into the enveloping flue, shown by the dotted lines, Fig. 4, where their external openings are shown at *b p*, *b p*, and the plugs by which they may be opened or closed in Fig. 1. It is evident that by removing these plugs and opening the damper of the steam-pipe a blast of hot, dry air will be delivered into the roaster at its back part, and it must pass forward to escape by the steam-pipe. As these blow-pipes are raised to a red heat when the fire is burning briskly, the temperature of this blast of air may be very high; with even a very moderate fire, sufficiently high to desiccate and spoil the meat if they were kept open during all the time of cooking. They are accordingly to be kept closed until the last stage of the roasting is reached; then the fire is urged by opening the ash-pit register, and when the blow-pipes are about red-hot their plugs are removed, and the steam-pipe damper is opened for a few minutes to brown the meat by means of the hot wind thus generated.

It will be observed that a special fire directly under the roaster is here designed, and that this fire is inclosed in brickwork. This is a general feature of Rumford's arrangements, which I shall have to discuss more fully when I come to the subject of kitchen-fires. The economy of the whole device will be understood by the fact that, in a test experiment at the Foundling Institution of London, he roasted one hundred and twelve pounds of beef with a consumption of only twenty-two pounds of coal (three pennyworth, at twenty-five shillings per ton).

Rumford tells us that "when these roasters were first proposed, and before their merit was established, many doubts were entertained respecting the taste of the food prepared in them," but that, after many practical trials, it was proved that "meat of every kind, without any exception, roasted in a roaster, is *better tasted, higher flavored, and much more juicy and delicate* than when roasted on a spit before an open fire." These italics are in the original, and the testimony of competent judges is quoted.

I must describe one experiment in detail. Two legs of mutton from the same carcass made equal in weight before cooking were roasted, one before the fire and the other in a roaster. When cooked both were weighed, and the joint roasted in the roaster proved to be heavier than the other by six per cent. They were brought upon table at the same time, "and a large and perfectly unprejudiced company was assembled to eat them." Both were found good, but a decided preference given to that cooked in the roaster; "it was much more juicy, and was thought better tasted." Both were fairly eaten up, nothing remaining of either that was eatable, and the fragments collected. "Of the leg of mutton which had been roasted in the roaster, hardly anything visible remained, excepting the bare bone; while a considerable heap was formed of scraps not eatable which remained of that roasted on a spit."

This was an eloquent experiment; the six per cent gained tell of juices retained with consequent gain of flavor, tenderness, and digestibility, and the subsequent testimony of the scraps describes the difference in the condition of the tendonous, integumentary portions of the joints, which are just those that present the toughest practical problems to the cook, especially in roasting.

But why are these roasters not in general use? Why did they die with their inventor? I will take up these questions in my next.

XII.

Returning to the question suggested by my last paper, Why has Rumford's roaster fallen into disuse, notwithstanding the fact, mentioned in his essay, that Mr. Hopkins, of Greek Street, Soho, had sold above two hundred, and others were making them?

Those of my readers who have had practical experience in using hot air or in superheating steam, will doubtless have already detected a weak point in the "blow-pipes." When iron pipes are heated to redness, or thereabout, and a blast of air or steam passes through them, they work admirably for a while, but presently the pipe gives way, for iron is a combustible substance, and burns slowly when heated and supplied with abundant oxygen, either by means of air or water, the latter being decomposed, its hydrogen set free, while its oxygen combines with the iron and reduces it to friable oxide. Rumford does not appear to have understood this, or he would have made his blow-pipes of fire-clay or other refractory non-oxidizable material.

The records of the Great Seal Office contain specifications of hundreds of ingenious inventions that have failed most vexatiously from this defect; and I could tell of joint-stock companies that have been "floated" to carry out inventions involving the use of heated air or superheated steam that have worked beautifully and with apparent economy while the shares were in the market, and then collapsed just when the calls were paid up, the cost of renewal of super-heaters and hot-air chambers having worse than annulled the economy of working fuel described in the prospectus. Thus a vessel driven by heated air, as a substitute for steam, was fitted up with its caloric engine, and crossed the Atlantic with passengers on board. The voyage practically demonstrated a great saving of coal; patent rights were purchased accordingly for a very large amount, and shares went up buoyantly until the oxidation of the great air-chamber proved that the engine burned iron as well as coal at a ruinous cost.

Although no mention is made by Rumford of such destruction of the blow-pipes, he was evidently conscious of the costliness of his original roaster, as he describes another which may be economically substituted for it. This has an air-chamber formed by bringing the body of the oven-door so as to inclose the space occupied by the blow-pipes shown in Fig. 1, and placing the dripping-pan on a false bottom joined to the front face of the roaster just below the door, but not extending quite to the back. An adjustable register door opens at the front into this air-chamber, and when this is opened the air passes along from front to back under the false bottom, and rises behind to an outlet pipe like that shown at *v*, Fig. 1. In thus passing along the hot bottom of the oven the air is heated, but not so greatly as by the blow-pipes, which, being surrounded by the flame on all sides, are heated above as well as below, and the air in passing through them is much more exposed to heat than in passing through the air-chamber.

To increase the heat transmitted in the latter, Rumford proposes that "a certain quantity of iron wire, in loose curls, or of iron turnings, be put into the air-chamber."

This modification he called a "roasting-oven," to distinguish it from the first described, the "roaster." He states that the roasting-oven is not quite so effective as the roaster, but from its greater cheapness may be largely used. This anticipation has been realized. The modern "kitchener," which in so many forms is gradually and steadily supplanting the ancient open range, is an apparatus in which roasting in the open air before a fire is superseded by roasting in a closed chamber or roasting oven. Having made three removals within the last twelve years, each preceded by a tedious amount of house-hunting, I have seen a great many kitchens of newly-built houses, and find that about ninety per cent of these have closed kitcheners, and only about ten per cent are fitted with open ranges of the old pattern. Bottle-jacks, like smoke-jacks and spits, are gradually falling into disuse.

When these kitcheners were first introduced, a great point was made by the manufacturer of the distinction between the roasting and the baking oven; the first being provided with a special apparatus for effecting ventilation by devices more or less resembling that in Rumford's roasting-oven. Gradually these degenerated into mere shams, and now in the best kitcheners even a pretense to ventilation is abandoned. Having reasoned out my own theory of the conditions demanded for perfect roasting some time ago (about 1860, when I lectured on "Household Philosophy" to a class of ladies at the Birmingham and Midland Institute), I have watched the gradual disappearance of these concessions to popular prejudice with some interest, as they show how practical experience has confirmed this theory, which, as already expounded, is that *the meat should be cooked by the* *action of radiant heat, projected toward it from all sides, while it is immersed in an atmosphere saturated with its own vapors.*

Herein I diverge from my teacher, as the preceding description of both his roaster and roasting-oven shows. His explanation of the prejudice of Englishmen against baked meats may have been to some extent justified by his own experience, seeing that he heated his ovens by a fire placed below, and, if he first used these without his water-pan, they doubtless effected the decomposition of the dripping and gravy of which he speaks (see No. XI of this series, page 591); but even in this case the flavor of merely burned fat is not very serious—far less objectionable than that of the vile mixture of vapors described in No. X.

The few domestic fireplace ovens that existed in Rumford's time were clumsily heated by raking some of the fire from the grate into a space left below the oven. Those of the best modern kitcheners are heated by flues going round them, generally starting from the top, which thus attains the highest temperature. The radiation from this does the "browning" for which Rumford's blow-pipes were designed.

According to my view of the philosophy of roasting, this browning, or the application of the highest temperature, should take place at the beginning rather than the end of the process, in order that a crust of firmly coagulated albumen may surround the joint and retain the juices of the meat. All that is necessary to obtain this effect in a sufficient degree is to raise the roasting-oven to its full temperature before the meat is put in. Supposing an equal fire is maintained all the while, this initial temperature will exceed that of the continuing temperature, because, when the meat is in the oven, the radiant heat from its sides are intercepted by the joint and doing work upon it; heat can not do work without a corresponding fall of temperature. While the oven is empty, the radiations from each side cross the open space to re-enforce the temperature of the other sides.

Is there, then, any difference at all between roasting and baking? There is. In roasting, the temperature, after the first start, is maintained about uniformly throughout; while, in baking by the old-fashioned method, the temperature continually declines from the beginning to the end of the process; but, in order that a dweller in cities, or the cook of an ordinary town household, may understand this difference, some explanation is necessary. The old-fashioned oven, such as was generally used in Rumford's time, and is still used in country houses and by old-fashioned bakers, was an arched cavity of brick, with a flat brick floor. This cavity is closed by a suitable door, which, in its primitive and perhaps its best form, was a flat tile that was pressed against the opening, and luted round with clay. Such ovens were, and still are, heated by simply spreading on the brick floor a sufficient quantity of wood—preferably well-dried twigs; these, being lighted, raise the temperature of the arched roof to a glowing heat, and that of the floor in a somewhat lower degree. When this heating is completed (the judgment of which constitutes the chief element of skill in thus baking) the embers are carefully brushed out from the floor, the loaves, etc., inserted by means of a flat battledoor with a long handle, called a "peel," and the door closed and firmly luted round, not to be opened until the operation is complete. Baked clay is an excellent radiator, and, therefore, the surface of bricks forming the arched roof of the oven radiates vigorously upon its contents below, which are thus heated at top by radiation from the roof, and at bottom by direct contact with the floor of the oven. The difference between the compact bottom crust and the darker, bubble-bearing top crust of an ordinary loaf is thus explained.

As the baking of a large joint of meat is a longer operation than the baking of bread, there is another reason besides that already given for the inferiority of meat when baked in a baker's oven constructed on this principle. The slow cooling down must tend to produce a flabbiness and insipidity similar to those of the roast meat which is served at restaurants, where a joint remains "in cut" for two or three hours. Of this I speak theoretically, not having had an opportunity of tasting a joint that has been cooked in a brick oven of the construction above described, but have observed the advantage of maintaining a steady heat throughout the process of roasting in the iron oven of a kitchener, or American stove, or gas-oven.

AGRICULTURAL EXPERIMENT STATIONS.

By H. P. ARMSBY.

WITHIN the past eight years there have been founded in several States institutions which, though they have not yet attracted much attention from the general public, can hardly fail to exert, in the near future, an important influence both on the material and mental welfare of the people. These institutions are the agricultural experiment stations, of which six now exist in this country, with a prospect of the speedy establishment of at least two more.

By an agricultural experiment station is understood an institution established and maintained "for the purpose of promoting agriculture by scientific investigation and experiments." Such institutions have, in most cases, owed their existence to governmental action, and have been sustained at the public expense, though in a few instances universities and private individuals have carried on what are in effect experiment stations, the most notable example of the latter being the well known Rothamsted experiments of Messrs. Lawes and Gilbert, in England.

Although experiment stations are still somewhat of a novelty in this country, they are far from being so in others. There is scarcely a country in Europe where one or more is not in operation, while in the German Empire they number not less than fifty. The first to be established was that at Rothamsted, just alluded to, in 1843. This has continued to the present time, though not under the name of an experiment station. Nine years later, the station at Möckern, in Saxony, which had been carried on for some two years by private and corporate generosity, received a grant of money from the state, and became the first public station. In 1853 a station was founded at Chemnitz, in 1855 one at Gross-Kmehlin, and, for the succeeding twenty-two years, 1860 was the only year which did not witness the institution of at least one station. Other European nations followed the example of the German states, and stations were established by France in 1856, by Austria in 1857, by Holland in 1857, by Sweden in 1861, by Russia in 1864, by Italy in 1870, by Denmark in 1871, by Belgium in 1872, by Switzerland in 1872, by Austro-Hungary in 1873, by Scotland in 1875, by Spain in 1876. The value of the scientific work done by these stations during the last thirty years and the impetus it has given to rational agriculture are very great. The fact that, in a volume published on the occasion of the twenty-fifth anniversary of the Möckern station, one hundred and forty-six octavo pages are occupied with a list of the *titles* of papers published by them up to that time will give some idea of its amount.

The first experiment station in this country was founded at Middletown, Connecticut, in 1875, being supported in part by the State and in part by Wesleyan University. In 1877 it was reorganized and removed to New Haven, becoming entirely dependent on State support, and in 1882 it was provided with land and buildings by the State.

In 1877 North Carolina organized a station, located first at the State University at Chapel Hill, and subsequently at Raleigh. New Jersey followed the example of these two States in 1880, placing its station at the State Agricultural College at New Brunswick. The New York station was incorporated in 1881, and began operations in 1882 at Geneva. The Ohio station was organized in April, 1882, and is located at the State University at Columbus; and the Massachusetts station was organized in the autumn of the same year, at the Agricultural College at Amherst. The private experiment stations are represented by Houghton Farm, in New York, where experimental work was begun in 1879; and mention should also be made of the Cornell University experiment station at Ithaca, which has published a single report. At least two other States are debating the question of establishing stations, and there is every indication of a rapid multiplication of them in this country in the immediate future.

With regard to the value of experimental station work in America, it is yet too early to formulate an opinion. In general it may be said that the principal cause leading to the establishment of such stations was the great and steadily increasing extent to which commercial fertilizers are used in American agriculture, and to the absolute necessity which was felt for some means of protecting consumers against fraud in these articles, which are of such a nature that even the grossest frauds can in most cases be detected only by chemical analysis. Consequently, most of these stations were and are, first and foremost, fertilizer control stations. They put at the service of every consumer of fertilizers in their respective States the skill of professional chemists by whose aid he may test the genuineness and value of the goods he proposes to purchase. A method has also been worked out (the principle being adopted from the German stations) by which the money-value of a fertilizer may be calculated approximately from the results of analysis and the market prices of a few standard materials. Most or all of the stations follow the custom of frequently publishing analyses and valuations of the fertilizers brought to their notice, or in some cases of all brands sold in the State, and the publicity thus insured proves an efficient and sufficient check to fraudulent practices. Of late, a growing interest has manifested itself in the chemical examination of cattle-foods and their rational use, and numerous analyses of fodders have been made, accompanied in a few cases by practical feeding-trials. Other work has also been done to a less extent, but it is safe to say that, after deducting the fertilizer and fodder analyses from the work of our stations, the residue would be comparatively inconsiderable.

It was quite natural that the activity of the stations should at first take this direction. The fertilizer question was an important one, involving large money interests, and, moreover, it offered a field in which quick and tangible returns were yielded for the money invested in a station. The most short-sighted could not fail to see that the suppression of fraud in articles whose aggregate sales amounted to hundreds of thousands of dollars in single States annually was well worth the expenditure of a few thousand dollars for an experiment station. But the fertilizer question brought others in its train. Indeed, no small part of the benefit which our agriculture has derived from the introduction of commercial fertilizers has been entirely aside from the pecuniary advantage attending their use. They have aided in introducing definite ideas of what constitutes a fertilizer, and why. The habitual use of chemical analyses of fertilizers is rendering nitrogen, potash, and phosphoric acid almost as familiar terms as air, soil, and water, and thus is contributing in no small degree to the education of farmers. A knowledge of what fertilizers are has led to a demand for information as to how they act, and the most suitable method of using them, and the successes of science in this field have led to the inquiry whether the feeding of animals may not derive as much benefit from it as the feeding of plants. It would be difficult to-day to find an intelligent farmer who is opposed to experiment stations, or who would have them limited in their operations to the analysis of fertilizers. There is a general if not always intelligent demand for scientific experiments on plant and animal production, and we may venture to predict that in future such investigations will form a more important part of the work of our experiment stations than has hitherto been the case.

It is not proposed in this article to consider the propriety of the founding of experiment stations on the part of the State. That the general welfare is sufficiently promoted thereby to justify the expense appears evident to the writer, but the question has been practically decided in so many States that any discussion of it at this late day would be quite superfluous. It seems almost certain that within a few years a great development of the business of agricultural experimentation in this country will take place. What the nature of this development shall be and how it can be guided to the best results are questions alike interesting to the agriculturist, who hopes for personal advantage from it, and the statesman, who desires the prosperity of this most important branch of industry. Nor is it material benefits alone that may be anticipated from a wise treatment of this question. The educational influence of such a center of information and research as a good station should be, the influence which it would have on the intelligence and methods of thought of its constituents, is not easily overestimated.

What, then, should an experimental station be? How should it be organized, and by whom conducted? What should the public expect from it in return for its support? By what standard judge whether it is fulfilling the purpose of its existence?

Three courses are open, any one or all of which an experiment station may pursue:

First, it may undertake police duties, and devote its energies to the prevention or detection of fraud in fertilizers, fodders, seeds, foods, etc. This species of work has of necessity occupied the larger share of the attention of the American stations thus far, and, unless other means are provided for its performance, must continue to form an important part of their duties until human nature becomes other than it is.

A second and broader field of activity, and one whose importance, we venture to think, will be more and more appreciated from year to year, provided it is wisely cultivated, consists in applying what is now known of agricultural science to the conditions prevailing where the station is located. Such work, for example, would be a physical and chemical study of the different varieties of soil in the State with regard to the kinds of fertilizers best adapted to them, the most appropriate methods of tillage, the most suitable crops, etc.—in short, an agricultural survey of the State, the benefits of which would doubtless, in many cases, amply repay the expense of a station. Or, the leading crops of a State might be made the subject of scientific study, either with regard to their value as food for men and animals, or as to their demands on the soil for plant-food. The number of these examples might be increased manifold were it needful. Investigations of this sort would have for their main object the adaptation of general truths to local conditions. Their benefits would be immediate and evident, and they could not fail, if intelligently conducted, to exert a salutary influence on both the agriculture and menticulture of the region.

Third, an experiment station may make it its aim to advance agricultural science in general, without regard to obtaining immediately useful results.

This would probably be the most unpopular course it could pursue. The great demand is for something "practical," by which is meant something whose value is at once apparent, and can be measured in dollars and cents. This is true in all departments of mental activity, but in none more emphatically than in the one we are considering, unless, indeed, it be in education, and nowhere does the "practical man" render his impracticality more evident. It is a difficultly learned lesson that knowledge pays. We glibly repeat the maxim that "knowledge (i. e., science) is power," but we scarcely half believe it. What we mean is that knowing how to do some particular thing or things gives us power. But knowledge *is* power, nevertheless, to every man in his own way and along his own lines of work, and no knowledge is valueless to any man. Therefore it ought to be made possible for our experiment stations, and, indeed, made part of their duty, not only to teach their constituents how to use such knowledge of agricultural science as the world now possesses, but also to aid in increasing the common stock of knowledge. They should be originators as well as distributors of science. Can any one doubt, in view of the past history of science, that such a course would be of lasting benefit to agriculture? We need not seek for striking illustrations of the practical application of the discoveries of pure science to justify such an opinion, though such illustrations lie all about us, as, for example, the electric telegraph, the coal-tar colors, and Pasteur's method of inoculation for splenic fever, to mention no more. It is not in brilliant inventions or ingenious processes that the advancement of agricultural science is chiefly to be traced, but in the gradual separation of the false from the true, in a better understanding of the reasons of old methods, and the perception of how they should be modified to meet new conditions. In short, what science does for agriculture is not so much to transform the art or its processes, though it does much in that direction, as it is to educate the artisan. It does, indeed, put many new tools into his hand, but it also teaches him how to use old and new tools to the best advantage.

Our State and national governments have recognized the importance of agricultural education by founding the agricultural colleges, and in so doing they have done well; but, unless we are prepared to maintain that we know already all that we can or all that we need of the science of agriculture, the system needs, to complete it, such provision for increasing our knowledge in this direction as well-equipped experiment stations can furnish. Despite the great advances of agricultural science in the last thirty years, there is still a vast region to be explored; there are many errors to be corrected and partial views to be extended; and, unless the professors in our agricultural colleges have and impart to their students a sense of the extent of their ignorance and a thirst for more and fuller knowledge, their instruction will be largely fruitless. We must provide for teaching the teachers. As the colleges are now situated, it is in most cases practically impossible for the professors to undertake any extended experimental work. Agricultural experimentation, especially, demands both time and money, and usually no large amount of either is available for it. It is not a work that can be taken up at odd minutes, in the intervals of other occupations, with any hope of success. It must be followed as a business, and this it can be only in an institution maintained for this purpose—i. e., in an experiment station.

It would appear, then, that agricultural experiment stations are important agents in promoting the welfare of the agricultural classes, and through them that of the whole community. They may do this by repressing fraud or adulteration, and thus preventing pecuniary loss; or, by developing practical applications of scientific principles, and thus leading to pecuniary gain; or, last, but by no means least, by promoting the advancement of agricultural science and of sound agricultural education, and so contributing both to the physical and mental well-being of important classes in the community.

We emphasize this latter function of experiment stations, not with a desire to depreciate their other uses, which are highly important, but which are also sure of general appreciation, but because it is the one most likely to be overlooked, and because it seems to us the most important of all. Our experiment stations will doubtless continue to test fertilizers, seeds, etc., as they have done, and they will, in all likelihood, extend the scope and number of their field and feeding experiments. How far they will enter upon purely scientific work it is not so easy to foretell. Many, doubtless, will take it up to a small extent, if at all, finding their time and means fully occupied with other things. It must also depend largely on the public sentiment, particularly in the case of stations supported by the State, and it is perhaps questionable whether much but "practical" work can be expected from them. Private stations, of course, would be free from any limitations arising from lack of public appreciation, and, provided their means were adequate, might very appropriately devote themselves to the cultivation of agricultural science. It would seem, too, that agricultural colleges or even other institutions of learning, in view of their special interest in the educational aspect of the matter, might very properly establish stations for scientific investigations bearing on agriculture, as has been done by several German universities. Here, however, financial questions would, under present circumstances, be likely to prove a serious obstacle to such a project; but, whether practicable at present or not, the question of promoting agricultural science in this way is one worthy of thoughtful attention.

A no less important question than that of the kind of work a station should do is that of who shall conduct its work, and how the station should be organized. Local circumstances will, of course, decide the form which the business organization shall take; we are concerned here only with the conduct of the actual station-work. It may be remarked in passing, however, that it is eminently desirable to keep the station out of "politics," and free from the control of "rings," and to provide it with an assured income. This much settled, to what sort of a man shall we confide the direction of the station? This must evidently depend on what the station is to be. If its business is to be simply the analysis of fertilizers, etc., what is needed is a man with sufficient technical ability for the work, and whose character will command the confidence of all parties concerned. For anything beyond this, however, something more than an analyst is needed.

An impression prevails somewhat widely that because an agricultural experiment station is designed to advance agriculture, its director must be, first of all, a practical farmer. It is said, or intimated, that only such a one can be trusted to expend the State's money in a way really profitable to agricultural interests; and the same feeling finds expression in covert sneers at scientists as "doctrinaires," and "theorists," and "impractical." We maintain, on the contrary, that the prime requisite in the director of a good experiment station is thorough scientific training. It is not necessary that he possess the highest degree of talent for original research, but a training in the scientific methods of working and thinking is absolutely indispensable to lasting success. That this is true in case the station is to be devoted mainly to scientific research will probably be admitted at once, but it is equally true when the work to be done is making so-called "practical experiments." A truly scientifically conducted practical experiment differs from those practical experiments which thinking farmers are continually trying for themselves, not in being made on a larger scale, or with a more elaborate plan, or with greater accuracy in weighing and measuring—all these differences may exist, but they are differences of degree, not of kind—but in being so conducted that at its close it is possible to know *how far the results can be trusted.*

It is this characteristic, and this alone, which gives them their greater value, and justifies the expenditure of the public funds to make them. Farmers have been experimenting since Adam was expelled from Eden, yet scarcely a meeting of farmers occurs where the most diverse opinions are not maintained on the most familiar subjects. Our experiment stations should improve on this state of things. It is a comparatively simple matter to make experiments—as simple as playing Hamlet's pipe—but to so experiment as to obtain results that will stand is quite another matter. Experimenting is an art, and requires an apprenticeship no less than music. Now, all real scientific training —cramming we do not consider—is a training in the art of experimenting, and hence the statement, that the first qualification for the director of an experiment station is scientific training, is equivalent to saying that he must have learned his trade.

In the second place, the director of an experiment station must know what experiments to make as well as how to make them. He must be familiar with the needs of agriculture on the one hand, in order not to waste time in making needless experiments ; and he must know what other experimenters have done, that he may not needlessly repeat their work.

To sum up briefly, the director of an agricultural experiment station should be a trained scientist, who has made a special study of agricultural science, and who is reasonably familiar with agricultural practice. We have named these requirements in what we believe to be the order of their importance. A certain measure of all of them is indispensable, but deficiencies in the latter two may be more or less readily made up, while lack of the first is, in our view of the matter, fatal.

Many other points regarding the organization and management of experiment stations suggest themselves for consideration, but it is the purpose of this article simply to point out the general principles which should prevail in the founding of these stations, their organization, and the determination of their lines of work. In the decision of these questions public opinion is the most powerful factor, and if this paper shall contribute in any degree to the formation of liberal and enlightened views on a subject of growing importance, or even succeed in awakening more general interest in it, and directing inquiry toward it, its object will have been accomplished.

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

ASTHMA.

IT has been said that no doctrine can ever attain a large degree of popularity without containing some admixture of truth. The rare exceptions from that rule do not include that most preposterous of all medical theories, the "Brunonian System of Physics." John Brown, M. D., of Preston, Scotland, divided all disorders of the human organism into "sthenic" and "asthenic" diseases: the former produced by an excess of vitality, and to be counteracted by bleeding and cathartics; the latter arising from a defect of vital power, and to be cured by beefsteaks and brandy, etc. The grain of truth in the chaff-barrel of absolute nonsense is the pathological influence of *asthenia*, or a deficiency of vital power. Impaired vitality can not be restored by alcoholic stimulants, but its causal connection with a large number of functional disorders admits of no doubt. Every process of the animal organism derives the impulse of its normal performance from a reserve fund of vital energy and the depletion of this fund impairs the efficiency of the organic functions. A man may be too tired to sleep. A child may be too feeble to breathe, too weak to assimilate its food. Exhaustion alone may lead to that total suspension of the vital process which we call death.

But generally *asthenia* is only a proximate cause of disease. It reveals a pre-established morbid diathesis by affecting the weakest part of the organism, and its influence becomes thus localized. The affected part may become the center of attraction for a variety of asthenic agencies, for each successive attack increases the morbid diathesis, and thus, as it were, confirms the pathological precedent. This convergence of asthenic influences is most strikingly illustrated in the pathology of the asthmatic affections. Asthma, or chronic dyspnœa, a torpor of the semi-voluntary muscles which effect the process of respiration, has thus far not been traced to its original cause. Professor Reese ascribes it to a spasm of the muscular fibers inclosing the bronchial tubes; Dr. E. Bock defines it as a diminished elasticity of the pulmonary air-cells, caused by an undue dilation of the lungs (as in violent exercise). Villemin considers it as a purely nervous affection. In its most frequent form, however, it seems to be a legacy of arrested tuberculosis—an intermittent affection induced by a tendency to a pulmonary torpor that may remain latent for an indefinite time, but unmistakably connected with an asthenic proximate cause. Chronic asthma, in the strictest sense of the word, occurs only during the last stage of pulmonary consumption. When the lungs have been reduced to a certain degree, their utmost activity is insufficient to supply the needs of the organism, and the patient suffers the tortures of an irremediable air-famine. The automatic action of the lungs has to be supplemented by a desperate muscular effort, the motions of the contracted organ become spasmodic and wheezing, the sufferer is unable to breathe in an horizontal position, and after a short slumber awakens with a sense of suffocation. But a chronic disposition to all these symptoms in their extreme malignity may exist without a phthisical diathesis, and remain latent for weeks and years. The exciting cause generally operates without a moment's warning. During the laborious digestion of a heavy dinner, or even after a moderate meal, eaten on a sultry day, the process of respiration begins to alternate with inert pauses, relieved at first by an occasional yawn, by-and-by only by a violent gasp ; a feeling of uneasiness supervenes, the air-deficit becomes more and more perceptible, and the patient suddenly realizes that he is booked for a five days' struggle with a pulmonary torpor. Changes of temperature, a sudden thaw in midwinter, or a sultry day after a protracted rain, have a similar tendency, but the most frequent proximate cause is violent mental emotion—fear, anxiety, and especially suppressed anger. Nothing else so strikingly illustrates the intimate interaction of mental and physical conditions as this sudden pathological effect of a purely physical cause. In the same instant almost, when a fit of wrath—even in the form of a transient irritation —accelerates the throbbing of the heart, its reaction on the respiratory organs betrays itself by a spasmodic gasp, the patient instinctively clutches his ribs and tries to master the incipient mischief, but emotional asthma is a form of the disease that can rarely be nipped in the bud ; the *primum mobile* can not be revoked, and the sufferer may think himself lucky to get off with a result of twenty-four hours' misery. Excessive exercise—lifting weights, running, wrestling, etc.— is merely an adjuvant of the fore-named cause. With his mind at ease, an asthmatic may chop cord-wood on the warmest day in the year, carry corn-sacks, or run up-hill till his lungs are ready to burst with panting ; that panting will be entirely distinct from the ineffectual gasps of the air-famine. But, under the depressing influence of mental worry, an exhausting physical effort will bring on a fit of asthma as surely as heat and exercise would result in perspiration.

Among the rarer proximate causes are loss of blood, starvation, nervous exhaustion from mental overwork, sexual excesses, and sudden fright, or rather the *shudder* which sometimes follows the nervous shock produced by a real or imaginary danger, as a slip of the foot at the brink of a steep declivity, a snake-panic, the unexpected visit of a stranger, etc. *Nausea* in some of its forms may produce an analogous effect. "A young lady," says a correspondent of the London "Lancet," "was sitting at dinner, apparently in perfect health. She partook, among other things, of some rabbit, and in about ten minutes or so after she had eaten of it she was attacked with acute urticaria (nettle-rash), showing large erythematous patches and wheals very prominent on the face and neck. She then was seized with violent attacks of spasmodic asthma, which obliged her to leave the table. I inquired if she had ever suffered this before, and she informed me she had, after eating hare." *

Asthma is a warm-weather disease. The first frost mitigates its worst symptoms as surely as it would cure a fever or relieve insomnia, and "hay-asthma," often ascribed to the effect of some vegetable pollen, is probably a consequence of the relaxing influence of the first warm weather; for in midwinter, when the air is entirely free from vegetable spores, a single mild day, following upon a protracted frost, may produce symptoms exactly resembling those of a hay-catarrh. The complication of chronic bronchitis, sometimes described as bronchial asthma, should properly be called bronchial congestion, and differs from an asthmatic affection as a constipation differs from a gastric spasm. Asthma proper occurs under three forms: phthisical asthma (in the last stage of pulmonary consumption), chronic asthma, and acute spasmodic asthma. In the latter phase the disease recurs at longer intervals than in its chronic form, and limits its attacks to a few minutes or hours, but involves a greater amount of distress than any other disorder of the pulmonary organs—not excepting the pleuritic tortures of pneumonia. In pneumonia the difficulty of breathing consists in its painfulness; in asthma, in the *persistent torpor* of the respiratory organs. The patient feels as if the expansion apparatus of his chest were utterly paralyzed, the inhaled breath seems to come to the gate of the lungs and no farther; no gasping avails; the increasing distress of the air-hunger appears only to aggravate the stubbornness of the inert organ. The violence of the paroxysm often turns the color of the face into a livid purple, the throbbing of the heart becomes spasmodic, but, when the hopes of the sufferer are almost reduced to the supposed euthanasia of strangulation, the rigor suddenly relaxes, a deep gasp fills the lungs to their very bottom, and a few minutes after the breathing becomes quiet and regular, and only a cold perspiration reminds the patient that he has passed through the chill shadow of death.

As the primary cause of asthma is as yet unknown, its diathesis is not directly curable, though its latency may be prolonged by avoiding and counteracting the well-ascertained proximate causes. The mode of treatment varies with this twofold object: prevention and palliation—which frequently differ where we have to deal with spasmodic affections that call for the promptest means of relief. Thus 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 sea-sickness,

* Quoted in the St. Louis "Eclectic Medical Journal," June, 1883, p. 269.

though it diminishes the danger of future attacks. We have seen that a strenuous physical effort can under circumstances become the direct cause of an asthma-paroxysm, yet under proper precautions exercise is the best corrective of an asthmatic disposition ; for all vital vigor is based upon muscular strength. It would be a mistake to suppose that the invigoration of the lungs alone could be a protection against asthma. An asthmatic diathesis may coexist with a perfect freedom from the usual symptoms of weak lungs ; nay, chronic asthma seems to counteract the development of pulmonary phthisis. The asthmatic predisposition seems rather to consist in a general want of vital energy, and the object of the treatment should therefore be the invigoration of the whole system, not by means of "chest-expanders" alone, but by out-door life, pleasant exercise—such as gardening, hunting, or co-operative gymnastics—by a free use of cold water, and a liberal but non-stimulating diet. The latter proviso would exclude a large number of comestibles which the Brunonians would enumerate among the essentials of a "tonic regimen": The beef-and-beer cure deals in sham-remedies. We are not nourished by what we eat, but by what we digest. Plethora is not strength, but often its very opposite : the accumulation of expletive fat impairs the disease-resisting power of the organism ; a gaunt wood-cutter, a wiry peddler or mail-rider, will survive epidemics that slaughter hecatombs of stall-fed burghers. The modern macrobiots, the long-lived inhabitants of the Ionian Archipelago, subsist on figs, goat-milk, and maize-bread ; the herculean natives of the eastern Caucasus live on honey, barley-cakes, and poor cheese. The self-made Samson of modern times, Dr. Winship, of Boston, satisfied his craving for animal food with an occasional box of oiled sardines, and, on a diet of fruit and farinaceous dishes, spiced with daily gymnastics, made his body a complex of superhuman muscles and sinews. A constitution, built up after that pattern, might not secure the possessor against heart-disease, nor—if he confined himself to in-door gymnastics—against consumption, but it would insure him against asthma. In ninety-nine out of a hundred cases, an asthmatic disposition is combined with a deficient muscular development.

The pathological peculiarities of the disease make it safest to begin the movement-cure in midwinter, and suspend it during premature spring weather, and again during the moist, hot weeks of early summer —*June* being, *par excellence*, the asthma-month of the year. I knew people who could foretell the very week when they had to get their "asthma-weeds" ready. By a permanent suspension of his exercises an hygienic gymnast would gradually lose the gained vantage-ground, but during a few days' pause the unemployed surplus of vital energy is put at the disposition of the organism. Such pauses, therefore, become advisable whenever the premonitory symptoms of the disease indicate the agency of asthenic influences, and for greater security also after every annoying mental emotion. The occasions for such annoyances should, however, be carefully avoided, even at the risk of incurring the penalties of social non-conformity. An asthmatic old Antwerp merchant of my acquaintance used to retire to his *gardenhuys*, a little summer-house at the farthest end of his garden, whenever his feelings became unduly excited, and also after dinner, as he had noticed that an interruption of his *siesta* was apt to react on his lungs. One afternoon, however, he had a visit from a commercial associate who had threatened to break the partnership, but now came to lubricate matters and tender a very acceptable peace-offering. At his return from the interview Mynheer made no attempt to conceal his glee, but suddenly became thoughtful and monosyllabic. "What's the matter?" asked his broker, "are you afraid it's a trap?"—"No, no," said he, "N—— is all right, but"—with a sigh—"d—n him, anyhow; it will cost me a week's tussle with old Nick." "With the asthma? What!—the mere excitement?"—"Yes," he groaned, "the talk, the miserable formalities, and the tight necktie—and right after dinner!"

Any waste of vital power may bring on a fit of spasmodic asthma, and the aggravating effect of *incontinence* is so prompt and so unmistakable that experience generally suffices to correct a *penchant* to errors in that respect. Like gout, asthma is a moral censor, but its reproofs do not so often come too late. With an ordinary amount of will-force, even persons of an inherited tendency to asthma may manage for years to keep its worst symptoms in abeyance.

Among the palliatives of spasmodic asthma COLD WATER ranks first. A plunge-bath into a pond (or tub) of water, of a sufficiently low temperature to produce a gasp and a shiver, rarely fails to break the spell of the suffocating stricture. It is the most reliable remedy, for, unlike chemical antispasmodics, it acts irrespective of precedents—its efficiency does not decrease with each subsequent application. After the second or third time, "asthma-weeds" have to be used in almost lethal doses before they produce any appreciable effect, though their disagreeable *after-effects* are perceptible enough. For these weeds are generally strong narcotic poisons. *Tabac de Chine*, or "Chinese tobacco," is a mixture of tobacco-leaves and inspissated opium. Stramonium (*Datura ferox*) is as virulent as belladonna, and the smoking of the leaves produces vertigo, heart-spasms, and violent headaches. It does relieve asthma, on the principle that diseases yield to more serious diseases. Thus the languor of dyspepsia can be temporarily relieved by alcoholic stimulants, but the dose has to be steadily increased, till the remedy becomes worse than the original evil. Such household remedies as black coffee (swallowed by the quart) or sulphur-and-vinegar fumes are liable to the same objection. They help once or twice, and afterward only in monster doses. *Coffee-poisoning*, which old *habitués* avoid by a very gradual increase of the dose, is a frequent sequel of an asthma-cure by domestic narcotics. The mediæval physicians, with their *penchant* for heroic remedies, cured asthma with actual cautery—the application of a hot iron to the ribs of their patients, who naturally preferred the risk of suffocation: Dr. Zimmermann ascertained that the mere proposition of the hellish corrective made the delinquent gasp in a way that relieved the stricture. But the agreeable disappointment probably impaired the efficiency of subsequent threats; and the chill of a cold plunge-bath never fails to produce a contraction of the diaphragm that serves the same purpose.

After the first strangling-spell has been relieved, a very simple mechanical contrivance will help to restore the regularity of the respiration: "Take a straight stick, about six feet long and one inch in diameter, and mark it from end to end with deep notches, at regular intervals, say two inches apart, with smaller subdivisions, as on the beam of a lever-balance. Then get a ten-pound lump of pig-iron, or a large stone, and gird it with a piece of stout wire, so as to let one end of the wire project in the form of a hook. The exercise consists in grasping the stick at one end, stretching out arm and stick horizontally like a rapier at a home-thrust; then draw your arm back, and (still keeping the stick rigidly horizontal) make your hand touch your chin, thrust it out again, draw back, and so on, till the forearm moves rapidly on a steady fulcrum. Next, *load* the stick—i. e., hook the stone to one of the notches, and try to move your arm as before. It will be hard work now to keep the stick horizontal; even a strong man will find that the effort reacts powerfully on his lungs: he will puff as if the respiratory engine were working under high pressure. On the same principle, the lungs of a half-drowned man may be set awork by moving the arms up and down, like pump-handles. But the weighted stick, bearing against the sinews of the forearm, still increases this effect, and overcomes the stricture of the asthmatic spasm, as the movement of the loose arms relieves the torpor of the drowning-asphyxia" ("Physical Education," p. 137).

But a lethargic feeling about the chest still remains behind: the spasm has ceased to obstruct the entrance of the air, but breathing has still to be effected by an effort of the voluntary muscles, as if the lungs were yet too weak to perform their proper work. After an attack of spasmodic asthma this lethargy may continue for twenty-four hours; in chronic asthma, where it constitutes the chief symptom of the complaint, it may last for a week or two. Next to out-door exercise, the best corrective is *conversation*, *laughing*, and *singing*—any continued vocal effort seems to overcome the passive resistance of the torpid organ. Many physicians must have noticed that a large proportion of their asthma-patients are persons of solitary habits. Laughter is a peptic stimulant, while silence and brown studies favor dyspepsia, asthma, and sleeplessness. Bed-ridden garret-dwellers can at least talk to themselves; and, with the aid of a pet squirrel or a copy of the "Asthma-Cure Almanac," may manage to organize an occasional private laugh. Wealthy bachelors should at once pack a valise, and (as the period of their martyrdom will generally coincide with the excursion-season) take a steamboat-ticket to some popular picnic grove, and associate with the noisiest and merriest of their traveling-companions. Mirth itself has a stimulating effect. Sorrow deadens the energy of the vital powers, for Nature is too economical to prolong a losing game, and, if the burdens of life begin to outweigh its pleasures, the organic apparatus gravitates toward a suspension of its functions. The mainspring has lost its tension. But, if life becomes visibly worth living, the soul procures a new lease of vital power; every organ seems to work with a will, and asthenia disappears without the aid of Dr. Brown's brandy-bottles. "Being happy," says Ludwig Boerne, "is a talent that can be cultivated"—certainly a talent of great hygienic value; the gift of confining the flow of ideas to a pleasant channel, of wearing roseate spectacles as others would wear an electric belt, of enjoying life by a sheer effort of will-force, may be a faculty that can only be exercised during a limited period, but that period suffices for the cure of various distressing complaints, insomnia, for instance, and many symptoms of chronic dyspepsia, but especially chronic asthma. Asthma does not prevent longevity; there are people who have smoked stramonium-leaves for half a century, and, if they had chronicled their experience, they would find that in the dullest years they had to light the greatest number of pipes. A piece of good news is worth bushels of asthma-weeds; buoyant spirits seem to react directly on the stringency of the bronchial tubes, and the relief thus obtained is not apt to be followed by a relapse.

There is also a curious correlation between asthma and *close stools*. They come and go together. Any thorough and permanent aperient serves at the same time as an asthma-cure. Drastic purges act only for a day or two, and then leave the bowels in a worse condition than before. The cathartic effect of Glauber's-salt, for instance, is almost invariably followed by an astringent reaction. For a permanent relief of costiveness a change of diet is the safest plan, and no dietetic aperient of the Graham school can compare with the three legumina—beans, lentils, and peas. Stewed prunes rank next, and next such household remedies as blackberry-soup, clabber and rye-bread, or molasses with warm water. But the aperient effect of molasses decreases after each repetition of the dose, while stewed peas taken like medicine, three times a day, will prevail where Glauber's-salt fails. As an asthma-cure it can do no harm to apply the remedy beyond the alimentary wants of the system, temporary overeating being a lesser evil than continual under-breathing. At the end of the second or third day the bowels will yield, and the simultaneous improvement of the asthma-symptoms is generally permanent.*

* Hospital statistics have revealed the fact that the inhabitants of the beer-drinking countries of Southern Germany enjoy a remarkable immunity from asthmatic affections,

In exceptionally malignant cases it may be necessary to supplement the legumen-cure by refrigeration—sponge-baths, or artificially cooled bedrooms ; and while there is any danger of a relapse it is the safest plan to postpone the bed-hour beyond the usual time. After rolling and tossing about till relieved by that form of sleep which the Germans call "Ein-dämmern"—the twilight state between sleeping and waking—the patient is almost sure to start up with a feeling of strangulation, but the slumber induced by the silence and drowsiness of the small hours is not apt to be thus interrupted. Leaving the club-house at 11 P. M., or the family circle at 10 ; then a few hours with an interesting book, reserved for that special purpose ; perhaps a little midnight lunch (but no coffee, unless habit has palliated its anti-hypnotic effect) ; then a somnolent old story-book ; an easy-chair within reach of a boot-jack, ready to take advantage of the first drowsy spell—for those spells come and go—and a well-timed attempt will secure immediate success, with large odds in favor of a good night's rest.

An horizontal position aggravates dyspnœa, and with a few extra pillows, or by simply raising the head of the bedstead, the patient can sleep in a *half-sitting posture*, and should still further assist nature by opening the bedroom-windows, or removing his bed to the airiest place in the house. After a heavy supper, an unventilated dormitory alone can lethargize the lungs to a suffocating degree, for a nightmare is mostly nothing but a transient fit of asthma.

Fresh air, combined with a *lung-stimulating exercise*, is the last resort in an obstinate case of chronic asthma, and a foot-journey in summer adds to those stimulants the too often underrated nerve-tonic of *sunlight*. Maurus Nagy, the Hungarian *Natur-Doctor*, used to cure his asthma-patients by making them strip to the waist, and keeping them at work in his mountain-vineyard. The ancient Romans had establishments for regular sun-baths (*solaria*) ; and I can not help thinking that the robust health of their country population had much to do with their habit of working bareheaded and bare-shouldered in

while both among the North-German schnapps-drinkers and the abstemious natives of Southern France the complaint is almost as frequent as consumption. In explanation of the paradox some German doctors have alleged the "diffusion of the tonic effect," secured by the large quantity of the Bavarian stimulant ; others, the demulcent influence of malt-liquors. The key of the enigma, I suspect, is the peptic influence of a liberal diluent. Our greasy, pungent, and concentrated diet needs a larger admixture of fluids. The dread of cold water, and of water-drinking during meals, is a consequence of the sadly-prevalent delusion that suspects the competency of our natural instincts. The food of our arboreal relatives contains at least eighty per cent of pure water ; the diet of the grape-cure patients about ninety-five per cent. Instinct is a pretty safe guide in such matters, and, unless the habitual indulgence in distilled liquors has made water distasteful, the stomach craves about a pint of fluids for each pound of solid food. Fresh water is healthier than beer, but even in the form of lager-beer an abundant diluent would relieve the symptoms of gastric distress resulting from a daily struggle with an overdose of undiluted viands.

the sunlit fields, imbibing vitality at the fountain-head, for the same sun that evolved the fern-forests of the Miocene alluvium has still means of his own for quickening the vital energy of the most complex organisms. That tonic catholicon operates even through the triple teguments of a French uniform. After the tedium of a long voyage, and the delay in the Vera Cruz harbor-barracks, the French troops in Mexico suffered from a form of asthma that resisted all medication, but a six days' march through the hills of the *tierra templada* brought permanent relief, except to a few invalids who had been transported in closed ambulances. At first, though, the remedy is apt to aggravate the evil. After a couple of sleepless nights, the first day of a pedestrian tour, even through the paradise of a June landscape, is steep, uphill work, but, with the aid of a merry traveling-companion and a light knapsack, Nature will at last prevail, and three days' hardship is a cheap price for the remission of a three weeks' daily and nightly martyrdom—besides the possible sequelæ. For the chief danger of chronic asthma is the probability of serious pathological complications. The direct result of *dyspnœa* is the impoverishment of the blood by an impeded process of aeration, and the concomitants of the disease are therefore analogous to those of pulmonary phthisis and protracted in-door life—hypertrophy of the heart, emphysema, or swelling of the lungs, inflammation of the bronchi, dropsical swellings of the extremities. Even short attacks often lead to malignant after-effects—insomnia, indigestion, headache, and a peculiar affection of the lungs that closely simulates the premonitory symptoms of pneumonia; after the asthma proper has entirely subsided, a new difficulty of breathing supervenes in the form of twitching pains in the pleura and the upper lobes of the lungs. Before the end of the second day, rest, embrocations with hot mutton-tallow, and a spare diet, generally relieve these symptoms, which follow more frequently after a drug-suppressed case of asthma than after the pedestrian-cure. The latter method of treatment is intuitively indicated by the *restlessness* of asthma-patients. The same hygienic instinct which makes a passionate longing for refrigeration a regular symptom of climatic fevers seems here to prompt peripatetic enterprises by associating in-door life with the idea of apoplexy and suffocation.

Like consumption, asthma is a house-disease. Want of fresh air and exercise will counteract all prophylactics, while the out-door liver can confine his precautions to the beginning of the warm season. A frugal diet, both as an hygienic aperient and a sedative of irate passions, will help the patient over the asthma-weeks (May and June in the north, and April and May in the lower latitudes); an airy bedroom and cold baths, over the summer season. The winter months will take care of themselves, and every year thus passed diminishes the danger of relapse.

FIRE-PROOF BUILDING CONSTRUCTION.*

BY WILLIAM E. WARD.

IF society is indebted to the restless spirit of progress for most of its modern comforts and conveniences, it certainly is not yet a debtor for any methods which guarantee immunity against calamities from fire. While other departments of industry have received the benefits of improvement, the persistent use of combustible material for exposed portions of buildings has limited the intrinsic elements of the art of building construction, and confined improvements only to matters of design.

Incombustible materials are easily obtained, and, for every apparent reason, much better adapted to the purpose. Doubtless, the question of increased cost, both in money and in time required for more thorough construction, may be in a measure responsible for the tardiness in adopting safer methods; and, in addition to greater expenditure, there may have been a want of confidence in the fire-proof methods which have been offered to the public for adoption. The importance of this question induced the writer, in 1871–'72, to make some experiments in a new and special direction, for the purpose of ascertaining whether a practically fire-proof building could be designed and constructed at a comparatively moderate cost.

The incident which led the writer to the invention of iron with *béton* occurred in England in 1867, when his attention was called to the difficulties of some laborers on a quay, trying to remove cement from their tools. The adhesion of the cement to the iron was so firm that the cleavage generally appeared in the cement rather than between the cement and the iron.

The experiments which followed were confined exclusively to working up the reciprocal value of béton, in combination with iron, in the construction of beams which were designed for supporting floors and roofs made of the same material. In this particular the facts were conclusively developed that the utility of both iron and béton could be greatly increased for building purposes, through a properly adjusted combination of their special physical qualities, and very much greater efficiency be reached through their association than could possibly be realized by the exclusive use of either material, separately, in the same or in equal quantity.

Experience had long ago proved that unprotected iron, associated with combustible materials, is altogether unreliable for building purposes when exposed to a severe fire-test; but it has been demonstrated,

* Read at the meeting of the American Society of Mechanical Engineers, held in Cleveland, Ohio, June, 1883.

that, if iron is well protected by a heavy clothing of béton, its integrity can be safely depended upon in almost any emergency.

When all doubts concerning the reliability of the several combinations of materials required in the construction were removed, a building, embracing the following radical new features, was erected, for dwelling purposes, near Port Chester, New York: Not only the external and internal walls, cornices, and towers of the building were constructed of béton, but all of the beams, floors, and roofs were made exclusively of béton, re-enforced with light iron beams and rods.

Furthermore, all the closets, stairs, balconies, and porticoes, with their supporting columns, were molded from the same material; the only wood in the whole structure being window-sashes and doors, with their frames, mop-boards, and the stair-rails, thus excluding everything of a combustible nature from the main construction.

Béton can be used in any form of construction, and will serve the requirements of any architectural or decorative effects. All the exterior portions of this house, which are more or less ornamental in their functions, were made of béton in place during the progress of the work. In the interior of the house, the cornices, stiles, and panels of the ceilings are formed of béton, and covered with the hard finish usual in such work. There appears to be no limit to the reproduction in béton of any form used in stone masonry or in stucco. The proportions of material composing the béton for the work varied in strength to meet the requirements of the different parts of the structure: the heavy walls needing the least proportion of cement, while the beams, floors, and roofs required a much larger proportion. Only the best quality of Portland cement, clean beach-sand, and crushed blue-stone, were used in combination with iron for constructing the building.

The proportions used for the heavy wall-work were one part of cement to four parts of sand and fine gravel, thoroughly mixed dry, and dampened with only sufficient water to give it the consistency of well-tempered molding sand.

A finely crushed and screened, hard, blue limestone was found to be better adapted for use in combination with the béton than a coarse-sized stone filling, because small-sized stones pack closer than large ones, thereby realizing a proportional saving in cement. The tests made to ascertain the comparative transverse strength of different compositions proved that the bond was stronger in béton made with small stone. In breaking test-sections made of béton in the form of bricks, the fracture of those filled with small stone was almost invariably across the stone lying in the line of fracture, while the fracture of the test-bricks made with a filling of stone three or four times larger showed a frequent tearing away from the bond between the béton and the larger stone filling, the composition of the béton being the same in both cases.

The proportions of cement and coarse beach-sand and gravel, used in re-enforcing iron beams for floors and roof-supports, were one part of cement to two parts of sand and gravel. The size of the iron beam, selected for an experimental test, was a four-inch I-beam of lightest pattern, twelve feet long, weighing thirty pounds to the yard, and its safety load was limited to eleven hundred and fifty pounds. A plank mold was made the length of the iron beam, twelve inches deep by five inches wide, in the bottom of which a layer of béton was first moderately tamped down to an inch in thickness; then the iron beam was laid on the course at equal distances from each side of the mold, and settled down on the surface of the course of béton to a good bearing. This brought the top surface of the beam seven inches below the top of the mold. The work of filling and tamping the courses was then continued until the mold was filled.

The reason for placing the iron beam so near the bottom of the mold was to utilize its tensile quality for resisting the strain below the neutral axis when this composite beam was exposed to heavy loads, while the béton above this line was relied on for resisting compression from load-strain. The béton became thoroughly hardened in about thirty days, when the following tests of transverse strength were made: It was placed upon suitable supports, with a bearing of three inches at each end. A lever was adjusted so as to bring the testing-load on a knife-edge bearing at the center of the beam. Weight was then applied to the long end of the lever, until the stress on the center of the beam reached nine thousand five hundred pounds. Under this load there was a deflection at the center of the beam of seven sixteenths of an inch, but not a sign of rupture appeared at any point.

The load was then removed, and the beam returned to the original line it occupied before the test, showing that the combination possesses the essential quality of elasticity in addition to the enormous increase of capacity to resist strain over that which was possible for either material to sustain if used separately, and in the same quantity.

It is suggested that for future construction an inverted ⊥-beam would furnish a more preferable distribution of iron in the composite beams than the I-beams which were used.

The result of this experiment demonstrated the reliability of the composite beam of iron and béton, and showed that the adhesion of the cement to the iron could be depended on under heavy strains. This warranted the adoption of béton, re-enforced with small rods, for the floors and roofs.

The beams for supporting the floors throughout the house were placed at such convenient distances apart as to insure perfect safety to the floors, and at the same time afford ample opportunities for producing the best effects in deep, paneled ceilings.

All the beams were molded in the positions where they belonged, both for the floors and roofs, and by the same method as the experimental beam above described. The iron beams varied in width and weight per yard in accordance with their length and the prospective load, the largest being nineteen feet long by seven inches wide. When the combination beams were completed and ready for the floors and roofs, heavy planks were firmly placed in position and securely supported between the beams, the upper surface of these plank foundations being adjusted on a level with the top surface of the molded beams. These planks served as the bottom of the floor-molds, and, after the béton forming the floor was hardened, they were removed.

Channel-ways had been molded in the walls, on a line with the top of the beams, for the purpose of supporting the outer edges of the floors.

Before the floors and roofs were laid, care was taken to cover all the supporting surfaces with paper, to prevent the adhesion of floor and roof sections to their supports. This precaution was necessary, to permit the movement of the floors and roofs that would unavoidably take place under varying temperatures and loads.

A part of the experimental system contemplated an attempt to warm the house by passing currents of heated air between the floors and ceilings, and up through flues, made in close proximity to each other, for that purpose, in the interior walls of the building; and it was necessary to core out a liberal area of lateral openings through the upper portion of the beams, in order to permit a free circulation of heated air. The ceilings rested upon flanges projecting from the lower portion of the beams, as shown in Fig. 1.

Instead of using sand and gravel, or both, in combination with cement, for floor and roof construction, the preliminary experiments that proved the superior value of broken blue-stone for massive work, led to the adoption of washed, fine screenings from the same material for the floors and roofs, because its greater angularity insured a stronger bond in the work than could be realized by using sand and gravel.

The proportions of materials used for this purpose were, one part of Portland cement to two parts of the fine stone screenings. The preparations being completed for laying down the floors, a thin course of the béton was first put on, and evenly tamped down, to about an inch in thickness, over the whole space intended to be covered. Then rods of iron, five sixteenths of an inch in diameter, were placed both longitudinally and laterally, at a uniform distance of eight inches apart, over the whole surface. Then, on this, a final layer of two inches in thickness was carefully tamped down. In about eight hours, the béton was hardened sufficiently to allow the application of the top surface, which was floated down with a half-inch coat of cement and fine beach-sand mortar, made of equal parts of each. This completed the finish, and made the whole thickness of the work three and a half inches. It will be observed that for the same reason as in beam construction, and as before explained, the iron rods for re-enforcing were placed near the bottom of the work, so as to resist the tensional stresses due to the load, while that due to compression in the upper

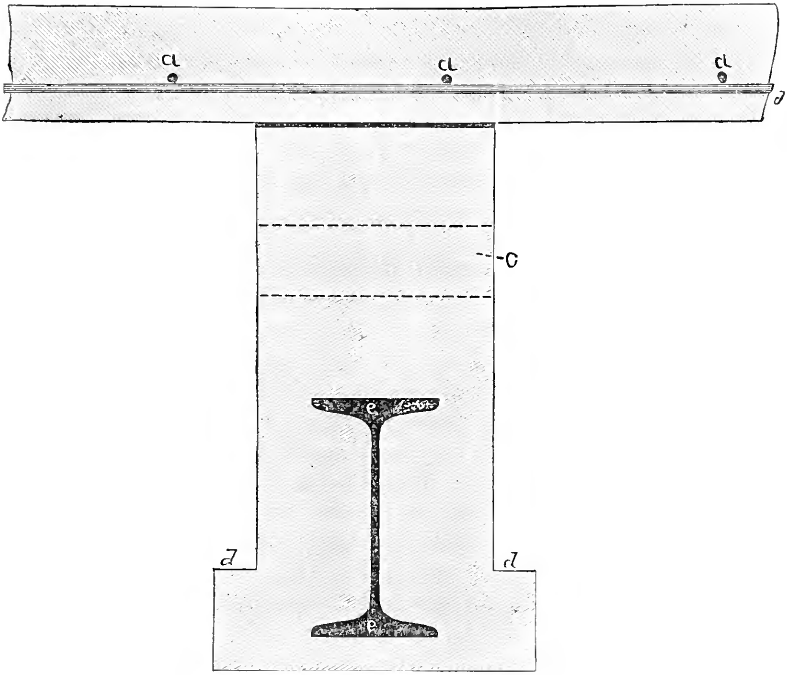

FIG. 1 REPRESENTS A RE-ENFORCED BEAM OF BÉTON SUPPORTING A SECTION OF THE FLOOR: *a a a*, $\frac{5}{16}$-inch iron rods; *b*, same sized rods running at right angles with *a a a*; *c*, lateral openings through the beams for the circulation of heated air; *d d*, flanges supporting ceilings; *e e*, re-enforcing beam of wrought-iron.

portion would be sustained by the béton alone. In this manner, and by this process, over thirteen thousand square feet of flooring and roofing were constructed in the building.

The only test of any consequence upon the combined strength of the floors and beams together was made on a section of the widest floor in the house, where the beams are eighteen feet span and six feet between centers. Casks of plaster were placed upon the floor over the beam, forming a triangular load of thirty tons, which was sustained without any injury to the floor, or measurable permanent deflection. The dimensions of the beam that sustained this load were, seven by sixteen inches, and eighteen feet span, re-enforced in its lower portion with a seven-inch I-beam, weighing fifty-five pounds to the yard.

This test indicates that in addition to its admitted fire-resisting qualities, the re-enforced system of construction challenges comparison with other methods of building in matters of strength and of cost, whether for buildings requiring long or short floor-spans.

Experimental tests were made with several partition walls, to ascertain how thin it would be advisable to construct them where the load was small. The result of the experiments showed that the resistance of partitions eight feet in height made of béton two and a half inches thick, and re-enforced with one-quarter-inch iron rods, was equal to brick walls eight feet high, and eight inches in thickness.

It is the opinion of the writer that for the great majority of houses required for dwelling purposes, a system of thin re-enforced double walls, with a space of from six to ten inches between them, and re-enforced cross-connections every two or three feet apart, to unite the outer and inner walls firmly together, could be built up to thirty or forty feet in height, at a cost not exceeding that of first-class brick-work.

Besides an equal economy in the construction, such double walls would be an incomparably better defense against stormy weather than the best quality of brick-work, because the absorptive capacity of béton is so much less than that of brick.

Thus, all things considered, the thin double-wall system commends itself as embodying the desirable qualities, essential to the outer and inner wall construction of dwelling-houses, furnishing as it would a sure protection against both fire and dampness, and the means for thorough ventilation. Besides the special fitness of the re-enforcing system for floors, roofs, beams, and thin walls, it is an interesting question whether the same system may not be also applicable, and advantageously extended, to a more general use in many engineering requirements—especially in situations where immense weights must be sustained, and where iron construction alone is difficult of application; notably in such an important work as the Hudson River Tunnel, where its tubular form is constructed with an outer cylindrical shell of flue-iron, and lined inside with heavy brick mason-work. Much of this tunnel rests upon a treacherous bed of silt, and might be made absolutely safe from rupture by settling, induced by vibrations resulting from railroad traffic in addition to its own weight, by adding to a thin brick lining a strong béton sixteen or eighteen inches thick, which should include three or four courses of iron bars, of suitable size, laid longitudinally and in sufficient number to bear any amount of strain that might be brought upon it. Rings of flat bar-iron, interspersed in the béton-lining a few feet apart, would further add to its security.

The re-enforced béton system has also been employed with admirable results, in heavy foundations, for stationary engines. The writer, three years ago, mounted a two-hundred-and-fifty-horse-power, tandem, compound engine, of very heavy pattern, on a re-enforced béton-bed, twenty-three feet long, five feet wide, and seven feet deep. It is apparently as firm and hard as a single mass of granite of those dimensions. The outboard bearing of the main shaft is also mounted on a single block of the same construction. The cost of these foundations was less than the estimate made for the same in first-class brick or stone mason-work.

It has also been used for lining a reservoir of ninety-six thousand gallons capacity, which was blasted into a ledge.

Another great advantage realized in re-enforcing béton with iron, is that the iron overcomes its tendency to check in hardening, within useful limits, however large the surface may be, if the distribution of the iron through the work is made with ordinary good judgment. This is demonstrated in the instance of entire freedom from shrinkage checks in the single section of béton-flooring laid in the drawing-room of the house. Its dimensions are eighteen by thirty-six feet, three and a half inches thick, and after a period of eight years, during six of which it has, in winter, been more or less subjected to unequal strains from the expansion and contraction, caused by changing temperatures, while employed as a transmitting medium of heat for warming the room, there is no trace of a check throughout its whole extent.

The method of heating the house is shown in Fig. 2, where the section exhibits the arrangement of hot-room and heating-flues in the walls and floors.

In the center of the cellar is a heating-chamber, measuring eleven by sixteen feet, and eight feet in height. Within this chamber is placed an ordinary cast-iron heater, of a capacity for burning about three hundred and fifty pounds of coal per day. Openings were made, about twelve inches apart, all around the top of the surrounding walls of the chamber, leading outwardly to the spaces between the first floors and the cellar-ceilings, and also up through the flues within the interior walls, which communicate with the spaces between the second-story floors and ceilings beneath them. Vertical iron pipes, of suitable size, are located so as to connect the open spaces between the cellar-ceilings and first floor with a large, closed trunk, or passage-way, which extends nearly all around the inside of the main wall foundation, under the cellar-floor, and finally terminates in a large flue, which leads directly under and into the heating-chamber.

This comprises about the whole system of arrangements in the construction for warming the house with heat radiated from the floors and interior walls.

Its mode of operation simply consists in the body of warmed air passing from the heating-chamber upward, through the walls and under the floors, and in its passage giving up its surplus heat to the surfaces of these flues. As the air becomes reduced in temperature, it naturally descends through the pipe and trunk passage-ways provided for its return to the heating-chamber, where it is again recharged with heat. It will readily be seen that, by this method, a continuous circulation will be maintained with the same quantity of air ; and furthermore, that the velocity of the current will vary with the difference of temperature of the air when leaving the heating-chamber and when re-entering the heating-chamber.

By this system there are about fifty-five thousand cubic feet of the interior of the house heated by radiation, through about thirty-

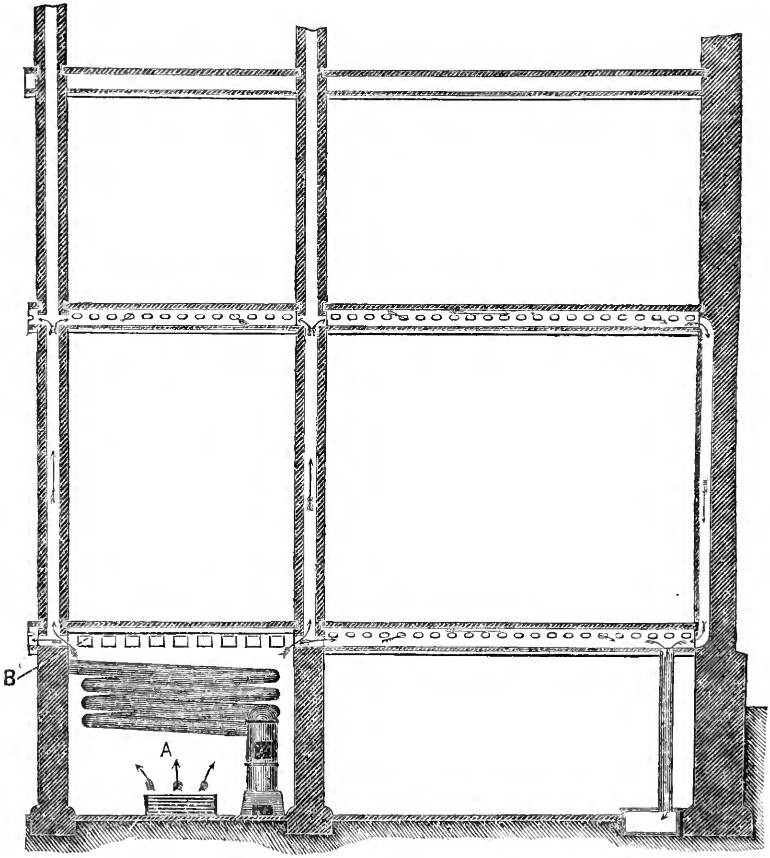

Fig. 2.—Section of House, showing the Method of Heating: A, heating-chamber; B, openings in heating-chamber communicating with flues in the interior walls leading to spaces under the floors. The arrows show the direction taken by the current of air.

five hundred square feet of floor and wall surfaces, and the capacity of the heating-chamber is fourteen hundred cubic feet, so there is one cubic foot of heated air to forty cubic feet in the house.

The temperature of the air in the heating-chamber averages, in very cold weather, 170°, and after delivering its surplus heat to the floors and interior walls, its temperature registers 58° in the flue where it re-enters the heating-chamber for reheating, showing that 112° of heat had been given up and utilized for warming purposes. With ordinary care in managing the furnace, a temperature of 68° can be uniformly maintained on the first floor, and from 60° to 62°

on the second floor, with a consumption of about three hundred and twenty-five pounds of anthracite coal per day in the furnace.

The temperature produced by this system of heating is free from the objectionable variations so common with other modes of heating. The walls and floor form such large heating surfaces that the temperature is uniform in all portions of the rooms, while the air is not vitiated by escaping gases or heated dust, as is universally the case where furnaces or steam-pipes are used for heating.

It is not asserted that its economic results per pound of coal are greater than those claimed for the steam or hot-water systems, but, if the latter were required to make as liberal provision for the renewal of fresh air in the interest of an equally good ventilation, the percentage of useful results per pound of coal from steam or hot water would average no higher than by this method.

The rain-water falling upon the roof passes through two six-inch iron pipes, which are set in the walls, extend across the cellar, and connect with a béton tank in the rear tower, holding five thousand gallons, whose water-level is thirty inches below the level of the roof. This inverted siphon also forms a distributing system to the various points of consumption in the house, through short branch pipes connected with these mains.

There are also two other tanks made of béton, and holding three thousand gallons, situated under the main tank: one of these sustains a head of over twenty feet of water, and has never given any indications of leakage.

In regard to the important factor of cost involved in this system of béton construction, its average for beams, floors, and roofs, including the supporting platforms for laying them down, was a fraction over sixty cents per square foot. This cost also includes the re-enforcing iron beams and rods. The cost of the heavy wall-work, not including cornices, was about twenty-four cents per cubic foot, which includes the cost of plank molds, required for building up the walls. The advantages that contributed most to these economical results were cheap material and cheap labor.

The bulk of the material required for the work abounds in inexhaustible quantities, and is always obtainable at moderate cost. The skill needed consists in a simple knowledge of the right proportions of material, and of its proper manipulation, which can be obtained in a half-day's practice. The most inexperienced laborers can do all the work of the most elaborate béton construction, excepting only the surface-finishing, and this, with all the other work, can be superintended by one competent, experienced builder.

Along with the foregoing data, it may be well to include an account of some experiments that were made to test the heat-enduring qualities of béton. A number of large test-bricks were made of the same proportion of materials used in the construction of the walls, and, in subjecting them to heat of different intensities to see how much they could withstand before breaking up, there was no perceptible difference observed in the tendency to fracture, whether the bricks were exposed to a gradual or rapid heating. Not one of them broke when subjected to a white heat. Several were heated to a bright-red heat, and then plunged into a bath of cold water. They withstood this test without showing a decidedly damaging fracture, and one of the bricks was exposed to an alternate heating and cooling three times before breaking up.

These results were a surprise, and they suggest the advantage of using such a material for the walls of buildings, as a sure defense against uncontrollable conflagrations. The facts that appear to be established by the line of experiments are:

1. That a system of iron beams re-enforced with béton can be made to sustain weights many times greater than the iron beams alone can bear without re-enforcing.

2. That floors and roofs can be economically made of béton re-enforced with iron rods, capable of sustaining heavier loads, with a less number of supporting beams, than any other system of flooring and roofing, of equal cost, now in use.

3. That the system of re-enforced beams and béton floors affords advantages for a more perfect method of heating buildings uniformly than by the steam or hot-water system.

4. That the sanitary requirements of complete ventilation are plainly within the reach of this system of construction.

5. That it affords a perfect defense against the interior destruction of buildings by fire.

The intrinsic worth of béton construction appears most valuable in furnishing the elements of fire-proof construction, and thus inaugurating a reform in the prevailing system of building based on the principle that safety can be more economically realized through reformation than by exclusive dependence on insurance indemnities for losses by fire. The amount of capital destroyed by fire appears almost fabulous, and has been estimated by insurance authorities to be over one hundred million dollars annually in this country. This enormous estimate takes no cognizance of the losses due to the disturbance of business relations and labor by such enforced interruptions of industry, but the sum of the losses accounted for seems to be enough to awaken an interest in the discovery of some effective remedy for reducing them.

Yet, if the remedy is only to be found in building more thoroughly, its adoption may remain doubtful so long as the hazardous method of building, and the rates for insuring hazardous property, occupy their present relations to each other. Such radical departures from conservative ideas of building as are herein described must necessarily find a slow recognition.

However destructive to the material wealth of the country may be the vast losses of property by fire, they sink completely out of view when compared with the terrible sacrifices of human life that are constantly resulting from unsafe building construction. Against these fearful consequences, humanity can reasonably protest, and claim, for the sake of human welfare, that such structures as hotels, theatres, public schools, and all other places of public resort, shall be made invulnerable to fire.

The writer has heretofore declined to make any public statement concerning the experiments herein described, for the reason that he considered that they ought to undergo thoroughly satisfactory tests of severe weather exposures, and varying temperatures, through a period of time long enough to determine their true and relative value.

In conclusion, it is to be hoped that these experiments may shed enough additional light on the fire-proof building question to make the way easy for reducing re-enforced béton construction to a system, that will deserve public confidence, and ultimately find general adoption.

WAYS OF PRESERVING FOOD.

By Dr. HERMANN KRÄTZER.

THE protein constituents of our animal and vegetable foods, such as albumen, etc., render them in a high degree sensitive to external influences and easily susceptible to decay. For this reason attention has for a considerable time been given to the search for methods of preserving them as long as possible unchanged. Formerly, this matter was left to the housekeeping department; but within the last eighteen or twenty years it has become an object of scientific investigation.

The most common methods of protecting meat, fish, vegetables, and fruits against destruction have been to preserve them in sugar, salt, or vinegar; and the processes of pickling, smoking, drying, pressing, and refrigeration, have been devised for this purpose. Extracts of the essential constituents have also been employed, and forms of compressed meat have been introduced. A number of other special methods of preservation will be described in this article.

A well-known process of securing meat, vegetables, etc., against decay is by canning, which consists in heating the substances so as to drive out the air, and sealing them up while still hot in air-tight vessels. For this purpose they are put into the cans, only a small hole being left in the top of the vessel and exposed to a salt-water bath, in which they are heated to a higher temperature than the boiling-point of pure water, when the can is closed. This method has the advantage of preserving all the nourishing qualities of the substances and their taste unimpaired. The use of glass and earthen ware jars instead of tin cans is familiar.

A method has been patented in England for preserving meat in gross. The beast is killed, and, after all the blood has run out, is at once skinned and disemboweled. It is then dipped entire into a mixture of 72 per cent alcohol and one per cent of carbolic acid, and after it has dried is laid in a concentrated alcoholic solution of sugar. It is then cut up and packed in casks which are afterward filled with melted fat.

By another English patented process the meat is soaked during from twenty-four to thirty-six hours in a solution of 150 grammes of boric acid, 300 grammes of borax, 155 grammes of common salt, and 53 grammes of saltpeter, which had been previously dissolved in two litres of water, after which it is packed in casks. A practicable method of preparing meat for long transportation is to expose it to a current of refrigerated air till it is stiffened, then sprinkle powdered borax upon it, and put it in a refrigerator-car.

Herr F. Wickersheimer's process employs a solution of 36 grammes of potash, 15 grammes of common salt, and 6 grammes of alum, with three litres of water, which is heated to 122° and added to a second solution of 9 grammes of salicylic acid, 45 grammes of methyl alcohol, and 250 grammes of glycerine; and with this the whole animal is charged.

Kauffmann's method of preparation has been tried in household practice, with satisfaction. The top of a cask is removed carefully so that it can be tightly fitted in again, and a pan of sulphur is put in the bottom of the barrel and set fire to. The top, to which the meat has been hung, is then fitted in. By repeating the fumigation often enough, meat can be kept for a long time even in the summer, without ice, and without imbibing the odor or taste of the sulphur.

The exclusion of the air is sought in the canning processes. The real object is to exclude the germs of decay that are brought in with the air. The same purpose may be effected by filtering the air. To do this, a thickness of cotton between two pieces of linen may be put over the mouth of the jar. The vessel with its contents having been heated to expel the air within, the air that returns upon cooling deposits its germs upon the cotton in passing through it. The vessel may then be tightly closed with parchment-paper.

Among other methods of preserving foods are the familiar ones with sugar, salt, saltpeter, and vinegar. The first three substances act by withdrawing water from the conserves and leaving in place of it their own concentrated solutions, which are unfavorable to the development of germs. To obtain a perfect preservation, the solutions should be in a state of very great concentration and should surround the food-matter on every side. The sugar-process is expensive on account of the amount of sugar required to make it efficient. Dr. Bersch has suggested a way of cheapening it by adding salicylic acid to the sugar. His directions are to dissolve 100 grammes of sugar and three grammes of salicylic acid in hot water, and to pour the solution, after it has cooled to about 100°, over the fruit to be preserved. If the fruits are wholly covered with the solutions they can be kept in open vessels without changing; but it is best to seal the vessels with salicylic-acid paper (made by dipping common writing-paper into an alcoholic solution of the acid), so as to keep out the dust. Thus prepared, a ten per cent sugar-solution is strong enough for such fruits as cherries, apples, pears, etc., and an eighteen to twenty per cent one for the sweeter fruits. A difficulty in the application of this process arising out of the qualities of salicylic acid as to solubility may be obviated by previously dissolving the acid in glycerine. The old-fashioned way of packing meat in salt and saltpeter is bad, because it takes all the juices from the meats. It is preferable to prepare a brine by heating a kilogramme of salt, 160 grammes of white sugar, and 80 grammes of saltpeter in six litres of water over a gentle fire, and pour the mixture, after it has been cooled, over the meat.

Fruits, cucumbers, and meat, may be preserved for a long time with vinegar, by processes which are too well known to require a close description. Meat is not generally preserved by the direct action of vinegar, but by the vapors of acetic acid. For this purpose the meat is placed on a shelf in a cask, in the bottom of which concentrated vinegar has been poured. The escaping acetic vapors exercise a preservative influence which is effective for a considerable time. The processes of pickling and smoking are so well known that we speak particularly only of a rapid-smoking process, which consists in painting the meat some three or four times with a brush dipped in pyroligneous acid, after which it acquires the taste and properties of well-smoked meat.

The processes of direct drying, which have long been employed with fruits, have more recently been applied to vegetables. By late improvements they have been brought to a degree of perfection in which the freshness, taste, and tenderness of the fruits and greens are well preserved. Potatoes are dried by Casseten, at Lubec, into a light, citron-yellow, gummy, transparent mass, which, when cooked with water and a little salt, regains the color and mealy consistency of the original tuber, and can not be distinguished by its taste from a freshly-cooked potato.

Meat is dried, by the processes of Endemann and others, into a very nourishing food. By Endemann's method, the meat, cut into slices, is placed in a chamber heated to a temperature of about 140°, in which a current of air of the same temperature is kept constantly circulating. If the ventilation is sufficiently active the meat will be dry enough in three hours to be ground up in a mill. The powder, which has a faint smell of roast meat, is very good, and can be used in the preparation of soups and broths.

The meat-biscuit of Gail Borden is prepared by seething freshly-killed beef with hot water till all the nourishing constituents are extracted. The solution of these constituents is then dried to the consistency of an extract, and this is mixed with flour into a dough which is made into cakes and baked in a moderately hot oven. According to Mr. Borden, five hundred grammes of the biscuit contain as much nutritive matter as two and a half kilogrammes of fresh meat. In a similar way, turnips, celery, spinach, and other vegetables, are dried and compressed in square cakes, which, enveloped in tin-foil, will keep fresh in the market for a very long time.

Other methods of preservation depend on the use of antiseptics. Besides carbolic and salicylic acids, borax, boric acid, boroglycerine, and xanthogenate of potash, may be used in preserving. Aqueous solutions of boric acid and borax are very effective preservatives, for many months, of meats, fish, vegetables, or fruits, which are immersed in them. Pulverized borax is also effective, whether by itself or mixed with pulverized alum and gypsum.

The substance called boroglycerine has recently attracted considerable attention. With it Professor Barff has prepared meat for preservation during long voyages, and has shipped experimental packages of beef across the Atlantic Ocean and back without their undergoing any change. Mr. Russell, President of the English Society of Arts, has also, independently of Professor Barff, found it excellent for the preservation of meat and milk. It promises to come into general use, for its application is without the slightest danger to the healthful or other qualities of the food, and it is very cheap. The "Deutschen Industrie Zeitung" gives the following directions for its preparation: Glycerine is heated to as high a temperature as it will bear without decomposition, and as much crystallized boric acid is added to it as it will dissolve. The usual proportion is 92 parts of glycerine to 62 parts of boric acid. The mixture is then heated to a temperature of about 400°, till after four or five hours the vapor of water ceases to pass from it. The resultant product, after cooling, is boroglycerine, in the form of a yellow, transparent mass, soluble in water and alcohol. It is applied to organic substances in solutions of one part to forty parts of water.

With xanthic acid, Professor Zöllner, of Vienna, has preserved beef and veal, poultry, pigeons, and over-ripe plums. Its operation is the more effective because it is volatile at ordinary temperatures, and a very small proportion of its vapor in the air of a chamber is efficient to prevent all decay.

A preservative salt, patented by a German manufacturer, consists of crystallized boric acid and phosphate of soda, to which a mixture of common salt and saltpeter is added.

We stop, without having yet exhausted the list of possible processes for preserving food. New ones are discovered from time to time, which may prove practically applicable for general use; and many are still in an experimental stage, not yet sufficiently tested or sufficiently perfected to justify recommending them to the public.—*Translated for the Popular Science Monthly from Die Natur.*

INSANITY.

BY ONE WHO HAS BEEN INSANE.

PERHAPS, if some of our most celebrated experts, in cases of insanity, had been, for a while at least, insane themselves, it would have been to the advantage of science. Of some diseases, like malarial fever, or small-pox, a physician can doubtless give a better idea than the patient who has suffered from them; because, these diseases being distinctly physical, the symptoms furnished by the body are generally sufficient data for an accurate diagnosis. But insanity may be said to possess more of a psychological than a physiological character. The brain, being the organ through which the mind communicates with the outside world, can not, if it becomes disordered or diseased, give or receive any trustworthy intelligence. Only the patient himself can know his condition, and he only so far as he can subsequently recall his experiences. Sometimes his recollections are confused and worthless, and at other times they are remarkably vivid. I have been undoubtedly insane twice, the delusions on each occasion continuing for the space of three or four weeks. These attacks occurred several years ago, and were about six or seven months apart. I propose, in this article, to allude to so much of my experience, during the two periods, as may throw some little light upon a subject that has always been as interesting as it is obscure, and that has occupied the attention of some of the ablest intellects in this country and in Europe.

In consequence of overwork, excitement, and mental anxiety, my nervous system had become almost totally prostrated, and I suddenly and without warning lost my reason. Neither my friends nor myself had received any such intimations as led us to apprehend a calamity of that kind. So far as we knew, there had never been any insanity among my ancestors or relatives. During the trial of Guiteau, it may be remembered, the question was raised, to what extent insanity could be regarded as hereditary. A distinction without a difference was drawn between inheriting insanity and inheriting a tendency to become insane. Few persons, perhaps, are born insane; and few are born with consumption. A man whose ancestors have been drunkards is not born an inebriate. But nobody believes it would be safe for him to tamper with intoxicating liquors, because, in all probability, he has inherited a predisposition to inebriety. And, if one's ancestors have been consumptives, the disease that affected their lungs would, under favorable circumstances, be more apt to affect his than those of one whose ancestors had never had consumption. If a man had an uncle, or an aunt, or a brother, who had suffered from that disease, it would seem to indicate that it was "in the blood." And so, in the same way, as regards insanity. It would not be correct, of course, to say that a person inherited insanity from an uncle or a brother. But the fact that the uncle or the brother had been insane would show that the disease was in the family—in the blood—and one, in such a case, would have good reason to be apprehensive lest he himself might have inherited a predisposition to become insane from the same source whence his relatives had derived their tendency.

The first that I remember of my attack was while I was riding in a railroad-car. It seemed to me that the passengers in the forward part were getting up amateur theatricals. The fact that this did not surprise me, nor appear at all out of place, illustrates one curious feature of insanity, and that is, its close similarity in many respects to *dreaming*. It is well known that the strange phantasmagoria attendant upon most of our dreams never strikes us at the time as at all astonishing, illogical, or contradictory, because the critical faculty in sleep is partially and perhaps wholly dormant. And so also is it in insanity. And as a sound or a touch will suggest or give direction to an ordinary dream, so everything that occurs within the sight or hearing of an insane man affects him in like manner. Also, he has no more control over his words and actions, when the insanity is complete, than a somnambulist. And, when a patient comes to himself, after having been insane, he feels as though he had been having a long and, sometimes, a very unpleasant dream. Some of my delusions were of a frightful character, and resembled a nightmare more than anything else; but more often they were by no means disagreeable. Of course, it seemed strange to me afterward that I could have been carried away by such absurdities. At one time I thought that the end of the world had come, and that the day of judgment was at hand. This was somewhat remarkable, because I had not for years been a believer in the scriptural prophecies relating to those two events. Nor had I any faith in the doctrine that there is a hell of fire; yet, in imagination, I visited that place of torment, and witnessed the tortures of the damned—without, however, getting scorched myself. Some strange conceits, that I had come across in books, occasionally suggested material for my mind to work on. I saw men whose souls I believed had been taken from their bodies, leaving behind the intelligent personal identity—an idea suggested by a character described in Bulwer's "Strange Story." Again, I thought that demons occasionally reanimated human bodies after death; and this fancy I must have got from a dramatic work by Bishop Coxe, entitled "Saul," in which the evil spirit sent to trouble that unfortunate monarch reanimated and took possession of the body of a priest whom Saul had slain. I mention these instances as serving to show the dream-like character of insanity.

I was confined in an asylum, and during the first part of the time I thought I was unjustly imprisoned, I knew not why, and that my friends were not far off, doing all they could to liberate me. I could hear them, as I thought, talking to me from some place not far distant. Many insane patients, with whom I have conversed, while they and I were convalescing, have told me that they also had heard similar voices, and been deceived much in the same way. This is called "false-hearing." Since my recovery I have had several attacks of it, but not to such an extent as to create any delusion. Sometimes after a day's hard work, or after reading or writing too long, I have heard voices that sounded as though they were out-doors, or in an adjoining room, or in the air. I have experimented with them for the purpose of finding out, if possible, how the brain is affected to produce them. They have led me to believe that there is a great deal more "unconscious cerebration" going on in every man's brain than any one is aware of. While listening to these voices, and conscious all the while of the fact that they were purely imaginary, I have heard remarks that astonished me! What was this but the mind surprising itself by its own communications? I have heard long conversations at such times, and when, for the sake of experiment, I have for the moment treated them as realities, I have received replies that staggered me for the time being, and almost led me to believe some intelligent being was talking to me. There can be no doubt that there have been many people who, without knowing it, have been victims of false hearing, and have honestly thought they were hearing the voices of their disembodied friends, while in fact they were being deceived by an unconscious mental action going on in a disordered brain.

The question, "What is insanity?" will probably never be fully and satisfactorily answered; and one reason for this may be because there are so many different kinds. One kind makes the patient lively and hopeful: he believes himself a king, or immensely wealthy; and he is full of the wildest projects. Another kind of insanity is directly the reverse in its characteristics; it is called melancholia, and often sinks the patient in the depths of despair. Then there is softening of the brain, that ends in dementia, or total absence of intelligence, so that the patient does not know enough to eat or drink, although his body may be apparently in a healthy condition. But, generally speaking, insanity may be said to be a state of delusion in which the mental faculties, to which it would be necessary to appeal in order to dispel the delusion, are so paralyzed or diseased that they can not be exercised. A few years ago, during the trial of an insane man in Chicago, it was asked whether there could be, strictly speaking, such a condition as partial insanity—that is, whether a man could be perfectly sane and responsible as regards all subjects except one or two. A very celebrated physician endeavored to maintain that it was impossible, because, he said, if one part of the brain was diseased, the whole organ, being in sympathy with that part, would be diseased also. It seems to me that, practically, this physician was mistaken. If the brain is the organ of the mind, there seems no reason why, notwithstanding one portion of that organ may be in an abnormal state, the other parts may not perform their functions well enough. I have certainly seen insane men whose opinions in reference to certain subjects it would be safer to trust than those of some men that have never been suspected of insanity. The question of responsibility is, of course, what gives insanity, from a legal view-point, its chief interest. It is certainly a mistaken idea that no insane person is responsible. It does not obtain in the asylums, at any rate; for discipline is very often maintained there by a system of rewards and punishments. If a patient misbehaves, he is informed that a repetition of his offense will put him back in some ward where his surroundings will not be so pleasant. This threat is seldom without avail, especially if the patient has once already had an experience of the penalty. This would seem to show that he knows good from evil, and has self-control enough to restrain himself from wrong-doing. There are some insane patients, though, of course, that have passed beyond the possibility of all self-control. It is plainly impossible to furnish any general rule by which to decide when a man is responsible and when not.

Insanity does not change a person's character so much as is usually believed. A distinguished English physician has said that, if there be anything in this world that is immutable, it is character. We meet with illustrations of the truth of this assertion almost every day. "Conversion" is believed, by many excellent church-people, to work a complete change for the better in a man's moral nature. But has any one ever seen a mean, close-fisted, narrow-minded man become, in consequence of conversion, liberal and generous? I trow not; and so even insanity seldom alters a man's nature much. For instance, the insane man may imagine people are plotting to kill him; he fancies he hears threats, and thinks he sees motions to carry them into execution. Now, if he be naturally a timid man, and a non-combatant, he will run, and try to escape; but if he is courageous by nature, and inclined to fight, he will act just as he would were all the circumstances really just as his disordered imagination pictures them. Compare the number of murders committed by insane men with those committed by men under the influence of alcohol, and the latter, in proportion, will be found to be greatly in excess. For my own part, I would sooner trust my life with an insane man than with one whose brain has been inflamed by over-indulgence in the liquors sold in the saloons and grog-shops. Before a person becomes insane there are two symptoms that almost invariably manifest themselves, insomnia and constipation. All the testimony I have been able to collect upon the subject goes to show this; and I have made very extensive inquiries. There has never been a single case brought to my notice, where the patient's mind was much drawn to any one subject, that it did not, to a greater or less extent, prevent his sleeping, and always enough to excite the attention of those about him. For my own part, although I believed Guiteau to be a "cranky" individual, of very peculiar mental characteristics, I never thought him in a sufficiently abnormal condition to be called insane, and principally for this reason, that with all the intensity of his purpose to shoot President Garfield, and notwithstanding the "pressure" he alleged that he felt upon his mind, he was never known to lose a night's rest. He himself said that he always slept well. Now, an insane man, in the condition which Guiteau wished to make the world believe he was, would not have slept well. He would have been up and down in his room all night, and would have been a nuisance to any one trying to sleep in an adjoining apartment. Nor did Guiteau suffer from constipation. The absence of either of these symptoms would have been sufficient to occasion distrust as to his insanity; but the lack of both, to my mind at least, furnished conclusive evidence that he was a responsible man.

Before concluding this article, I wish to say a few words in behalf of a certain class of insane patients that, perhaps more than any others, deserve the sympathies of the public.

When I was convalescent, in the asylum, I attended an evening card-party, given in one of the pleasantest wards, for the amusement of those patients that were well enough to appreciate and enjoy such an occasion. I met a lady, a patient, who had been in the asylum three years. Although I could see that she was somewhat flighty, yet in all other respects she was quite an intelligent person. She told me that she had left at nome her daughter, an only child, about fourteen years old, whom she had not seen in all that time. This lady's husband had virtually put her in prison, and had never taken the pains to call on her himself oftener than once a year, and had never allowed her daughter to visit her. Tears stood in the poor woman's eyes as she told me these things, and I had no reason to believe that she was deceiving either herself or me. And upon inquiry I found that her case was not an exceptional one. There are mothers confined in all our asylums, as there were in the institution where I was, who, while they are insane enough to warrant their being put under restraint, are yet sufficiently intelligent to be sensible of their condition, and, like the lady I have alluded to, be overwhelmed by the thought that they are in a hopelessly helpless condition, and may be kept imprisoned thus for years, or even for life, away from their kindred and friends, and from the little ones for whom their hearts yearn with an intensity that no human being can appreciate, except some mother that has lost a child. This lady said she had known such patients, when taiking about the little children from whom they had been separated, to sob and moan for hours at a time. But the law is inexorable. It says that a husband may confine his wife in an asylum if he can prove that she is insane—and that is a very comprehensive word. In some States the certificates of two physicians will accomplish this purpose; and, when once a patient is shut up in a ward, there is no deliverance that can be depended upon, as I shall presently proceed to show. But not only do the women suffer in this way, for there are men whose affections are as keen and as strong as those of any woman, who long to be with their boys and girls, to see them growing to manhood and womanhood, but who know neither the day nor the hour when that longing shall be gratified.

In some of our asylums, if not in all, there is a disinclination on the part of the superintendent to take the responsibility of discharging a patient, even when cured. One superintendent explained it to me in this way: "There is," he said, "no certain way of knowing whether a patient is thoroughly cured. Now, if I discharge one such, while his friends do not wish him to be sent away, and he subsequently becomes insane again, I am held responsible, and it tells against my reputation, and, in some cases, I may be obliged to pay the expense of getting the patient back again into the asylum. For that reason," he continued, "I never like to discharge any one until his friends call for him. I keep them informed of his condition, and leave it to them to decide when they will take him away."

But some one will say, there is a Board of Charities or some such arrangement by which the asylums are visited and such patients liberated. In most cases such visitors do not visit in the way the public imagines or the law requires. I have yet to learn of a case of deliverance effected by any such board. They go to the asylum, glance through the "crack wards," and then partake of a sumptuous dinner got up for their benefit by the superintendent, and that is all. But as to any careful search and investigation, to see whether there are not patients whose conditions might not be improved, or whose sufferings alleviated, I never heard of anything of the sort, nor have I ever talked with any one that had. Now, I am not saying that superintendents are cruel, nor that they do not do their duty. I am simply pointing out a system that affords every facility for the perpetration of the grossest and most outrageous injustice; and I leave it to the public to say whether any such system ever existed long anywhere without suffering the perversions which it seemed to invite. Some way should be devised—and a legal enactment would be the best remedy—by which those who confine, or are instrumental in confining, persons that have children, should be compelled to see that the children are brought, a certain number of times every year, to visit the parent thus confined. Again, patients should have greater freedom in communicating with the outside world. As it is, every letter written by a patient is carefully read by the superintendent or some officer ; now, suppose a man is unjustly confined, and that the superintendent is an accessory to this false imprisonment. What opportunity would such an unfortunate prisoner have to obtain his freedom? The superintendent can prevent any letter going out that contains any reflections upon himself or the institution in his care. Should friends wish to see such a patient, all the superintendent need do is to say that he can not permit an interview, because the patient is excitable or sick—any such excuse will do. It is always against rules for a patient to address visitors unless they come to see him particularly. But suppose a patient was successful in laying before a stranger a case of injustice—what then? Why, the superintendent can say that the patient did not know what he was talking about, and that would end the matter with ninety-nine people out of a hundred, for every one knows how humiliating it is to appear to be deceived by an insane person!

Let the reader remember that I am not publishing this to bring a railing accusation against asylums or superintendents. While I was confined I was treated like a gentleman, and was shown every consideration by the superintendent and all the officers. I do not believe that in the institution where I was a case of unjust imprisonment could possibly occur while the present superintendent is in charge. What I wish to demonstrate is that the system *invites abuses* by making it so easy for an unprincipled superintendent to act in collusion with an unprincipled outside party, where there are financial or other temptations to deprive some innocent man or woman of his or her personal liberty. It is enough to say there is the writ of *habeas corpus;* but how is an unfortunate person in such a case to inform a lawyer that he wants such a writ issued in his behalf? And does any one believe that, if the Board of Visitors in New York could have been relied upon to do their duty thoroughly, any such outrage as that upon Mr. Silkman could ever have been perpetrated, or that it would have ever been attempted?

The "cottage system" has been spoken of as one means of rendering asylum-life pleasanter. But, although that system is better for the patients, it is not nearly so convenient for the officers ; and, as these latter have always more to say on the subject than the patients, it is not likely that the cottage plan will ever be very extensively adopted. It is much easier to manage an institution where everybody and everything are in one large building than where they are scattered in different houses. Nevertheless if patients could have more of out-door life, could move about in a flower-garden and breathe the fresh air and bask in the sunshine, more than they possibly can while they are penned up in wards, they would improve mentally and physically more rapidly than they do. I do not not know of any more depressing influence within the range of the possibilities than that which settles upon one who has recovered his senses in an asylum, and is retained there until he recovers his health! The possibility of recovering one's health, surrounded by insane people, is what I have always doubted, and why I insisted upon leaving the asylum as soon as I did; and I never look upon such an institution without a heart-felt pang for the many sad and wretched beings I know it must contain; and with this comes the still more horrible thought that there may possibly be among them some who, in all justice and right, should be as free as I myself.

THE LITTLE MISSOURI BAD LANDS.

By Professor T. H. McBRIDE.

II.

"Knew you what silence was before?
Here is no startle of dreaming bird
That sings in his sleep or strives to sing;
Here is no sough of branches stirred,
Nor noise of any living thing."—Lowell.

HOWEVER interesting the Bad Lands may be in their scenery and in their conditions purely physical, it is only when we consider them in their relation to life and its progress on the earth that they become most attractive, most engaging.

To describe the present flora and especially the fauna of this region would require no very long chapter, and yet the list of species would be longer than some might suspect. Where erosion less interrupted by the fires has been allowed to do its perfect work, there are level areas of considerable extent sparsely covered with short grass, on which the prong-horn, the elk, the deer, and the big-horn sheep, have been wont to graze. The valleys, and even the flat tops of the buttes in May, are said to abound with flowers. Cottonwood-groves occur along the banks of the river, and occasionally a thicket of low box-elders, plums, and various kinds of thorny shrubs, divides with the sage-brush the occupancy of some sheltered ravine; while up the northern faces of some of the higher and more sloping buttes, where the snow of winter lingers longest, low, ragged cedars creep in straggling file. But, where the fires have done their part, the desolation is extreme. Even the vegetation which the spring-time may have brought seems to vanish from the earth, the precipitated alkali whitens the valleys, and from all the naked hills comes up a glare of dazzling light as from a desert absolute. Far as you can look or listen there comes not the faintest sign or whisper of living thing. No bird visits those forgotten hills, no insect stirs about your feet or beats with humming wings the air; the very wind is silent, and from the glowing buttes, as from a furnace, the heated atmosphere rises in shimmering columns. It seems as if it had never rained, or, if it has rained, it seems as though it would never rain again. Here is the trail by which, in 1863, passed General Sully and his train when all these hill-tops were alive with hostile Sioux. The Indians are long since gone, but the trail remains unchanged, and can be easily followed after a lapse of twenty years. Yonder, along that other trail still so clearly visible over the distant buttes, went Custer and his band when they marched away to the west and disappeared from human sight forever. The climate is an arid one, and the process of erosion slow. Looking out over the landscape as we now see it, none would imagine that all this territory was at one time favored with a climate perhaps nearly semi-tropical, that over all this wide area were waving forests of perpetual green, stretching away to the north, south, east, and west, almost to the limits of the so-called "Plains." Yet such is the case, and this complete transition from the wealth of primeval woods to the poverty of semi-desert has been brought about not by the devastation of short-sighted man, but by the orderly procedure of all those indefinite forces which for convenient description men sum up as Nature. The evidence of this transition is not far to seek. Scattered over the grassy low-lands, crowning many an isolated pillar of sandstone or clay, lying here and there on all the high hills, are remnants of gigantic trees, remnants more or less perfectly silicified, stumps, boles, and branches. In some localities these "petrified stumps" cover the whole face of

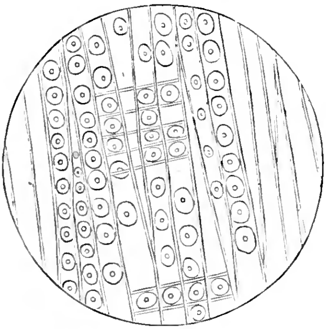

Fig. 1.—Longitudinal Section of Silicified Wood, × 150.

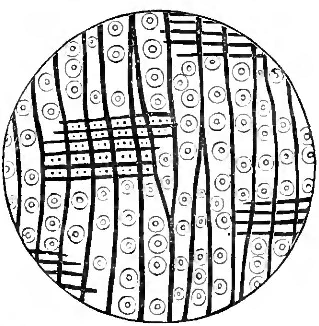

Fig. 2.—Microscopic Section of the Wood of the Common Larch, cut in the Long Direction of the Fibers.

the country, and scores have been carried away on flat-cars to decorate the lawns of those able to pay freight on such unwieldy "curiosities." Scientists are frequently disposed to doubt petrifactions, and are often compelled to disappoint popular expectation in regard to forms most fairly outlined; but that these stumps and logs and splinters have been wood there can be no possible doubt. Our microscope settles the question once for all by revealing the very form and markings of the original wood-cells now replaced by silex. In Fig. 1 we have the microscopic view of a section taken from a log lying on the summit of one of the buttes. The medullary rays are plainly seen, as well as wood-cells bearing series of peculiar concentric circles, which every botanist instantly recognizes as characteristic of the *Coniferæ*, the cone-bearing trees, pines, cedars, firs, sequoias, so that we may not only safely pronounce the petrifaction on the hill-top a fossil log, but we have determined without doubt the vegetable order to which it belongs. For the silicifying of such masses of organic material long submergence was doubtless necessary, but to which of the beds of the series exposed these relics belong it is difficult to determine. Such fossils come to light only by erosion, and erosion leaves them always at the lowest levels.

But these are not the only evidence of a former vegetable life very different from that now prevalent in the Bad Lands. All these beds

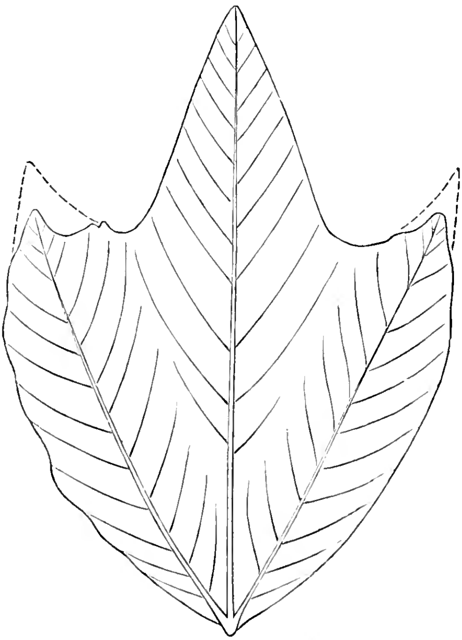

Fig. 3.—Platanus nobilis (Newberry) × ½.

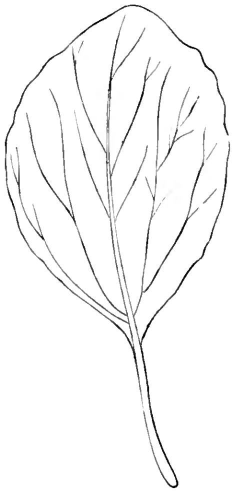

Fig. 4.—Populus cuneata (Newberry).

of lignite, said to exceed in area all the other coal-fields of the world, are of undoubted vegetable origin. Knowing what we do about coal in general, we can conceive of no other history for them, and although we find in these American beds no such veritable logs as characterize the *braun-kohle* of Northern Europe, yet the presence in the lignite of bits of carbonized wood, twigs, and bark, leaves no doubt as to the character of the primal vegetation.

But it is in the beds immediately associated with the coal that we find the most indubitable evidence at once of the presence and character of the former flora. Here, in strata of sand and clay, lie most beautiful impressions of the leaves of both deciduous and coniferous trees. We may say fossil leaves, but this is hardly the correct description, since we have preserved to us not a vestige of the original leaf, but simply a mold left in the imbedding clay, as the matter of the leaf disappeared. In fortunate cases, therefore, we have both the upper and lower surfaces of the leaf exhibited, and these impressions are perfect, so that experienced observers can determine, not the order only, but the genus, often the very species and variety, of the tree from which a given leaf has fallen! This seems astonishing to the

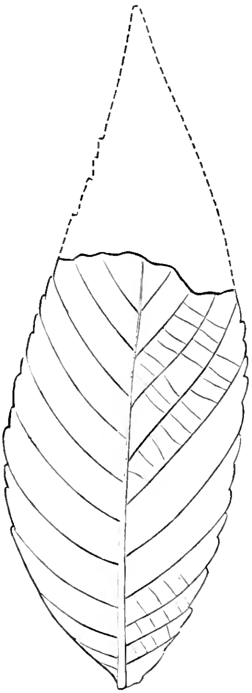

Fig. 5.—Juglans woodiana (Heer).

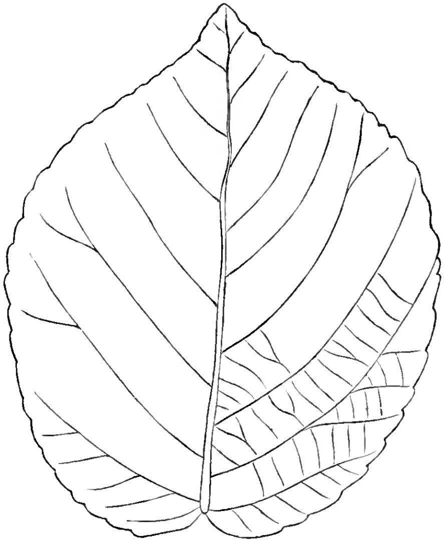

Fig. 6.—Corylus grandifolia (Newberry).

ordinary student or analyst of flowers, or to him who notes the great variety of form and feature which the leaves of a single tree present—a box-elder, for instance—but fails to see the hidden lines which betray relationship. But such men as Goeppert, Heer, Saporta, and our own Lesquereux, like Tischendorf among the MSS., have a vision and an experience not possessed by many, a "special insight," Professor Lesquereux says, which, in presence of a single organ, a single leaf, can conjure forth from the dim ages past the plant entire; and men like Gray and Hooker, while acknowledging themselves not possessed of similar divining power, admit the veracity of the results obtained. I have said a leaf, an organ, sometimes a fragment, is sufficient, and that which to the ordinary observer is wholly enigmatical becomes to the paleophytologist a revelation. "These are the scattered fragments of the old book of Nature. When one sets himself to decipher them, he very soon forgets the singularity of the characters and the poor condition of the pages. Thought rises, ideas develop, the manuscript

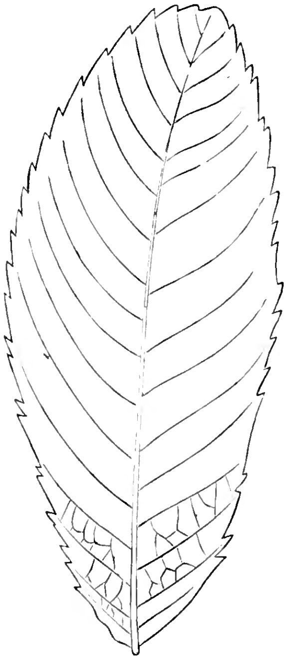

Fig. 7.—Carpinus betuloides (Ung)?

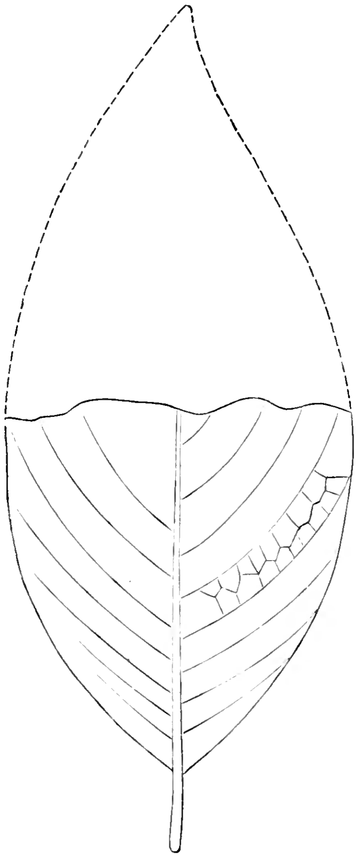

Fig. 8.—Persea —— ? × ½.

unrolls. It is the tomb that speaks and delivers up its secret." * We are reminded of the prophetess of classic fable, who wrote the burden of her prophecy on forest-leaves, and then committed the precious pages to the winds. He who would find the inspiration of her song must have the wit to rearrange.

* Saporta, "Monde des plantes avant l'apparition de l'homme."

Of these leaf-prints the finest specimens collected in the Bad Lands come from strata which have been baked by the burning coal. This burned material furnishes a matrix of sufficient hardness to preserve perfectly the mold and to endure the stroke of the hammer which brings to light the hidden image, and so the life-history of Dakota, like the history of some of the old Oriental monarchies, is revealed by the cleaving of burned bricks.

So far as I am informed, no systematic search for these fossil leaves has ever been made. They occur on the surface in isolated spots, and different localities furnish different as well as similar forms. The baking to which the fossil-bearing beds have been subjected has, in a measure, obliterated the distinction of strata, so that it is difficult in any case to determine the exact horizon, or to say whether all the leaves are from about the same level, and hence contemporaneous ; it suffices our purpose to know that they are nearly so. At all events, in strata such as these, and as geology reckons time, no intervals have been very great, and we may omit discussion of the relative age of the leaves, and consider immediately their kinds and meaning. We have represented, in Figs. 3–12, leaves of the following genera : *Platanus, Populus, Juglans, Corylus, Carpinus, Persea, Ficus, Sequoia, Cornus.** These names are all familiar, although we are not accustomed to see them grouped together. *Platanus* is represented throughout the northern Mississippi Valley by the sycamore, frequenting the water-courses and rocky banks, and often attaining grand dimensions. Two species of the genus occur in California, two in Mexico, and one in the far Levant. *Populus* we know from our aspens, balm of Gilead, and more than all by the cottonwood—a prairie-tree—abundant along our Western rivers, and following the Missouri and its tributaries to the very foot-hills of the Rocky Mountains. These trees all secrete about their buds more or less of fragrant wax, and possibly from the tiny pits seen at the base of the leaf of *P. glandulifera* exuded some such balsamic gum which spread and polished the upper surface of the young leaves. Of *Corylus* and *Carpinus* little need be said. The hazels and hornbeams are sufficiently well known as characteristic of north temperate forests everywhere. The genus *Juglans* we know from our invaluable walnut, once common throughout the Eastern United States. A single species is found also in Asia Minor and Europe. *Cornus*, the dogwood, has some northern species. But the three remaining genera are more interesting. *Persea* is a laurel, and laurels are especially tropical plants, extending in hardier forms as evergreens into the sheltered or milder parts of the temperate regions. This particular genus extends along the Atlantic coast from Delaware southward, and is abundant in the West Indies. *Ficus* is also a tropical genus, or, at least, occurs in warm climates only, as in Florida, South America, around the Medi-

* For the identification of these leaves, except one or two, I am indebted to Professor Lesquereux.

terranean, in India, in Java; while *Sequoia* is limited to the mountains of California, and is to us best known through the "Big Trees" of the Mariposa.

All these genera, belonging to so many different orders, leave no doubt that the vegetation of the times when these leaves were green was abundant and varied. We may be sure that the genera mentioned

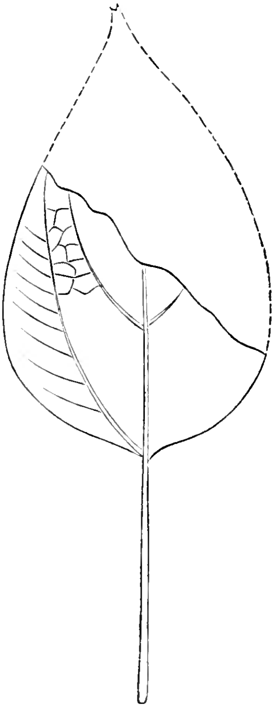

Fig. 10.—Sequoia disticha (Heer).

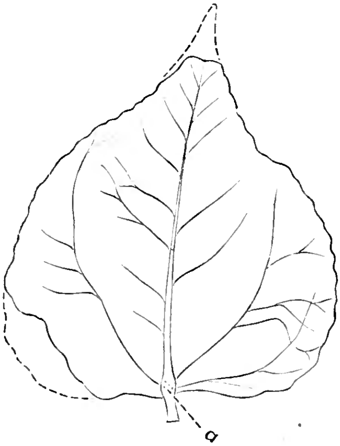

Fig. 9.—Ficus —— ? × ½.

Fig. 11.—Populus glandulifera (Heer), a = glands.

are only a few, a very few, of those to be found, that these were surrounded by their congeners and by a multitude of other and different forms, whose remains man has yet to see and understand. North Dakota was once, if not repeatedly, a land of forests.

But what a strange association of leaves we have here!—the flora of Florida, the flora of California, and the flora of our Northern woods. As we collect the leaves, we find *Sequoia* associated with *Juglans*, *Persea* and *Ficus* lie side by side, *Populus* and *Platanus* seem to affiliate, although *Populus* has of all the widest distribution. In the beds where they are found these leaves lie flat and smooth. Preserved just where they fell, they seem, as they lost hold upon the parent tree, to have settled once for all into quiet waters. They have never been much tossed by winds nor rolled by currents, and hence can not be said to indicate that these differing genera represent different altitudes. Besides, the strata have evidently never been disturbed in such a way as to afford any great variety of altitude in this locality. We are therefore shut up to the conclusion that, at the time these leaves were green, a climate prevailed very different from any now known in the same latitude anywhere in North America. The climate must have been warm and equable. Indeed, that the climate, not of Dakota only, but of the whole northern hemisphere, was at one time far milder than now seems proved, for leaves such as these of which we speak have been found in Greenland and many other circumpolar lands. What may have been the prime cause of this former high temperature in high latitudes we leave students of physical geography and surface geology to decide, but we may say this: the warm and equable climates of the world are maritime, or characteristic of islands, as the climate of Italy or the Grecian Archipelago. That a large body of fresh water may work wonders in temperature and amount of moisture, is to us a familiar fact witnessed by the climate of the peninsula of Michigan. And so, to meet the requisite climatic conditions suggested by these few leaves, we are ready to accept without doubt the statements of men who from their study of the topography of the Bad Lands declare the whole region to have been, perhaps again and again, the bed of a wide-spread inland lake or sea. On the shores and islands of this Mediterranean of the Western world stood the forests primeval whose foliage has come down to us like the sad memory of better days.

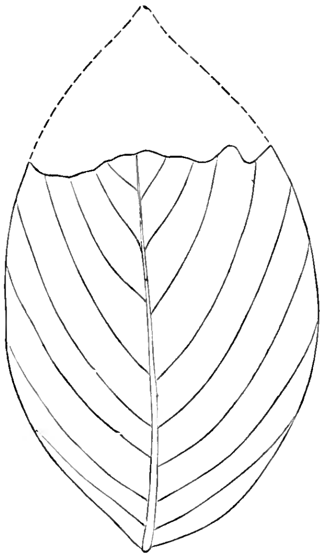

Fig. 12.—Cornus rhamnifolia (O. Weber).

As one looks upon these fairly outlined relics of a long-forgotten age, he may catch glimpses of landscapes in presence of which all the bleakness and barrenness of the present disappear. Instead of sterile hills and buttes, far stretches the quiet sea, unvexed by storms, but filled with happy islands like the "Islands of the Blest." Over the islands the laurel blooms, abundant fig-trees spread their dense and shining foliage, and send down aërial roots in thickets impenetrable. Along the curving shores the bending willows sweep the water's surface, while hard by stands the broad-leaved plane-tree and the feathery elm, and farther back the hazel and its kindred oak. The poplar shakes its shining leaves and fills the air with fragrance. Over the cornel and the hornbeam creeps the vine, and high above all, walling the horizon like the cryptomeria in the forests of Japan, sequoias, magnificent sequoias, whose skeletons now lie white like other skeletons on the hills, lift their tufted branches. The forest-trees fall in natural decay, the mirror waters sleep in peace, while the centuries of the early Tertiary come and go.

FACULÆ AND SUN-SPOTS.

By HENRY A. SMITH.

THE sun when examined with a suitable telescope, properly adjusted as to the power used, exhibits, scattered over its disk, great facular waves, which are elevated portions of its surface, and are composed of luminous matter which has extended through its denser atmosphere. In order that these waves may be seen, it is requisite that they attain a height of at least forty-five times that of the Himalayas. Their appearance is very rare in polar regions, but very abundant in the close neighborhood of spots; in fact, they generally precede the formation of a spot. The faculæ, at a distance from the spots, change somewhat slowly, remaining for several days without much variation in their appearance. But it is quite otherwise near a spot, for here these waves change with a rapidity which renders it exceedingly difficult to make a draft of them. Movements not less than one thousand miles in an hour are not uncommon. The faculæ are generally round, though sometimes they appear in long strips of light. When they take the shape of a wreath, a group of spots quite soon appears, as a rule. With the discovery of solar spots may be said to have commenced our knowledge of the physical condition of the sun. Kepler was of the opinion that, in lines 441 and 454 of Virgil's first "Georgic," the solar spots were referred to. We also find in the annals of the Chinese, made many centuries ago, that spots were observed by the unaided eye, and in the year 807 an exceedingly large spot was seen for eight days. A solar spot consists, in the main, of two parts—the central part, called the umbra, surrounded by a less dark portion called the penumbra; and, as Professor Young has said, "The appearance is as if the umbra were a hole, and the penumbra filaments overhung and partly shaded it from our view, like bushes at the mouth of a cavern"; the umbra being a depression below the photosphere, filled with less luminous matter, while the penumbra may be seen around the edges.

It is observed that the spot, when half through its existence, is circular in shape, but, as it approaches disruption, it is subject to great change, sudden and violent. Respecting the average life of a spot, we may say it is from two to three months. The spot, however, observed in 1840 and 1841 lasted eighteen months, the longest time on record. Again, some may last but a few hours, being suddenly formed and rapidly shattered in pieces. They appear generally in groups, though single spots are seen at times. When a large one is divided into parts, they seem to repel one another, and move away in various directions with great velocity ; it is not uncommon that this separation is equal to one thousand miles in an hour. Respecting what is sometimes seen about or crossing spots, we call attention to the simultaneous observations of Mr. Carrington and Mr. Hodgson upon two luminous objects, resembling in shape two new moons, each 8,000 miles in length and 2,000 miles wide : these, separated by at least 12,000 miles, came instantly into view at the edge of a large sun-spot, with a brightness several times greater than the surrounding photosphere, then passed eastward over the spot, and disappeared in about five minutes, having gone not less than 36,000 miles. In no way did the disturbance apparently affect the shape of the spot (passing probably above it). On the following evening a great magnetic storm and aurora were decidedly manifest, and there can be little doubt that they were connected with the event seen in the sun the day preceding. Likewise we know that a great solar storm is in progress when our northern heavens are so beautifully illuminated with the northern light. As to the formation of some spots they have been very slow, requiring no small amount of time after the disappearance of the facular waves ; again, as stated, some come and go in a few hours, and assume in some cases huge dimensions as compared with any one thing on the earth. A single spot has measured from 40,000 to 50,000 miles in diameter, in which, as will be readily seen, we could put our earth for a standing point of observation, and note how the vast facular waves roll and leap about the edge of the spot, and also how the metallic rain is formed from the warmer portions of the sun. In June, 1843, a solar spot remained a week visible to the naked eye, having a diameter of about 77,000 miles ; and in 1837 a cluster of spots covered an area of nearly 4,000,000,000 square miles. When we call to mind that the smallest spot which can be seen with the most powerful telescope must have an area of about 50,000 miles, we can readily see how large a spot must be in order to be visible to the unaided eye. Pasteroff, in 1828, measured a spot whose umbra had an extent four times greater than the earth's surface. In August, 1858, a spot was measured by Newall, and it had a diameter of 58,000 miles—more, as you will see, than seven times the diameter of the earth. The largest spot that has ever been known to astronomy was no less in diameter than 153,500 miles, so that across this you could have placed side by side eighteen globes as large as the earth ; and, when the depth of this cavity is considered mathematically, the result shows that probably not less than one hundred globes the size of our earth would have been requisite to bring it up to the photosphere of the sun. So numerous have been the observations and measurements, that any attempt to present them all would require many pages.

INSECTS AND DISEASE—MOSQUITOES AND MALARIA.*

By Professor A. F. A. KING, M. D.

THE animalcular, or insect, origin of disease is not a new idea. It was suggested by Linnæus, by Kircher, and by Nyander, but gained little ground. It received a new impetus after the publications of Ehrenberg on the Infusoria. Later, it received attention in Bradley's work on "The Plague of Marseilles," in Dr. Drake's books on "Epidemic Cholera" and on "The Topography and Diseases of the Mississippi Valley," as well as in Sir Henry Holland's "Medical Notes," and other works.

More recently the researches of Dr. Patrick Manson in China, Dr. Bancroft in Australia, Dr. J. R. Lewis in India, and Dr. Sonsino in Egypt, have tended to show that the mosquito "acts as the intermediary host of *Filaria sanguinis hominis*," and is thus indirectly instrumental in the production of chyluria, elephantiasis, lymph-scrotum, etc. (London "Medical Times and Gazette," January 12, 1878, p. 69; September 7, 1878, p. 275; December 28, 1878, p. 731; and June 4, 1881, p. 615).

Still later, M. le Dr. Ch. Finlay has hypothetically considered the mosquito an agent of transmission of yellow fever ("El mosquito hipoteticamente considerado como agente de transmission de la fiebre amarilla," Havana, 1881; and "Pathogonia de la fiebre amarilla," 1882). These papers were communicated to l'Académie royale des sciences médicales, physiques et naturelles at the dates mentioned. A review of them, by Dr. A. Corre, appears in the "Archives de méd. Navale," tome xxxix, pp. 67–70, 1883, Paris. (See also "Lancet," 1878, i, p. 69.)

Viewed in the light of our modern "germ theory" of disease, the punctures of proboscidian insects, like those of Pasteur's needles, deserve consideration, as probable means by which bacteria and other germs may be inoculated into human bodies, so as to infect the blood and give rise to specific fevers. It has long ago been demonstrated that "malignant pustule" is produced in man by the bite of a fly ("British Medical Journal," January 24, 1863, p. 239). Dr. Budd, in the article just quoted, refers to the greater frequency of this disease in hot, dry summers where insect life is active and teeming; and this, he thinks, would go far to explain the greater frequency of the malignant pustule in Burgundy than in England and the north of France,

* Abstract of a paper on "The Prevention of Malarial Disease, illustrating, *inter alia*, the Conservative Function of Ague," read before the Philosophical Society of Washington, February 10, 1882. For another paper, on "The Conservative Design of Organic Disease," see this journal for June, 1875.

as also its greater frequency in Siberia and Lapland, where insects of the mosquito tribe are the great pest of the traveler. In Lapland the popular belief was long ago universal that the disease was caused by a peculiar insect, which suddenly descended from the air, and as suddenly disappeared. In the London "Times" (1860) it is reported that four hundred persons lost their lives in the south of Russia and in the province of Kiev from the sting of a "venomous fly" imported from Asia, the same fly having made its appearance there on another occasion, sixty or seventy years before. Virchow, who has made malignant pustule a special study, says: "Most probably, insects with piercing probosces effect the inoculation, such as gadflies (Bremse); but flies which make no wound may also implant the poison on the skin by their soiled wings and feet." The bites of these same flies may be generally harmless; they have no venomous power of their own, but only convey poison from sources of infection to man and animals.

Furthermore, when it is remembered that disease-producing bacteric germs are so minute that a million may rest on the head of a pin, and that the smallest puncture of the finest needle-point (as in Pasteur's experiments with chicken-cholera), when charged with an atom of infecting matter, may be sufficient to infect the body with the septic matter, it scarcely seems possible to ignore any longer the punctures of mosquitoes and other proboscidian insects as possible sources of both infection and contagion. With our present knowledge of the "germ theory" one would hardly dare, even once, to plunge an inoculating needle into the blood of a yellow-fever or typhus-fever patient, whether living and comatose or recently dead, and then withdraw it and plunge it into his own blood or the blood of other persons, yet this is exactly what the mosquito is doing in nearly every yellow-fever epidemic, and what, perhaps, the flea is doing in the filthy jails and ships infested with typhus. In the yellow-fever instance, it is to be noted, also, that the spread of the disease ceases with frost; so also do the peregrinations of the mosquito.

In this paper, however, my chief design is to present what facts I may be able in support of the mosquital origin of malarial disease—in fact, of ague. And, while the data to be presented can not be held to prove the theory, they may go so far as to initiate and encourage experiments and observations by which the truth or fallacy of the views held may be demonstrated, which, either way, will be a step in the line of progress. It is scarcely necessary to premise that other—nay, all—insects that infest and wound the human body may share in the guilt that will here be charged, in particular, to the *culex;* and so, of course, other diseases than ague, yellow fever, etc., may possibly have a similar history. Be it noted *en passant* that, so far back as 1848, Dr. Josiah Nott, of Mobile, Alabama, published a lengthy essay on yellow fever, in which he maintained the insect origin of that disease, and also suggested the "mosquito of the lowlands" as a probable cause of malarial fever, in place of the marsh-vapors of Lanscisci ("New Orleans Medical and Surgical Journal," vol. iv, pp. 563–601, 1848). And, even before his time, I find that a paper on the "Mosquital Origin of Malarial Disease" was published by Dr. John Crawford in a periodical known as the "Baltimore Observer," 1807, no copy of which I have yet been able to get hold of.

I now propose to present a series of facts—some of the best known and most generally established facts—with regard to the so-called "malarial poison," and to show how they may be explicable by the supposition that the mosquito is the real source of disease, rather than the inhalation or cutaneous absorption of a marsh-vapor. These facts are, briefly, as follows: *

1. "Malaria affects, by preference, low and moist localities"—in fact, swamps, fens, jungles, marshes, etc. This statement no one will dispute. Conformably with it we find the mosquito does the same. The female lays her eggs, to the number of two hundred and fifty or three hundred, in a boat-shaped mass, on the surface of any natural or artificial receptacle for fresh water. Early in spring the larvæ are found in the bottoms of pools and ditches, feeding upon decaying matter (hence the works on entomology state that they are of great benefit in *clearing swamps of miasms* (?)). These larvæ are the so-called "wrigglers," or "wigglers," to be found in great numbers in any stagnant pools of water during summer. They change into pupæ, and, in a few days more, the pupa-skin is cast, and floating on this latter, like a raft, the insect finally takes flight, a full-developed gnat. Many thousands perish by drowning, or are devoured by fish while extricating themselves from their pupa-cases. As the eggs develop into perfect insects in three or four weeks, many broods are hatched during the warm season, which accounts for their increasing numbers during the later summer and autumnal months. Some species deposit their eggs in soft mud or in dry sand, but all require moisture in the larval state.

2. "Malaria is hardly ever developed at a lower temperature than 60° Fahr." A temperature of 60° F. is necessary for the development of the mosquito.

3. "The evolution or active agency of malaria is checked by a temperature of 32° F." The mosquito is killed or paralyzed, so that *its* active agency is checked, by a temperature of 32°.

4. Malaria "is most abundant and most virulent as we approach the equator and the sea-coast." The swarms of mosquitoes (as well as of sand-flies, ants, and other insect-plagues) that infest many equatorial regions are well known; and, with regard to sea-coasts, the accumulation of mosquitoes is both a fact and easily susceptible of explanation. Under the influence of gentle land-breezes the mosquito is wafted toward the ocean, but, in the absence of strong winds that

* Most of them are quoted from a paper read by Dr. John T. Metcalfe, United States Sanitary Commission, 1862; see, also, Flint's "Practice," p. 826, edition of 1867.

would carry it out to sea, the water will form a barrier to its farther progress seaward, for it is not a marine insect. Mosquitoes, therefore, accumulate on sea-coasts—notably at some of our familiar summer resorts, Cape May, Atlantic City, etc.

5. Malaria "has an affinity for dense foliage, which has the power of accumulating it when lying in the course of winds blowing from malarious localities."

6. "Forests or even woods have the power of obstructing or preventing its transmission under these circumstances."

These last two propositions, embodying, first, the "accumulation," and, second, the "obstruction," of malaria by forests and trees, may be considered together. That a wind coming from a marsh (from, in fact, a mosquito nursery), and bearing a colony of mosquitoes, should be screened or sifted of its insect burden by passing through the foliage of a forest, or a belt of trees, is certainly far more comprehensible than the conception of a malarial vapor being so screened by virtue of its "affinity for foliage." And though, in the case of a single belt of trees, even the mosquital filter may *appear* imperfect, the insect, should it have been carried far, is probably anxious to settle, and may so vary its course by steering as to take the first opportunity of clinging to anything that may come in its way; and, having settled, we may readily conceive its shifting round to the leeward side of a leaf or branch, and there holding on until the wind sufficiently subsides to allow of safer flight. Thus mosquitoes, like malaria, may both accumulate in, and be obstructed by, forests and trees.

The conduct, or rather the mechanical properties, of the mosquito, when carried by the wind, can hardly be better described than in the following verbatim quotation from Sir Francis Day, in his description of malaria. He says: "Malaria may be carried by the winds to places where it was not generated; it is obstructed by and hangs in the foliage of trees, or in mosquito-curtains; it subsides into low places, and may be blown over a hill, and, may be very virulent on the side opposite to that on which it was formed. In like manner it may be taken up the side of a hill, and, as a lull takes place in the atmosphere, consequent upon its weight it rolls down, and may thus envelop its base with a deadly belt of fever, for there, hanging in the leaves of the trees, it gradually sinks through them to the earth beneath, in which situations it is most dangerous to pass the night" (Sir Francis Day's work, p. 87).

7. "By atmospheric currents it" (malaria) "is capable of being transported to considerable distances, probably as far as five miles." So, certainly, is the mosquito.

8. "It" (malaria) "may be developed in previously healthy places by turning up of the soil, as in making excavations for the foundations of houses, tracks for railroads, and beds for canals." Here two things are confounded, viz.: 1. Turning up of the soil, as by plowing or dig-

ging; and, 2. Making excavations. Which of these two is the more fruitful in producing malaria is not stated, nor is the *modus operandi* of either suggested. In Hong-Kong, an island consisting of little more than bare and barren rocks of weather-beaten granite, and whose soil contains but two per cent of organic matter, malarial disease was formerly unknown, and only became prevalent, as it is at present, after *excavations* had been made in digging granite for building purposes. So, again, tanks and pools of water—cess-pools, mill-ponds, reservoirs, and bilge-water on shipboard—appear to be specially productive of malaria. In Ceylon, the tanks of Candelay and Minery — the one twenty miles in circumference, the other twelve—have been considered the cause of malaria in that region (see Davy on "Diseases of the Army," p. 51, etc.). It is easy to comprehend how such pools, tanks, and excavations containing water may constitute mosquito-nurseries, where the female may deposit her eggs and propagate, which would probably have been prevented in the absence of such water accumulations. How simply digging up the soil may contribute to the formation of malaria, or to the development of mosquitoes, *without excavations*, I am not able to explain.

9. "In certain countries it" (malaria) "seems to be attracted and absorbed by bodies of water lying in the course of such winds as waft it from the miasmatic source." That the malaria itself is absorbed by water is pure hypothesis. The known fact embodied in this ninth statement is really this: A body of water intervening between a healthy locality and a fever district will, provided it be sufficiently wide (three fourths of a mile or more) prevent the transmission of fever from the infected to the healthy locality, also provided, of course, that the prevailing wind does not blow the fever-generating element from one side to the other, as we have already seen it may do over a much wider space—probably five miles. This, again, is not difficult of possible explanation by the mosquito theory. All depends upon the answer to this question: Over how wide a sheet of water will the mosquito, in the absence of irresistible winds, attempt to fly? I am unable to answer this question positively. It may depend upon the degree to which the insect possesses far-sightedness, for, if it can not see land across a body of water three fourths of a mile wide, such a width would appear to its vision boundless as an ocean, and under those circumstances it might not voluntarily attempt to cross. Furthermore, the flight of the insect being mostly nocturnal, long vision would be all the more difficult. These suggestions need confirmation: they are tentative, but still sufficient to suggest the possibility of the protective influence of wide bodies of water being explicable on the mosquital basis.

10. "In proportion as countries, previously malarious, are cleared up and thickly settled, periodical fevers disappear." Here, too, we may remark that in such countries the land is cultivated, and its

swamps and pools drained, so that the mosquito can not so readily find a place suitable to deposit her eggs. And, as the forests and underbrush disappear before the implements of the agriculturist, colonies of mosquitoes, wafted from a distance by winds, are not "obstructed" and "accumulated" by foliage, nor can the insect so readily escape, as before, the numerous fly-catching birds that feed upon it. Even here, however, artificial pools, tanks, and excavations containing water, may constitute mosquito-nurseries from which many millions may be developed in a single summer.

11. Malaria usually keeps near the surface of the earth ; it is said to "hug the ground" or "love the ground." When blown by the wind, however, or drifting up ravines, it has been known to rise several thousand feet. Dr. Russell, in his address before the New York Public Health Association, April 13, 1876, stated that, "under ordinary circumstances, a certain altitude affords immunity from malaria, although low elevations of 200 or 300 feet above a miasmatic tract are often more dangerous than the flat lands, the poison seeming to float upward and become intensified." This, he says, has long been noticeable on the heights of Bergen Hill, West Hoboken, and Weehawken, which overlook the Jersey flats. In accordance with the malarial vapor theory, these facts are completely mysterious. The mosquito, on the other hand, is known to hover near the ground (or water) from which it springs, and, being wafted by winds, can readily be understood to be "obstructed" and "accumulated" by forests on the brows of hills, etc.

12. Malaria is most dangerous when the sun is down, and it seems almost inert during the day. Of this there is no doubt, and the various hypotheses on the marsh-vapor theory, that have been alleged in explanation of it, are almost as numerous as they are unsatisfactory. With regard to the mosquito, however, it is well known that it remains, for the most part, during the day, harbored in woods, weeds, or low underbrush, and comes out after sunset and at night to indulge its blood-sucking proclivities.

13. The danger of exposure after sunset is greatly increased by the person exposed sleeping in the night air. Again have the hypotheses based on the marsh-vapor theory been altogether insusceptible of explaining this circumstance satisfactorily. With regard to mosquital inoculation, however, it is undoubtedly true that, while awake, the person exposed will move about, or brush away the insect, while he will submit to be bitten during sleep.

14. In malarial districts, the use of fire, both in-doors, and to those who sleep out, affords a comparative security against malarial disease. Explanations on the marsh-vapor theory are numerous, various, and unsatisfactory. With regard to the mosquito, however, it is well known to be attracted by lamps, lights, and fires, into which it heedlessly flies at the cost of life. In countries where these insects are extremely nu-

merous, lamps are extinguished by the accumulation of their dead bodies. Every fire, therefore, whether in-doors or out, is a sort of mosquito hades. In some tropical countries, despite heat of climate, fires are kept up all night in every apartment as a preventive against fevers; and experience has demonstrated that they are more effective when placed between the open window (or door) and the body of the person to be protected. In this way it is easy to comprehend how every mosquito will fly directly into the light and the fire before reaching the thus protected sleeper.

15. "The air of cities in some way renders the poison innocuous, for, though a malarial disease may be raging outside, it does not penetrate far into the interior."

In conformity with this statement, we may easily conceive that mosquitoes, while invading cities during their nocturnal pilgrimages, will be so far arrested by walls and houses, as well as attracted by the lights in the windows and streets of the suburbs, as that many of them will in this way be prevented from penetrating far "into their interior." Even a single row of houses, on one side of a road, with its contiguous fences, lamps, and closely-knit hedge-rows, may so far completely obstruct the onward flight of mosquitoes coming from some neighboring swamp as to prevent their crossing the street. The curious instances in which people living on one side of a road are attacked with ague, while those living on the other side escape, as on the high-road between Chatham and Feversham (see Macculloch on "Malaria," p. 121), and in Cività Vecchia (see Johnson on "Tropical Climates," p. 315), are quite as susceptible of possible explanation by the mosquito theory as by the marsh-vapor conception, for that the infected air from the marshes does not cross the street is inconceivable.

16. "Malarial diseases are most prevalent toward the latter part of summer and in the autumn."

It has been already explained in what manner—and the fact is a common observation—mosquitoes are more numerous also during the later summer and autumn months.

17. Malaria is arrested, not only by trees, walls, etc., but also by canvas curtains, gauze veils, and mosquito-nets.

Sir Francis Day (p. 87) tells us that travelers, besides being warned against night and morning temperature, should be instructed at night to employ mosquito-curtains "through which malaria can seldom or never pass."

Dr. Macculloch (pp. 137, 138) says that, by surrounding the head with a gauze veil or *conopeum*, the action of malaria is prevented, and that thus it is possible even to sleep in the most pernicious parts of Italy without hazard of fever. The prophylactic efficacy of fine cloth or gauze at night is further attested by Dr. Johnson ("Tropical Climates," pp. 316, 317), as quoted on p. 318 of La Roche's well-known work. (See also p. 416 of Dr. Johnson's work, and p. 15 of Dr. W. J. Evans on "Endemic Fevers of West Indies," 1837.)

Dr. Oldham ("What is Malaria?" p. 172) tells us that the Jeevas of the Punjaub, employed in fishing and catching wild-fowl, spend the whole night in their boats, under the reeds of the marshes, "unharmed in the midst of malaria"; but they are wrapped from "head to foot" in a peculiar costume that completely envelops them, and which they always put on at sunset; and, moreover, a smoldering fire is kept up in the boat.

It is almost needless to add that, while these nets, curtains, etc., can hardly be conceived to intercept marsh-air, they certainly can and do intercept and protect from mosquitoes.

18. Malaria spares no age, but it affects infants much less frequently than adults.

The child *in utero* has even been alleged to suffer from ague when its mother was affected: she has felt it, as she supposed, shivering or executing spasmodic movements during the paroxysm, and such infants have been born with enlarged spleens. Nevertheless, it is a matter of daily observation that the sucking infant is less liable to malarial disease than older children and adults.

Young infants, however, be it remembered, are usually carefully housed, and in summer their beds or cradles are generally provided with mosquito-curtains to keep off house-flies, and they may thus be protected from mosquital inoculation. Furthermore, since the human infant, in savage life, and without the artificial protection of gnat-curtains, would be presumably helplessly exposed to mosquito-bites, it would not surprise us if Nature had given the infant some inbred eccentricity by which the inoculations would be rendered harmless; just as the bite of the African *tsetse*-fly, which will destroy cows and oxen, is perfectly harmless when inflicted upon the sucking calf, as attested by Burton, Livingstone, and Stanley.

19. "Of all human races the white is most susceptible to marsh-fevers, the black least so."

The black man, however, is not entirely exempt, and is probably more secure in his native clime than in the United States and other civilized countries to which he has been imported. Acclimatization is alleged to be the proper explanation of this exemption. The negro, it is said, is born in a country where he is obliged almost incessantly and universally to breathe malarial emanations; he is descended from ancestors who, from prehistoric times, have lived in such poisoned air; he has thus become acclimatized to it more than any other race, and on this account is able to prosper in places where the white man would suffer for a long time (see Quatrefages's "Human Species," p. 223, Appletons' "International Scientific Series"). But we are not told in what this acclimatization consists. Will the mosquito theory furnish any probable explanation?

Crude, simple, and at first sight ludicrous as it may appear, it is nevertheless worthy of consideration that the negro is *black*, and, in the absence of moonlight or artificial illumination, can not at night be so readily *seen* as a white man ; he may therefore on this account escape the sight, and consequently the bite, of the mosquito. The deep tint of his skin possibly constitutes a "*protective coloring*," such as in many other species affords a defense against natural enemies. Moreover, the habit, common with many negro races in their native heath, of daily anointing the body with grease, affords additional protection against mosquitoes, as do also, probably, the offensive odor and greasiness of his cutaneous secretions. In this connection the work of Dr. Balfour on "Sol-Lunar Influence" in malarial fevers, hitherto ignored, deserves reconsideration. The light of a full moon would render the negro more visible to his culicidal enemy.

When the negro is imported into this country, and subjected to the conditions of civilized life—which usually comprise, among the rest, his remaining during a part of the evening in rooms artificially illuminated, or sleeping with his black body portrayed in bold relief upon white bedclothing—the mosquital blood-suckers will then have little difficulty in finding their victim, notwithstanding his protective melanotic mantle.

The Conservative Function of Ague.—In my original paper, read before the Philosophical Society of Washington, on the 10th of February last (and of which, as I have said, the present production is an abstract), I suggested that the natural conservative design of the processes embodied in the term ague was to develop *malarial melanosis*—in fact, to change the skin from white to black, thus securing adaptation to (i. e., protection against) the environment of inoculating gnats, by clothing the individual with a cutaneous mantle of "protective coloring." The spleen I therefore regarded as the organ, one of whose offices is, as it were, to preside over and determine the cutaneous coloring of the individual—a function not hitherto ascribed to it ; though its pigment-forming function, by destruction of blood-corpuscles in its substance, has been long known. The absolute transformation from white to black under the influence of malarial disease has been frequently observed (see a case by Dr. William H. Falls, in the "Cincinnati Lancet and Observer," November 18, 1882, pp. 479–488). Surgeon-General C. A. Gordon, in his account of the fever among the British troops in Cyprus ("London Medical Press and Circular," new series, vol. xxx, p. 303), in 1878, says : "The Forty-second Regiment suffered terribly at Cyprus ; the men looked worse than they did on the Gold Coast—pale and sallow, or *black* (italics *his*), the pure malarial melanosis."

Be it noted, further, that the causes or conditions that lead to different tints of color in different races of men—since it is now known not to depend, as once supposed, upon heat of climate—is a complete and inexplicable mystery ; a mystery, however, that may be now possibly explained by man's geographical relations with his zoölogical tormentors, the proboscidean *diptera*.

That malarial diseases occur frequently without the development of malarial melanosis is not difficult of explanation. The disease is not permitted to pursue its natural course ; it is interrupted by quinine. The individual, moreover, is clothed, or protected from the sun —an artificial appendage and addition to the organism which the ancestrally inherited powers of adaptation could scarcely anticipate would occur. Possibly, if every ague-patient were exposed to a broiling sun, naked, during the chill, and were then suffered to follow the bent of his successive inclinations during the remaining stages of the disease, the accumulated pigment enlarging the spleen would find its natural and more salutary destination in an even distribution over the cutaneous surface—a phase in the natural career of the disease which seems to be further indicated by the circumstances that the chills of ague only occur, in typical cases, between sunrise and sunset, the paroxysms getting of later and later occurrence, as they are wont to do, until reaching sunset, when the night is "skipped," and the attacks begin early next morning. It seems as if Nature required the sun during the chill, in order that her beneficent purpose of protective cutaneous pigmentation should be carried out.

Although the ethnological bearings of this subject hardly belong to a medical paper, I can not refrain from expressing the suggestion that it is not at all impossible that future study and observation may demonstrate that much of the difference in type between the lowest grade of negro and the most perfect Caucasian white may find its true explanation in the changes produced by an environment of inoculating gnats. Even the characteristic type of the negro skeleton and the capacity of his brain, it is not impossible, may be susceptible of explanation in this manner ; for, when we remember that the spleen and its allies are not the only pigment-forming organs, this function being also performed by the marrow of bones, and when we recall, further, the aching of bones that so often attends an ague-chill, in some cases so severe as to have originated the term "break-bone fever," it is not difficult to conceive that the bone-marrow, like the spleen, may become congested during the chill, and in this way, in the course of time, so far lead to modified nutrition of the osseous structures as to set up, finally, a change of type in the embryological formation of the skeleton.

In certain tropical regions it has already been observed by ethnologists that tribes inhabiting elevated regions in the interior are superior to those dwelling on low tracts on the sea-coast, the superiority being manifest both in mental and bodily qualities. The lowlands and sea-coasts, however, are favorite habitats of the fever-producing and pigment-producing mosquito.

In further support of the mosquital origin of malarial disease, we may remark the general admission on the part of medical authorities that sickly seasons and localities are usually accompanied with an extraordinary number of winged insects, many of them being blood-sucking diptera. Lind, in his "Essay on the Health of Semen" (p. 58), referring to an army of Christians, half of whom were lost by fever while passing through Hungary, tells us, "The air swarmed with insects—a sure sign of its malignancy" (p. 60); and, in referring to the climate of Guinea and of the East and West Indies as being fatal to Europeans, he adds, "More especially when molested with heat within-doors, and the plague of mosquitoes, they have ventured to sleep in the open night-air" (p. 71). And again, describing a journey from the interior of Guinea to Senegal, he says (p. 94): "The earth had its white ants, the air its wild bees, its sand-flies, and its mosquitoes. These insects, though not the most tremendous, were perhaps their (the travelers') most distressing enemies." On page 77 he remarks: "The greatest plague was the mosquitoes and sand-flies, whose incessant buzzing and painful stings were more insupportable than any symptom of the fever." After landing on the Canaries the health of the men immediately improved, but they were here no longer "tortured with swarms of blood-sucking gnats and flies" (pp. 83, 85).

Mosquitoes are not generally troublesome in England, yet in the ague-fens of Lincolnshire and the swamps of Essex the use of mosquito-nets is as necessary and common as in India or any other tropical climate ("Chambers's Cyclopædia," article "Gnat"). The prevalence of the mosquito-plague in the fever-districts of Italy is also well known.

Furthermore, in certain districts where the so-called "malarial poison" is supposed to be lodged in trees and bushy plants near the ground, it has been observed that those persons are particularly prone to fever who cut down or disturb these malaria-laden plants, which is extremely suggestive of the mosquitoes being disturbed from their reposing haunts, just as one might get stung by stirring up a bee-tree or a hornet's nest. La Roche, in his well-known work (p. 282), says: "Malaria is collected by plants, particularly those of a dense and entangling foliage, so as to be disengaged on cutting them down or rooting them up, thus exciting fever in the laborers who might otherwise have escaped, as proved by the circumstance that in all these situations, while the workmen are in the erect posture and engaged at their work, they escape the fever, but are attacked if they sit, and more particularly if they lie down on the ground—and that whether they sleep or not."

Here it may be observed that the circumstances stated to conduce to the production of fever (viz., sitting or lying still) are exactly those which would favor being bitten by mosquitoes, the insect having less chance of inflicting its inoculating wound while the men when in motion are "engaged at their work."

The same thing has been observed by Macculloch in the Roman Campagna, where, he says (p. 124), it is remarked that, "if the laborers cut down certain plants (a bushy thistle chiefly), a fever, that would otherwise not have occurred, is the consequence."

In opposition to the mosquital origin of malarial disease it is known that numerous mosquito wounds may be inflicted without the occurrence of malarial disease ; but this is by no means incompatible with the theory. We do not yet know whether the poison be mosquital saliva, or whether the fever-producing element be a bacillus with which the puncturing proboscis of the insect may be loaded at the time of inflicting its wounds. The scratch of a lancet will not produce vaccinia, unless the instrument be charged with vaccine matter ; the puncture-needles of Pasteur would be harmless and impotent, did he not load them with infecting bacteria ; so with dog-bites and hydrophobia, etc.

Nay, it may even turn out that, under certain circumstances, mosquito-bites shall even be protective against malarial disease, for as Pasteur and others are able to produce, artificially, "attenuated culture-fluids," the inoculation of which, while producing slight symptoms, protects from more serious phases of disease, so may there exist in nature naturally "attenuated" fever-poison fluids, the inoculation of which, by mosquital puncture, may produce trivial symptoms, and thus protect from more decided attacks of veritable fever. What product of man's art has not been anticipated by Nature? Hardly any.

In the absence of direct experiments with the mosquito as a fever-producing agent, I have endeavored to ascertain if the geographical distribution of the insect had any relation with that of malarial disease. But the insect and the disease are both so wide-spread that it is difficult to find any locality entirely exempt from either. Tasmania, Singapore, New Zealand, Ceylon, and the Dismal Swamp of North Carolina, as well as the bog-country of Ireland, are said by some medical writers to be entirely exempt from fevers. Others discredit this statement. I do not know who is right ; but I have endeavored to ascertain whether insects of the mosquito tribe were or were not rife in these localities. On this point there seems to be little scientific knowledge available. Of the insects of Singapore—a locality in which the absence of fever seems to be generally admitted—I have been able to find no account. With relation to Tasmania (Van Diemen's Land), where exemption from fever is again generally admitted, I have only been able to find, in the Capitol Library, one reference to its insects. This is from the work of James Bischoff (London, 1832, p. 33), who, quoting from Widowson's "Present State of Van Diemen's Land," says : "The insects are not so numerous or so annoying as in most other tropical countries. The ant, the mosquito, and a common green fly are chiefly seen. The mosquito does not sting so severely as in hotter climates."

With regard to Tasmania, it may also be observed that the native inhabitants are universally of one color—absolutely black—which would suggest a previous history of malarial disease to which a prolonged succession of generations has finally secured complete adaptation and consequent exemption from symptoms. How far the eucalyptus-tree, which here abounds, has been instrumental in correcting malarial disease, also deserves consideration. Possibly the sticky, pendent leaves, and camphoraceous odor of the plant are not conducive to the prosperity of the mosquito genus.

The Dismal Swamp, so far from being exempt from mosquitoes, is said to abound with them during the autumn. Alexander Hunter, writing in "Potter's American Monthly," July, 1881, page 15, says: "The mosquitoes were in uncounted millions; they came armies on armies, waves upon waves, clouds upon clouds, and charged in platoons and single file, and threw themselves with bloodthirsty voracity upon every living thing in reach." On the same page, however, his negro guide, "Bob," is made to say that he reckons he would be quite fat "but for the 'skeeters and chills." Another writer ("Harper's Magazine," vol. xiii, 1856, page 450) refers to an hotel having been erected for a summer resort in the "Dismals," but "before the month of August visitors, servants, and proprietors had all cleared out and left the place in full possession of the mosquitoes and yellow flies. These insects are said to be savage enough to worry the life out of a mule. . . . The hotel was taken down."

In so far, therefore, as regards the geographical relation between mosquitoes and malarial disease, it may be said: 1. The two often coexist; 2. There is no decided proof that localities alleged to be exempt from ague are also exempt from mosquitoes; 3. There is no locality noted for malarial disease where mosquitoes or other blood-sucking insects do not exist.

In those isolated cases of ague occurring during the winter or early spring, before inoculating insects have made their appearance, there may of course be other modes of inoculation. We have only to admit the production of the *bacillus malariæ*, its transmission in the air and its deposit upon the skin, to see how easily it may be inoculated into the body by accidental wounds, such as pin-scratches, the cut from a pocket-knife, or of a razor in shaving, etc. Furthermore, it is generally admitted by medical authorities that the period of inoculation after the poison is introduced into the system may, exceptionally, extend weeks and even months before symptoms are developed. In these, or in some other ways, the isolated winter cases referred to may therefore be explained without necessarily conflicting with the mosquito theory. Finally, it seems incredible that a function so necessary to life as respiration—a function that can not be suspended in any atmosphere—should be the means of infecting the body with a fatal disease. It was surely never designed that breathing the indigenous air of any natural environment should be, and without warning of danger, a means of death. Such a supposition is inconsistent with that general beneficence of Nature as exhibited in the signals of danger, instinctively recognized by all living things, when contemplating their natural enemies, and when in the presence of conditions that are destructive to life.

Man naturally loves beautiful things—woman and the flowers. But the serpent also is beautiful—superficially smooth, tapering in form, elegantly elastic, absolute in symmetry, undulating in motion, every element of beauty in woman finds its counterpart in the snake; yet we love the one, loathe the other—loathe it because we have inherited the instinct that tells us it is one of our natural enemies, whose touch is destruction; and, when sight is not sufficient, the rattle is added, so that even in darkness we may hear the warning note of danger.

When man is prompted by Nature to invade a swamp in pursuit of fowl and fish, his natural foods, it can not be that the silent air he breathes shall, like a subtle enemy, and without any admonition, destroy his life. But when night comes, should he there lie down to rest, the annoying puncture of the mosquito and its siren-song, like the warning note of the serpent's rattle, would emphatically and persistently tell him, "This is no place to sleep!"

The mosquital origin of malarial disease is in this respect, therefore, more in accord with the beneficence of Nature's arrangements than is the conception of malarial fevers being produced by the respiration of a marsh-vapor.

I have before referred to "color-protection" as a means of defense from natural enemies. *Acuteness of audition* is another well-known means. It curiously happens that some forms of fever are followed in those who convalesce by a remarkable acuteness of hearing, which lasts for weeks and months, thus indicating another phase of adaptation to environment, an additional means of recognizing the warning note of the inoculating mosquito, or other insects inaudible to ordinary ears. Dr. J. B. Allan refers to this symptom in his description of a remittent fever prevailing on the African sea-coast ("Monthly Journal of the Medical Sciences," August, 1841, page 545). He says: "The acuteness of hearing sometimes came on during the second day in those who recovered. It was very distressing for the first six weeks or two months of convalescence; and every wave that burst on the distant reef was counted with pain and even dread."

If the mosquital origin of malarial fevers be correct—if protection from mosquital inoculation protects from ague—the means of prophylaxis from malarial disease will not be difficult. It comprises the following items:

1. *Personal* protection from all winged insects, especially during evening and night, by gauze curtains, window-screens, or clothing im-

penetrable to their probosces—a further protection from these, as well as from the bites of creeping insects, especially during epidemics and endemics in jails, ships, etc., by a daily inunction of the whole body with some terebinthinate, camphorated, or eucalyptalized ointment or liniment.

2. *Domiciliary* protection, exteriorly, by screens of trees, walls, fences, etc., interposed at some distance between dwellings and the sources of malaria or mosquito nurseries, together with fires, lamps, or electric lights, to act as traps for the attraction and destruction of such winged insects as may approach nearer; a further protection in the interior of dwellings being secured by the use of smoke (such as that of tobacco or pyrethrum), or of some volatile aromatic oil, as of camphor, etc., which may be offensive to proboscidian intruders.

3. *Municipal* protection, by the destruction or draining of swamps and pools which produce mosquitoes; and by the planting of forests to obstruct the latter in their flight, or cordons of electric lights for the same purpose, as well as for the destruction of insects that may be attracted by the flame or incandescence.

THE GROWTH OF HYGIENIC SCIENCE.*

By Professor DE CHAUMONT, M. D., F. R. S.

It is a little difficult in a necessarily restricted lecture to convey any exact idea of the way in which modern hygiene became formulated into so much of a science as it can at present lay claim to; but I will attempt to make a brief sketch of its more salient points. In the eighteenth century there were several important questions inquired into, and to a large extent solved, of which the chief were—1. The influence of air as a factor in the spread of disease; 2. The true cause and prevention of scurvy; and, 3. The prophylaxis of small-pox. Taking the last first, we may say that the introduction of inoculation was a most important step, even although we must admit that it introduced a greater danger to the community at large than could be compensated for by the protection to individuals. But it was the first step on the road which led at the close of the century to vaccination, one of the most signal triumphs of preventive medicine, and in our own time to the magnificent results obtained by the renowned Pasteur, results which seem pregnant with so much hope for the future of our race.

The inquiry into the causes of scurvy was another step in advance, of the most signal importance. No one in the present day can form

* From the inaugural lecture of the Parkes Museum, delivered June 1, 1883.

any idea of the ravages that terrible disease produced. All long voyages were imperiled by it, while the very existence of England depended upon her fleet, which had frequently to return to port absolutely crippled with scurvy, in some cases as many as ten thousand men being landed from the Channel fleet helpless. Although so far back as the seventeenth century the efficacy of fruits and fresh vegetables as preventives had been surmised if not actually noted, it is really to the renowned Captain Cook that the credit is mainly due of having established this important fact. That eminent navigator never lost an opportunity of taking on board fruits and fresh vegetables whenever he could, and the result was that he was able to bring home from a lengthened voyage crews in almost perfect health and condition, a thing never before known. It took many years, however, to impress this fact sufficiently upon the authorities, and it was not until 1796 that the medical officers of the navy (among whom was the renowned Sir Gilbert Blane) obtained the regulation ordering lime-juice to be supplied to our seamen. The effect was magical: scurvy lost its terrors, and it may be that the supremacy of England at sea during the Napoleonic wars was in part owing to the improved condition of her seamen during that gigantic struggle. We have still a monument of the extent of the disease in the immense naval hospital of Haslar, the largest in this country, which was built of such dimensions mainly to admit the extraordinary number of scurvy patients which were being continually landed from our fleets. We have not yet got entirely rid of this enemy, but I think we know now how to combat it, in spite of heretical opinions which find expression from time to time.

The recognition of foul air as a factor in disease was certainly begun in the last century, when the brilliant discoveries in pneumatic chemistry made by Lavoisier, Cavendish, Priestley, Black, and Rutherford threw such a flood of light upon a previously obscure subject, and opened the whole immense vista of the boundless science of modern chemistry. It was only then that the physiology of respiration could be even partially understood, and the changes recognized which take place in the respired air from the lungs of man. The great disaster of the "black hole" of Calcutta, and the terrible effects of the jail-fever, investigated by Howard and others, pointed to foul air as a main factor in the propagation of disease and death; and this was further corroborated by the observations made by military surgeons that outbreaks of typhus (or putrid fever) were most rapidly arrested when troops were encamped and scattered widely over the surface of the ground. It was reserved for the later researches of Neil Arnott and other hygienic observers of the present century to prove the still more important fact that foul air is the main cause of the still more general and fatal class of destructive lung-diseases, which in this and in other lands cut off so many of the brightest and the best.

Another important discovery of the last century was the determination of the cause of the well-known lead-colic by Sir George Baker. This opened up the large field of metallic poisoning which has received so much elucidation and proved of such importance in reference to the water-supply of large communities.

In the present century we have to point to the establishment of the fact of the water-carriage of disease, with which the name of Snow is so honorably associated, the differentiation of continued fevers by Stewart and Jenner, and their connection with the poison of infected excreta by the labors of Budd and other eminent men. To those we must add the elaborate investigations into the modes of propagation of cholera, dysentery, and other tropical diseases, and the means by which scarlet fever, diphtheria, etc., are carried from place to place by various channels of communication. It would be unadvisable, even if it were possible, to enter into details on these points, but there is one branch of the subject on which we must dwell for a little. No inquiry can assume a scientific form unless it has a numerical basis to work upon, and therefore it behooves us to note the starting-point of such a basis in hygiene, if we can find it. This we do find in the collection of statistics, a beginning of which was made a long time ago in the bills of mortality kept in this country. We know how imperfect those were, and how even the population of this country was not correctly known until within the lifetime of men still living. But still beginnings were made, and the question taken up more and more enthusiastically by enlightened men, until at last the Government Statistical Department was formed, and that remarkable series of reports begun which will immortalize the name of William Farr. From that time the future of hygiene was assured; for there was sound ground to work on, and, if we add to that the valuable reports on the health of towns published by the commission of which the present Duke of Buccleuch was president, we shall have stated some of the most important foundations of modern sanitary science. Those reports disclosed a state of things little dreamed of, and the statistical returns compiled by Dr. Farr showed how much the life and health of the nation were dependent upon the conditions in which its individual members were placed. The establishment of the General Board of Health, under Mr. Chadwick, was one of the valuable outcomes of this remarkable movement. Although the original Board of Health was brought to an end in 1854, yet its work has been continued and expanded under Mr. Simon, his colleagues and successors, in spite of many difficulties and obstacles.

The part which the public services, such as the army and navy, played in the progress of hygiene was very important, as might indeed be expected; for under no other circumstances could bodies of men be so well observed, and the effects of surroundings and conditions upon health noted. Accordingly, we have a long roll of names connected with those services which must ever be remembered with honor: in the navy we have such men as Lind, Blane, Trotter, Burnett, etc.; and in the army, Pringle, one of the most philosophical physicians who ever lived; Brocklesby, Fergusson, McGrigor, and a host of others. The labors of the late Sir Alexander Tulloch, Deputy-Inspector-General Marshall, and Assistant-Surgeon (now Surgeon-General) Balfour, in collecting and arranging the army statistics, were of the highest value, and it is not too much to say that the publication of the first army medical statistical report marked an epoch in hygiene, especially in that part that deals with climatology. It exposed the fallacy of the common notions of acclimatization, of the advantages of a seasoning fever, and similar ideas. It showed also that it was possible for men of temperate habits and in hygienic conditions to live and thrive in the tropics, while the death and sickness that were unfortunately so common were due much more to the ignorance and folly of man than the influence of climate in any form. The truth of that is to be seen now when life in the West Indies is actually healthier, especially for young soldiers, than service at home, whereas sixty years ago a tour of service there was looked upon as almost a sentence of death. It is true we have still yellow fever to combat, but we know now much better how to deal with it when it does come, and how to obviate its invasion when it is threatened. The army medical statistics are continued now yearly, but it is a matter of regret that they have been allowed to be published in so abstract and undetailed a shape as to deprive them of much of their utility. It is to be hoped that this mistake may be remedied, and that the saving of a trifling sum, which is said to be the reason, may be recognized as a truly false economy. But perhaps the most remarkable contribution the army has made to sanitation has been by the evidence given to the Royal Commission of 1857, which met after the Crimean War to investigate the causes of the sickness and mortality of our troops. The results of that commission are well known, and from its publication may be dated the reforms which have been productive of much advantage both to our own and foreign armies, and to the civil population as well. The paramount influence of foul air in the production of lung-disease was proved to demonstration, and the art of ventilation was placed upon a secure foundation. The Barrack Hospital Committee, of which Dr. Sutherland and Captain Douglas Galton were the active members, laid down a series of regulations for the construction of barracks and hospitals, which have been followed with the utmost benefit both at home and abroad. Following this came the Indian Commission, which did for that vast dependency what the Home Commission had done for the rest of the empire. The mortality in India was found to be inordinate, and it was equally clearly traced to insanitary habits and surroundings. To recognize an evil and its cause is half-way to curing it, and after a lapse of a quarter of a century we can point, not certainly to perfection, but to such an improvement as might fairly at one time have been looked upon as chimerical. The death-rate of the army at home is only two fifths of what it was before the Crimean War; the death-rate in India is only one third; and the death-rate in the West Indies one tenth.

In civil life it has recently been shown that the improvements of later times have resulted in a diminution of two per thousand in the general death-rate, and with the knowledge we now have of the causes of disease we may be sure that a general death-rate of not more than fifteen per thousand may be confidently looked for. We have not yet got rid of the fatal endemics in our midst, but they are in some directions diminishing, and we have good hope for the future; while it seems probable that neither cholera nor any other introduced pestilence could establish a foothold in our land. The remarkable immunity of soldiers and prisoners in the last epidemic shows what can be done when people can be compelled to lead fairly hygienic lives.

I might extend this lecture by reference to the various theories of disease propagation, but time will not permit of it, even if it were otherwise desirable. I may, however, say that no one theory yet promulgated completely satisfies the requirements of the case, and that there may be some basis of truth even in the most conflicting views. So much has been done hitherto, and so much activity is being shown in investigation, that we can not fail ere long to find the key to many of the mysteries that now baffle and perplex us. It is quite clear that it is only by a knowledge of the causes of disease that hygiene can be advanced, and that it can never be in any way perfected without a complete system of etiology; and we are at present in this position, that practical hygiene has to some extent outstripped the knowledge of disease causes. We look, therefore, anxiously toward the pathological investigations of the time, and we deeply deplore the well-meaning but misguided zeal which is at present placing such grave obstacles in the way of the only means by which true science can advance—namely, direct experiment.

Although there are many names I might refer to as great writers in hygiene, abroad as well as at home, there is one which we can not omit in a lecture like this, more especially as it is the first delivered in this museum which has been founded to his memory. Edmund Alexander Parkes did more than any other one man in this or any age to make hygiene a positive fact, a practical science, based upon not only philosophical conceptions but actual experiment. Starting in life as an army medical officer, he was able to produce, during his short service in India and Burmah, works upon dysentery and cholera which will always be of the greatest value. Retiring into civil life, he became eminent as a physician and teacher, and in 1855 he undertook the organization of the hospital at Renkioi, in the Dardanelles, which was a perfect model of successful hygienic administration. Struggling with distressing and dangerous disease he continued to lead a life of intellectual activity not often accomplished by the most robust; and when, in 1860, the Army Medical School was established by Lord Herbert of Lea, Sir James Clark had no hesitation in advising that Dr. Parkes should be secured if possible as the Professor of Hygiene. How excellent the foresight of that eminent physician was, we all know, for Dr. Parkes was not only the first professor of the science in this country in point of time, but also the first in every sense of the word. The publication of his well-known "Manual of Practical Hygiene" gave us for the first time a work on the subject which was not merely a string of opinions and surmises, but at every point brought opinion to the test of figure and experiment, where it was possible, and thus laid the foundation for a real science in the future. Similarly with his teaching he pressed upon the Government to establish practical laboratories for his pupils, where they could do for themselves as much of the experimental work as time and opportunity allowed; and he impressed upon those who studied under him the necessity of testing everything by actual investigation and bringing all statements to the proof of figures before accepting them as true. There was never probably a man of calmer and more judicial mind, a man more rigidly critical of his own work, or more kindly disposed to allow every credit to the work of others. Having known him personally for many years, during thirteen of which I was his assistant and colleague, I can bear confident testimony to the exceeding beauty of his character, in which "sweetness and light" were never more truly displayed, and the scrupulous accuracy and care with which every investigation of his was carried out. The science of hygiene could have no purer and better founder and its votaries no brighter and more spotless example.—*Lancet.*

"OUR MARRIAGE AND DIVORCE LAWS."

By E. T. MERRICK.

AN article in the June number of "The Popular Science Monthly" for 1883, on the subject of "Our Marriage and Divorce Laws," it seems to me, is worthy of further notice.

We have no occasion to find fault with the picture which the writer draws of the divorce laws of many of the States. It is highly probable that the cause of the deplorable disregard of the binding force of the marriage tie, in certain of the Eastern States, must be sought for outside of the statute laws themselves. Laws or constitutions have but little value except public opinion demands their enforcement.

When the universal sentiment of a free people is opposed to a statute, it might as well not be written ; it is practically a dead letter. It therefore seems to be of little avail to contend about the adoption of laws distasteful to the community in which they are to be enforced, and little use in passing them. The only true mode of obtaining beneficial legislation is to educate the people, who are to enforce the laws among themselves, to understand their necessity or usefulness. Most communities, when left free to act, understand their own wants and necessities better than anybody else.

Still, it does not seem so absurd for intelligent and benevolent people of New York and New England to disturb themselves about the laws affecting the marriage relation of negroes with white people in the South (say in North and South Carolina, Alabama, and Virginia), as it would seem for a colored congregation, or a meeting of field-hands in Louisiana, to pass resolutions condemning the divorce laws of Connecticut or Maine.

With the lawgiver, the contract of marriage—the most important of all contracts—may be supposed to rest upon the gravest considerations, and give rise to the most serious deliberations. He may well inquire :

1. What relations must be prohibited from marrying each other ?

2. At how early an age may marriage be permitted, and what relations must be called upon to assent to the marriage of minors ?

3. Ought the insane who have lucid intervals to be permitted to marry ?

4. Are there any diseases—such as leprosy, elephantiasis, scrofula, or others—which ought to prevent the marriage of such diseased persons ?

5. Ought marriage with inveterate drunkards to be prohibited ?

6. Are there any crimes which ought to be considered as a bar to the marriage of the criminal ?

7. Assuming, according to the prejudices of the largest number, that the white is the superior race, ought laws to be passed prohibiting marriage between white persons and Indians, negroes, Australians, or Chinese ?

What will be the effect of such marriages on the welfare of the State ? Will they drag down the assumed superior race, while they tend to build up the other race ? Will such marriages offend the race prejudices alike of the black and white races ? Or will such marriages be pleasing to the one race and displeasing to the other ? Will not the violation of race prejudices by such marriages occasion unhappiness, and is there any advantage to the State to compensate the misery ? What has been the result of the marriages of white women with negro men on the happiness of the wives and their offspring ?

Such questions as these, it may be assumed, are in the mind and province of the Legislatures when marriage laws are framed, and who shall say that such grounds ought not to be considered? When we bear in mind how difficult it is to pass laws through Congress, and how difficult it is to adopt uniform laws which do not operate harshly on some portion of our immense country, we may well question the advisability of amending the Constitution of the United States in order to put the subject of the marriage relation under the control of Congress. How many years has the Parliament of England been wrestling with the deceased-wife's-sister question!

So large a nation as ours, whether the laws are promulgated from Washington or the capitals of the several States, will always furnish the philanthropist with worry enough on a great variety of questions to make him comfortable, if not happy.

It is not probable that any laws which Congress could pass on the subject of marriage would be satisfactory to the advanced minority, and their passage would occasion the greater anxiety because such minority would suppose themselves in some manner directly responsible for the laws. It is, therefore, not at all strange that many of the State laws—such as those of Ohio, or Virginia, or Alabama, which prohibit marriage between the negro and white races—are supposed by people of other beliefs to contravene the fourteenth amendment of the Constitution of the United States. Hence, the writer of the article under consideration criticises the decisions of the Supreme Court of the United States for refusing to declare such laws null and void. He says the decision "abridges the privileges of a citizen on account of color; it denies the colored male citizen the equal privilege and protection of the law extended to the white male citizen—the right to marry a white woman. It denies the white female citizen the privilege and protection of the law granted the colored female citizen—the right to marry a colored man."

Perhaps the easiest way to set the matter right with those who might be inclined to think, from the adverse criticism, that the Supreme Court of the United States had erred, will be to state the facts of the case, and repeat what that high tribunal has said on the subject in the case of Tony Pace *vs.* Alabama, 106 United States Reports, pages 584, 585. Adultery and fornication, by section 4,184 of the Alabama code, are prohibited by a fine of one hundred dollars and imprisonment, with or without hard labor, *in the county jail*, for six months. Section 4,189 of the same code declares that, "if any white person and any negro, or the descendant of any negro to the third generation inclusive, though one ancestor of each generation was a white person, intermarry or live in adultery or fornication with each other, each of them must, on conviction, be *imprisoned in the penitentiary*, or sentenced *to hard labor* for the county for not less than two nor more than seven years."

The provisions of the fourteenth amendment to the Constitution of the United States prohibit any State from *making or enforcing* any law "which shall abridge the privileges and immunities of citizens of the United States," or denying "to any person within its jurisdiction equal protection of the law." *This amendment required congressional legislation to carry it into effect.* It did not provide for its own execution. To give effect to the amendment, the famous Civil Rights Bill was passed in 1870, which is referred to in the opinion of the court.

In November, 1881, Tony Pace, a negro man, and Mary J. Cox, a white woman, were indicted under section 4,189 of the code of Alabama, and were convicted, and each sentenced to two years' imprisonment in the penitentiary. The State Supreme Court having affirmed the sentence, Pace sued out a writ of error to the Supreme Court of the United States. After full argument, through Mr. Justice Field, its organ, that court said: "The counsel of the plaintiff in error compares sections 4,184 and 4,189 of the code of Alabama, and assuming that the latter relates to the same offense as the former, and, prescribes a greater punishment for it, because one of the parties is a negro, or of negro descent, claims that a discrimination is made against the colored person in the punishment designated, which conflicts with the clause of the fourteenth amendment prohibiting a State from denying to any person within its jurisdiction the equal protection of the laws.

"The counsel is undoubtedly correct in his view of the purpose of the clause of the amendment in question, that it was to prevent hostile and discriminating State legislation against any person or class of persons.

"Equality of protection under the law implies not only accessibility by each one, whatever his race, on the same terms with others to the courts of the country for the security of his person and property, but that in the administration of criminal justice he shall not be subjected, for the same offense, to any greater or different punishment. Such was the view of Congress in the enactment of the Civil Rights Act of May 31, 1870, chap. 114, after the adoption of the amendment. That act, after providing that all persons within the jurisdiction of the United States shall have the same right, in every State and Territory, to make and enforce contracts, to sue, be parties, give evidence, and to the full and equal benefit of all laws and proceedings for the security of person and property as is enjoyed by white citizens, declares in section 16 that they "shall be subject to like punishment, pains, penalties, taxes, licenses, and exactions of every kind and none other, any law, statute, ordinance, regulation, or custom to the contrary notwithstanding.

"The defect in the argument of counsel consists in his assumption that any discrimination is made by the laws of Alabama in the punishment provided for the offense, for which the plaintiff in error was indicted when committed by a person of the African race and when committed by a white person.

"The two sections of the code are entirely consistent.

"The one prescribes, generally, a punishment for an offense committed between persons of different sexes; the other prescribes a punishment for an offense which can only be committed where the two sexes are of different races. There is in neither section any discrimination against either race. Section 4,184 equally includes the offense when the persons of the two sexes are both white and when they are both black. Section 4,189 applies the same punishment to both offenders, the white and the black.

"Indeed, the offense against which this latter section is aimed can not be committed without involving the persons of both sexes in the same punishment.

"Whatever discrimination is made in the punishment prescribed in the two sections is directed against the offense designated and not against the person of any particular color or race. The punishment of each offending person, whether white or black, is the same."

The writer of the article referred to thinks it is a great hardship that one eighth of the people of the United States are prohibited by law from marrying with the other seven eighths.

We think he is mistaken about the fact of prohibition, and that the legal prohibition is very far from universal in the several States. We think, further, that the general sentiment of the negro race, where they dwell in large bodies, is at present opposed to marriage between the races. At all events, such marriages rarely take place where they are legally permitted. Negroes certainly have a higher regard for persons of full blood of both races, and seem in the main entirely unconscious of the injuries which the laws of some of the States are supposed to inflict on them. If the laws are to be changed so they can intermarry in order to elevate the races, why should not some sentimental white people be sent out to Dahomey in order to elevate Africa by the same process?

Let us rest assured of one thing: If the colored race has any virtue in it, it will assert itself. Sturdy integrity, sturdy intelligent industry, and patience, will command respect and will be accorded consideration everywhere. I know of no instance in history where a people has attained eminence without exhibiting energy on its own part. All great peoples have earned their positions. Recognition of the African race, for all it is worth, will come (if it is not now here) in due time.

There is one other matter contained in the article under consideration which ought also to be noticed. It is therein supposed that Congress has power to pass a law declaring the "marriage contract" to be of that kind "within the meaning of the Constitution, which declares that no State shall pass any law impairing the obligation of contracts."

As legal minds are not yet readjusted to the "newer condition of life" and "a higher civilization," there is an obstacle in the way: The Supreme Court of the United States, and not Congress, is invested with the august power of declaring what the Constitution of the United States means. But this may not be a satisfactory way of looking at the question. Let us take a step further.

A marriage contract, as viewed *by the law*, is only a contract in solemn form between two persons of different sexes, to live together in the state of matrimony until one of them shall die. In this aspect the contract is simply between two persons and binds only two. But another view may be taken: it may be considered as a contract affecting *the public order*, so that the public authorities are to be consulted as to the forms of its solemnization, and the causes and the proof needed for its dissolution.

Laws in force in a State are considered as forming a part of all contracts made during the existence of such laws. We may assume for this country, that there is no State in which it is not fundamental; that the willful violation of a contract in its essential particulars prevents the party who has violated it from enforcing it against the innocent party. Statutes which authorize the setting aside of contracts for their willful violation, or for fraud in their inception, come more properly within the police power, and as touching questions of morals and status, than as laws infringing a sound contract, and such laws are never thought to impair the obligation of a contract in the sense of the Constitution. *The party who violates* the contract is he who impairs it.

He will ask the courts in vain to enforce what he himself has willfully destroyed. So, too, the innocent victim ought not to be bound, where the other party refuses to be bound. But suppose the State steps in and says of the contract of marriage: This matter respects the welfare of the State; it is the interest of the State that the family should not be broken up; the children must have a home; scandal must be prevented, and, therefore, the marriage tie must not be severed.

But here, again, other considerations may be interposed. In ordinary contracts, damages are given the innocent party to compensate for their violation. But money can not atone for the continued desecration of a home or restore a blasted life. Suppose a case where the husband maltreats the wife, and her home is made intolerable and her life a burden. To condemn her to live with the brute is to punish the innocent and reward the guilty. An involuntary life-long degradation worse than servitude is imposed on the unhappy wife for the vices of her husband. Such an administration of law is revolting to our sense of justice.

The above brief suggestions may indicate some of the difficulties which environ the complex questions which "our marriage and divorce laws" evoke.

WOODLAND AND WATER-COURSE.

By HORACE LUNT.

AN interesting exhibition of a swarm of gnats, just out of their pupal state, playing up and down over a particular stone in the wall like jets of water in a small fountain—dispersing instantly as I strike my hands together in their midst, and reappearing over the same stone, again to commence their sport—has engaged my attention, and furnished a side-entertainment, so to speak, until a bird-note to which I had never before listened reaches my ear. At first it is heard at a distance, but, as the singer approaches, the strain is rich and clear, and I become absorbed in the melody. Presently a bird flies from the copse yonder to a tree near by, and, with the positions of serenaded and serenader reversed, pours out a heart-song, in six short stanzas, uttered at intervals of half a minute, which is interpreted thus:

" *Chee—cheer*—cheer—
Chip along—cheer—cheer!"

The words are pronounced with the tongue of a foreigner, it is true, and seem broken; but, considering the artist's recent arrival from Guatemala, he has succeeded admirably in mastering the language. At first, the song is begun in a low tone, as if the musician were doubtful how he might proceed; but, as he advances, it reaches a rapturous climax, and then falls down into the commonplace, ending almost as it began, faltering and inarticulate.

Looking up, I see a spot of white, red, and black among the leaves. Although I have seen the bird at a distance many times, this is my first real introduction to the rose-breasted grossbeak. Knowing what he is after, I seek a covert, to allow him free use of the stream, on the banks of which he soon appears, and, wading into the depths, where is reflected the carmine on his front, scoops up with his deep, broad bill the water needed to clear his throat after such a fine performance. He is a rare minstrel in this woodland, and indeed throughout this part of New England, not more than a pair or two appearing or being established in the same locality, which is generally near a stream of water or in the neighborhood of swampy tracts, for these birds are consummate bathers, and love to have houses with convenient bath-rooms attached.

Passing up the stream, and noting the differently cut patterns of the leaves on shrub and tree, I discover the former home of this singer, situated in the central portion of a high, stout cornel, about twenty feet from the ground. It has certainly been rifled, either by oölogists, young or old, or by the predaceous squirrel; for this is the season of incubation, and not an egg is to be seen.

The nest is composed of rather coarse material, and is very shallow and loosely constructed, somewhat resembling that of the swamp-sparrow, but larger, and not so elaborately built. It being such a simple nest, either the male or female must be on guard to prevent the eggs from rolling out. During the period of incubation, Nature has told the husband to relieve his wife occasionally of the household service, but has evidently forgotten to bestow one apparently essential quality—that is, silence. He is hilarious, even while engaged in his responsibilities, and thus, by his incessant singing, is apt to betray his presence to passing marauders.

The female is dressed in a much plainer suit of brown. Two white stripes, one above and one below the eye, are all she can boast of as head ornamentation, with some sprinkling of saffron about the wings. She is a wise-appearing bird, and does not wear her heart upon her sleeve, like her unwary husband.

It would be interesting to know the circumstances under which Linnæus classified our rose-breasted grossbeak, and gave him the name by which he should be known thereafter to all the nations of the world. The generic *Zamelodia* signifies *singing melody*, which is very appropriate ; and the specific "*Ludoviciana*," Louisiana, or relating to Ludovicus. It is likely that Louis XIV was meant, as that King of France took much interest in scientific matters, and invited many of the leading men of science of his day to visit his country. Among them was probably the great Swedish naturalist, who named the bird partly after Louisiana—which was at that time a more extended province than the present State, and where these beautiful songsters are plentiful—partly out of respect for the French monarch, with whom he must have had pleasant associations.

This low ground, where the swamp-roses and tall meadow rue blossom in profusion, is the favorite building-place of the Maryland yellow-throat. Here is one at this moment, the female, moving among the bushes apparently in an anxious state of mind, now darting in and out of sight, now alighting on a twig not ten feet away, her wings quivering with fright or anger, and uttering that peculiar scolding "*chip!*" which expresses so much distress and solicitude, and which has the power and eloquence behind it to arrest your steps for a time, however good your intentions may be in searching for the nest. Surely it can not be far away. The male has arrived with a spanner in his beak, which does not prevent him from chattering his discomfort at my near approach. A small bird he is, with upper parts much the color of the bark of the shrubs ; the breast greenish-yellow, with a broad band of black covering the cheeks, and a narrower light one above it. This ornament the female does not have, and she is somewhat smaller.

The application and meaning of the technical term *Geothylpis trichas*, by which the yellow-throat is designated in scientific books, is, says Coues, "obscure, its only pertinence being in *geo-*, earth, signifying the humility of this bird of brake and brier."

Keeping a sharp lookout, I see the pair flit down among the sedges, the white tops of the meadow rue trembling as they push against the stout stems, and go skulking here and there among the tussocks of rushes where their nest is concealed. Approaching cautiously and tenderly, pushing aside every culm and stem, I at last discover their home, exquisitely placed in a tuft of sedge, some of the spears of which are bent over it so as to form a regular canopy. Ornithologists say that the nest is often built over at the top, with a hole for the entrance. This one has no such contrivance, the thick, overbending sedges answering as a dome and portal. The foundation is composed of dead leaves and coarse grasses, very compact, as if the architects were aware of the dampness of the situation, and had taken the necessary precautions to prevent the eggs from spoiling before hatching-time. The cavity is quite deep and wide for the size of the bird, and has the unusual though sparse lining of horse-hair. There are two eggs in the nest, and, though I read from no authority that the general ground-color should be of a flesh-tint, it is certainly true of these, the larger end being covered thickly with dark purple and brown blotches. Bending the spikes over the nest again, as naturally as a clumsy hand could perform such a delicate task, I went away, trusting that the disturbed pair had comprehended my purpose of merely looking in upon them. But it was of no use ; their nice sense of the proprieties had been disturbed, and a week afterward the ogre had the remorse of gazing into the deserted home from which the songs, confined in their little round prisons, were never to be set free.

The streams and swamps offer more attractive entertainment, at this season, than the dry uplands. Every bird in the vicinity comes here to slake its thirst and bathe. Here is a merry skating carnival of gerris, and a larger party of whirligig water-beetles dodging about in every direction, but never appearing to collide, as they pounce upon the drowning flies, or the twisting, jerking larvæ of the gnat. Down through the thick alders and overhanging sprays of *sambucus* the red-eyed vireo flits from water to twig and from twig to water, striking it with her wings, and sipping it as she flutters over the stream. I am inclined to believe that this may be the manner in which all birds belonging to this group perform their ablutions and quench their thirst. They are not groundlings, and shun the earth as the swallows do the foliage.

Ah ! here is a small flock of chickadees (*Parus atricapillus*), that I have surprised, climbing about on the trunk of this patriarchal willow. The black-capped titmouse is a real Mark Tapley among birds, and actually seems to be less joyous in the midst of summer sunshine and foliage than when the cold winds whirl the snows of winter before his door. How wonderful it is that such a wee bit of a bird "should come out so strong under circumstances that would make many of the other birds miserable"! One would suppose a good cold breath from Jack Frost would whiff the life from them. It is true they are wrapped in the best kind of overcoats, with black caps drawn over their ears, and good chest-protectors. But what in the world of wonders saves those little wires of legs and claws? What fiery hearts they must have in their breasts, to force the blood-corpuscles through the tendons in the coldest days! What pleasant, convivial, round-headed little fellows they are, calling to one another from their holes in the trees, living on the best of terms with their neighbors, and ar ranging picnic-parties with the blue-jay and downy woodpecker!

By the middle of June all their children have become sufficiently clothed for the summer, and as the season advances they gradually don their flannels for the winter campaign. All that I see now in these woods have thus early in the season formed themselves into flocks, which leads me to believe that they have but one brood in the year. All birds seem to understand each other's alarm-notes, although they may belong to a different genus, and there is something that causes them to congregate from all quarters whenever it is sounded. For birds, like the higher bipeds, are of an inquiring turn of mind, and the same motive prompts them, I believe, to gather at any unusual occurrence in their precincts, which collects a crowd at a fire, or any other excitement, in the streets of a city.

At such times you realize the number and variety of birds that, a moment before, were hidden and silent all around you. Here a female oriole, startled by the close proximity of a meadow-mouse, that like herself has come down to the stream to drink, flies up scolding terribly at the spectacle, and instantly the other birds gather around to inquire the reason of this consternation. The cedar-birds appear suddenly on the spot, silent but observing. The song-sparrow hops upon a twig, from his washing, preens his speckled breast, and curiously eyes his brilliant neighbor. The yellow warbler holds up her head from behind an alder-leaf, and goes skulking through the thick foliage. The indigo-bird looks upon the scene from the lofty spray of yonder elm, and begins a song, when a puff of wind blows him off and cuts it short. The brown thresher, last to come, flies across the opening, flaunts his long tail as he alights on a low branch, and utters a few croaks. Then all is silent as before.

HOW THE EARTH WAS PEOPLED.

By M. le Marquis G. De SAPORTA.

I.

WHY should the study of prehistoric man excite bitter passions? Why should it trouble timorous souls? Its aim, with real scientific inquirers, is simply to attain an objective reality, worthy of the respect of all; and it has had the happy fortune to unite in a common pursuit minds of the most diverse character, having neither the same motives nor the same tendencies, but animated by the pure desire of increasing the domain of knowledge. In this way freethinkers and priests, men of the world and men of the study, collectors, pioneers, philosophers, and practicians, whether spiritualistic and Christian or positivists, resolute partisans of the doctrine of evolution or opponents of it, have labored hand-in-hand in prehistoric investigation—that is, in collecting all the signs, observations, and things which relate to the existence of man in the times anterior to history. The objects of this study also lie back of all chronology, and it is in question whether it is possible to make an estimate of the time within which they were embraced. History, as founded on documents and monuments of definite import and intelligible traditions, goes back to the foundation of the Egyptian empire by Menes, five thousand years before Christ, and there stops. At that time, the Egyptians had an organization, a well-developed civilization, and cities. It is not hazarding too much to add as many years to the figure we have named, or to accept Plato's statement that the Egyptian people were ten thousand years old in his time.

Prehistoric times begin at this period—twelve thousand years ago—and extend back into a much more remote past. Without written data, without even conjectural dates, is it possible to estimate their duration? All that we have are the marks that man has left on Nature, who, in her incessant action burying these marks under accumulations of successive strata, gives us a kind of relative chronology. It is now admitted by science that the life of man crosses the whole Quaternary period, and if we can measure the duration of that period we shall be able to fix approximately the age of our race. This is what M. de Mortillet attempts to do in formulating the conclusions of his book on the "Prehistoric Antiquity of Man."

The circles of growth of trees on American ruins and the rates of formation of river deltas and alluvions have been made the bases of partial and doubtless insufficient calculations from which an age of five or six thousand years has been assigned to the polished-stone period of Robenhausen, and thirteen thousand years for the accumulation of Nile-mud over a brick which was found beneath a statue of

Rameses. The stalagmites of the Kent Cavern, England, which cover both Roman relics and palæolithic implements of the Magdalenian period, have been made the basis of calculations which give an age of more than three hundred thousand years to the more ancient of the deposits. This, of course, is upon the supposition that the rate of incrustation has never been more rapid than it is now. Other calculations are more general in their bearing. The oscillations of the European lands under which Denmark, North Germany, and Russia have been raised from submergence during the Quaternary period, Scandinavia was depressed and has been slowly raised again, and England has been sunk till the connection that existed between it and the continent during the whole Quaternary period has been destroyed, required not less than seventy thousand years. Still another grand and surprising phenomenon, the extension of the Alpine glaciers, by which huge rocks were carried to distances of seventy or one hundred and seventy-five miles, required an enormous length of time. The maximum rate of progress of these blocks is not more than sixty metres a year; but in Quaternary times, when the slopes were not nearly so steep as now, the rate was, according to M. de Mortillet, five times slower, and each erratic block must have taken more than twenty thousand years to be carried from Mont Blanc to the lower Rhône. We may add that an enormous number of blocks were thus transported to form the terminal moraine. Add to the period of extension the period occupied in the retreat of the same glaciers, which must have been nearly as long as the other, and we shall find that the one hundred thousand years which M. de Mortillet asks for to express the duration of the glacial epoch is not an exaggeration. The epochs of the extension and retreat of the glaciers were, however, preceded by a pre-glacial period, and all the calculations together induce M. de Mortillet to adopt a total of two hundred thousand years to represent the entire duration of the Quaternary period, during which we are assured of the presence of man on European soil.

This period, long as it appears, is very short as compared with the myriads of ages of geological development that preceded it, and represents only the last and the shortest of the geological periods. The question arises, How has the human race been able to spread itself over the whole surface of the globe? Is it the product of different and independent origins in the several continents, or have all men sprung from a common cradle, a "mother-region"? On this point students are divided, Agassiz holding that men were created, and Carl Vogt that they were developed, at different centers, and Quatrefages and the theologians maintaining the unity of their origin. The fact is left that man, the same in all the essential characteristics of the species, has advanced into all the habitable parts of the globe, and that not recently, and when provided with all the resources that experience and inventive genius could put at his disposal, but when still young and ignorant. It was then that, weak and almost naked, having only just got fire and a few rude arms with which to defend itself and procure food, the human race conquered the world and spread itself from within the Arctic Circle to Terra del Fuego, from the Samoyed country to Van Diemen's Land, from the North Cape to the Cape of Good Hope. It is this primitive exodus, as certain as it is inconceivable, accepted by science as well as by dogma, that we have to explain, or at least to make probable; and that in an age when it is only after the most wonderful discoveries, by the aid of the most powerful machinery for navigation, through the boldest and most adventurous enterprises, that civilized man has been able to flatter himself that he has at last gone as far as infant man went in an age that is so far removed from us as to baffle all calculations.

We must insist on this point, for it brings into light an obstacle which those who have tried to trace out the connection between widely separated races and to determine the course that had been followed by tribes now separated by oceans and vast expanses have hitherto found insurmountable; for, if man is one—to which we are ready to agree—we must assign a single point of departure for his migrations. In these migrations, man has gone wherever he could, and, at every spot he has occupied and settled, has acquired characteristics peculiar to the place, and which differentiated him from the men settling in other places. Hence the varieties in human races. Some of these spots seem to have been peculiarly favorable to his advancement, and became centers of civilization. The number of such centers is, however, very limited, and their distribution is significant.

The continental masses are distributed in three principal groups, one feature in the configuration of which must strike every one who carefully examines a map of the world. It will be noticed that they are so expanded toward the north as to touch in that direction or be separated only by narrow passages, and that they also surround within the Arctic Circle a central polar sea with a bordering island-belt. Going down toward the south we find that the three continents, North America, Europe, and Northern Asia, which had approached each other so closely, give place to three appendages, South America, Africa, and Australia, which in their turn gradually taper off to mere points in an illimitable sea, long before they reach the Antarctic Circle. Within this circle the configuration of the land is precisely the reverse of that in the north; it is that of a solid cap of land around the pole, in the midst of the great ocean.

If we again observe these masses, we shall find that civilization was born in each of them under similar geographical conditions, viz., in the neighborhood of a smaller interior sea, near or rather north of the tropic of Cancer, between 20° and 35° north latitude. The most eastern of the centers is in China, near the Japan Sea. The most western, and apparently the most recent, was along the inner shores of the Gulf of Mexico. The last civilization was in the course of radiation and transformation when the Europeans came to America, and was wholly independent and autonomous; but, weak and relatively new, it was not able to resist the sudden onset of a stronger race.

Toward the center of the space whose extremes we have marked out must be placed two other centers of civilization, more ancient than either of the two already named, and in the same zone of latitude—Egypt, in the valley of the Nile, and near the Arabian Gulf, and Mesopotamia, near the head of the Persian Gulf. Thus, each continental mass had its particular center of civilization, except Asia, which had two—one in the extreme east, the other near the line which joins it to Europe. This peculiar grouping of the chief centers of civilization in such a relation of neighborhood constitutes the most considerable palæoethnic fact that we are able to record. The Nile and the Syrian sea on the west, upper Armenia and the Caspian on the north, the Hindoo-Koosh and the Indus on the east, and the Arabian Sea on the south, bound the region where Cushites, Semites, and Aryans, the first farmers, workers, and founders of cities, the second pastoral people, and the third mountaineers, afterward emigrants and conquerors, met, elbowed each other, and mingled, conquerors and conquered by turns, inventing arts and the use of metals, learning arms and how to organize themselves hierarchically, reaching their ideal through religion, and having in writing the most powerful instrument at the disposition of human intelligence. With them we have the beginning of history, and a continuous chain of social organizations, down to our own days. The growth of civilization in these centers leaves, however, still unaccounted for the diffusion of mankind all over the earth, which took place at a period far anterior to it.

The spread of man throughout Europe and Asia does not offer very great difficulties, for, in consequence of the long distance for which the two continents are joined, Europe is in reality only a dependency of Asia; and occupation of Europe from Asia is conformable to religious traditions. The difficulties are, however, formidable when we come to America, which we find occupied from one end to the other by races whose unity has struck the best observers. Not only, moreover, did the American man inaugurate on the soil of the New World an original and relatively advanced civilization, but he has left, chiefly in the north, indisputable traces of his presence in the most remote ages. Palæolithic implements have been found in the valley of the Delaware, at Trenton, New Jersey, and near Guanajuato in Mexico, so clearly characterized that they can not be mistaken, the situation of which at the base of the Quaternary alluvions and their coexistence with elephants and mastodons, indicate the existence of a race contemporaneous with that of the gravels of the Somme, having the same industry and doubtless the same manners and physical traits. Whence could this primitive American race, sister to the one that lived in Europe at the same date, have come, unless we suppose a direct communication between the two continents? The difficulty such men would have in crossing the Atlantic and the certainty which soundings give of the antiquity of the ocean remove all possibility of our believing either that the two continents were formerly joined, or that one of them was discovered by some unknown Columbus navigating the ocean a hundred thousand years before the later one.

We are thus in the presence of the problem, always coming up before us, and always escaping us, of the origin of the American man. Evidently it can not be resolved by invoking an accidental colonization of Asiatic wanderers, or a shipwrecked company; but it is one in which we have to deal with primitive populations flowing as in Europe by successive waves, and attesting the continuous presence of man, whose gradual development and extension have followed in America the same course as on the old continent. The hypothesis of an immigration from Asia by way of the Aleutian Islands to Alaska might be acceptable, did not the certainty of the presence of an indigenous American population in the Quaternary age reduce it to the proportions of a secondary fact. The same is the case with the relations—contradictory, it is true, and therefore suspicious—which some have attempted to establish between the monuments, statues, and graphic signs of Central America and those of Egypt and Buddhistic Asia. These analogies, aside from their insufficiency, must fall before two paramount considerations: first, the certainty of the contemporaneousness of the American man with the great animals of the Quaternary age; and, second, the relative uniformity of the copper-colored race, so like itself through the whole extent of the continent, except in that part which is occupied by the Esquimaux. The difficulty arises from the fact that the monogenists, having in view a single birthplace and a single point of departure for the whole human race, and placing neither in the New World, have supposed America to have been colonized by European or Asiatic immigrants following the direction of the parallels of latitude. Emigration in this direction at once meets an obstacle in the oceans, which grow wider the farther south we go. The obstacle disappears if we give up the idea of lateral emigrations, and suppose the movement to have taken place in the direction of the meridians from north to south. No obstacle of any kind offers itself to such migrations; and the relative uniformity of the Americans, from one end of the continent to the other, would never have excited astonishment, if we had not been preoccupied with the idea of their introduction at a later date.

We may remark, on this topic, that the extreme southern points of the three continents are occupied by races which came originally, without doubt, from somewhere else, and which are ranked, in Terra del Fuego, at the Cape of Good Hope, and in Tasmania, among the lowest of the species. These races, advancing in front of the others, have preserved the visible stamp of the relative inferiority of the stock from which they were prematurely detached. We have to believe, in effect, that these three branches—Fuegians, Bushmen, and Tasmanians—so little elevated in their physical, intellectual, and moral traits, have gone and planted themselves so far away only because the unoccupied space opened out before them. Scouts for the rest of mankind, they have reached, step by step, the extreme limits of the habitable land. They must have occupied for the moment, at least, the parts of the intermediate space, but they could not resist the push of the stronger races, and they could not have survived to our time, except under the condition of restriction to a small area in the most remote tract of their original domain. There is nothing surprising in the fact that MM. Quatrefages and Hamy, having described the most ancient European race of which we have the skulls, that of Canstadt, should have found its analogies only among these same natives of the extreme south—the Bushmen and the Australians.

It will be seen that we are inclined to remove to the circumpolar regions of the north the probable cradle of primitive humanity. From there only could it have radiated as from a center, to spread into several continents at once, and to give rise to successive emigrations toward the south. This theory agrees best with the presumed course of the human races. It remains to be shown that it is equally in accord with the most authentic and most recent geological data, and that, besides man, it is applicable to the plants and animals which accompanied him, and which have continued to be most closely associated with him in the temperate regions which afterward became the seat of his civilizing power.

The general laws of geology favor this hypothesis in a remarkable manner. To make it seem probable, we have only to establish two essential points that will not be seriously contested by any geologist. One is, that the polar regions, which were covered with large trees, enjoyed a climate more temperate than that of Central Europe, and were habitable and fertile to the eightieth degree, underwent a slow and progressive cooling down till the middle of the Tertiary period. Thence refrigeration made rapid progress till the ice gained exclusive possession of the country south of them. Under such circumstances, man as well as the animals and plants would have to remove or perish—to emigrate step by step, or find himself reduced to a daily more precarious state of existence.

The second point is the relative stability of the existing continental masses, and of their distribution around a sea occupying the Arctic pole; while the other pole was occupied with a cap of land surrounded by an immense ocean. The importance of the Arctic pole in respect to the production of animals and plants, and to their migrations, and the nullity of the other hemisphere in relation to this feature, result from such a grouping. The essential point is, that there is nothing capricious in such an arrangement of lands and seas, and that there have been, if not always, at least from a very ancient period, emerged lands occupying a considerable part of the northern hemisphere, advancing very far toward the pole, and describing around the Arctic Sea a belt of more or less contiguous countries and islands. This is, in effect, what geology teaches. The changes, immersions, and emersions have never been anything but partial and successive, while the skeletons of the continents go back to the most remote ages. There have always been a Europe, an Asia, an America, and Arctic lands. We know certainly that there have always been around the Arctic pole extensive territories, if not continents, long the home of the same plants as the rest of the globe, and that, beginning with an epoch that corresponds with the end of the Jurassic, the climate, at first as warm there as elsewhere, has tended gradually to become colder. The depression of temperature was at first manifested very slowly, and was far from having attained its present degree in the tertiary ; for the trees that then grew in Greenland—the sequoias, magnolias, and plane-trees—now attain their full development in Southern Europe, and are not suited with the climate of Central Europe. We are, then, assured of the ancient existence, near the Arctic pole, of a zone of lands covered with a rich vegetation. The permanent existence of a polar sea is none the less attested by fossils from all parts of the region. The neighborhood of the pole was long habitable, and inhabited by man in a time near that in which the vestiges of his industry begin to show themselves alike in Europe and America. In passing thus from the Arctic lands to those bordering on the polar circle, and through the latter into Asia, Europe, and America, man would only have taken the road which a host of plants and animals followed, either before him or at the same time, and under the stress of the same circumstances.

It is, in fact, by the aid of migrations from the neighborhood of the pole that we can generally explain the phenomenon of scattered or disjoined species, a phenomenon identical with the one which man of the Old World and man of the New World present when they are compared. Combining present notions with the indications furnished by the fossils, we discover numerous examples of disjunction—in which allied forms, often hardly distinguishable, have been distributed at the same time in scattered regions, at extremely remote points in the boreal hemisphere, without any apparent connection along the parallels, to explain the common unit. Europe attests by undeniable fossils that it had formerly a host of vegetable types and forms that are now American, which it could have received only from the extreme north. It had, for example, magnolias, tulip-trees, sassafras, maples, and poplars, comparable in all respects to those which grow in the United States. The two plane-trees, that of the West and that of Asia Minor, to which we may add an extinct fossil European plane-tree, illustrate the same phenomenon of dispersion. Europe in the Tertiary period witnessed the growth of a ginko similar to the one in the north of China. It had sequoias and a bald cypress corresponding with the trees of those names that are now growing in California and Louisiana. The beech seems to have been growing in the Arctic circumpolar zone before it was introduced and extended throughout the northern hemisphere. The same is doubtless the case with the hemlock, of which distinguishable traces have been found in Grinnell-land, above the eighty-second degree of latitude, of a date much earlier than that of its introduction into Europe. The well-established presence in both continents of many animals peculiar to the northern hemisphere must be attributed to emigrations, if not from the pole, at least from countries contiguous to the polar circle. This is obvious in the case of the reindeer, bison, and stag; but it ought to be equally true in respect to animals of more ancient times, and, although we have no other direct proofs of it than the abundance of the remains of mammoths in upper Siberia, the same law doubtless includes the elephants and mastodons. We mean here the species of these two genera which were propagated from the north to the south, and were, in America and Europe, the companions of primitive man. The connection of the continental masses with their belt of hardly discontinuous lands around the polar circle gives the key to all these phenomena. The cause on which they depend would be constantly producing radiations and consequently disjunctions of species and races, whatever kingdom we may consider.

Before leaving the questions that touch on the presumed origin of man, we can not refrain from speaking of the relations which it has been sought to establish between him and the pithecan apes. Primitive man, according to some authors of the transformist school, was an anthropomorphic ape, perfected physically as to his walk and erect attitude, intellectually by the development of his cranial capacity, till the moment when reasoning, or the faculty of abstraction and the power of using articulate language, took in him the place of instinct. Numerous and undeniable anatomical or physiological analogies of the human body and those of the more highly organized monkeys, which have no tails nor callosities on their paws, and whose faces and ways have something singularly human, favor this system, at least in appearance. The pithecans have, however, other contiguities than purely human ones. Their ways are rather analogous than directly assimilable to those of man; with other adaptations, they seem to have followed a wholly different course of evolution. They are essentially climbers, while man is exclusively a walker, and has always been predisposed to the erect position. The highest monkeys, the anthropomorphous apes, walk badly and with difficulty. When they leave the trees in which they live, their position is a stooping one, and they bend down their toes so as not to touch the ground with the soles of their feet. We have, then, reason not to admit the simian origin of man without decisive proofs. Moreover, the pithecans seem to have been evolved in an inverse direction from man. Rejoicing in the heat, they perish rapidly when brought into the temperate zones, and this is especially the case with the anthropoid apes. Thus, while man, coming from the north, advances toward the south only when the depression of temperature favors his progress in that direction, the monkeys, to which a strong heat is a vital element, were developed in an age when Europe had a sub-tropical climate, and disappeared from that continent as soon as the climate became temperate, so that their departure coincides with the arrival of man. They fled south to find the heat they needed, precisely when the diminution of the heat opened to man the region from which it excluded his predecessors. The necessity of placing the cradle of the pithecans in a hot country enables us to separate the monkeys of the Eastern and Western Continents into two distinct groups marked by differences in dentition important enough to oblige us to assume an extreme antiquity for their separation. Both are descended from the lemurians, now represented only in Madagascar, but of which early tertiary fossils are found in Europe. The most recent lemurians in Europe are found at the end of the Eocene. It is later, in the Miocene and that not the lowest, that we meet pithecans similar to those of the equatorial zone of the Eastern Continent. At this epoch, which was nearly that of Oeningen and the Mollassic Sea, which divided Europe from east to west, a subtropical climate still prevailed in the center of the continent, and the palm-trees extended up into Bohemia, along the northern banks of the great interior sea. By favor of this temperature the monkeys occupied Europe to near the forty-fifth degree, but without going above it, to disappear forever as soon as it became cool enough for men and elephants.

The *Mesopithecus Pentelici*, of which M. Gaudry has discovered twenty-five individuals at Pikermi, was small, walked on its four paws, and lived on twigs and leaves. The *Dryopithecus* of St. Gaudens had the characteristics of the highest anthropomorphs, with the bestial face of the gorilla ; but it is to this animal that M. Gaudry is inclined to attribute the flints, intentionally chipped, according to the Abbé Bourgeois, of the Beauce limestone at Thénay, in the St. Gaudens geognostic horizon. The *Pliopithecus* of Sansan (Gers) resembles a gibbon. To find the present analogues of the *Pliopithecus* and *Dryopithecus* of Miocene Europe, it is necessary to go across the tropic of Cancer to about 12° north latitude, or more than thirty degrees south of the locality of these fossils. If, as is probable, the same interval existed between the perimeter frequented by the European anthropomorphs and the natal region in which man was originally confined, we shall find the latter in the latitude of Greenland, at 70° or 75°. This is indeed an hypothetical calculation, but it is based on a double argument hard to refute.

We can reach almost the same conclusion by a little different reasoning. The abundance of large-flaked instruments in the contiguous valleys of the Somme and the Seine marks the existence at that point of external conditions evidently favorable to the diffusion of man, whose race was then multiplying for the first time. The flora of that epoch, as observed near Fontainebleau, indicates the presence of conditions similar to those now existing in the south of France, near the forty-second degree of latitude. Now, to reach, starting from the forty-second degree, the nearly tropical regions where palm, camphor, and southern laurel trees are associated together, we have to go twelve or fifteen degrees south, to the thirtieth or twenty-eighth degree of latitude, where we see the same climatological conditions existing as prevailed in Miocene Europe when it was hardly warm enough for the anthropomorphic apes. Between these conditions and those which seem to have been first favorable to the growth of the human race, there existed a space of twelve or fifteen degrees of latitude. But when palm-trees were growing near Prague, and camphor-trees grew as far north as Dantzic, man, if he existed then, might have lived without inconvenience beyond or around the Arctic Circle, within equal reach of North America and Europe, which he was destined to people. If it be objected to this view that man now lives in the hottest regions as well as in temperate ones, we answer that that shows simply that he has developed a capacity of adapting himself to them; but he flourishes best and has reached his highest development in temperate latitudes.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

PRIMITIVE MAP-MAKING.

By GEORG M. FRAUENSTEIN.

THE idea of representing the surface of the earth, or even a part of it, by a map, implies a considerable advance in knowledge. Every map, even the crudest one, is in a certain sense a concentrated representation, a kind of distillation of physical and politico-geographical knowledge. The clearer and more comprehensive this knowledge, the higher is the degree of accuracy with which it can be portrayed. We are not only taught this by the history of the peoples with which we have had the most to do, that is, of the civilized nations, but it is obvious to any one who is acquainted with the lower races. The same practical reasons which urged Europeans to the pictorial representation of geographical facts have also made their influence felt in the prairies of America and the islands of Australasia; and I have seen maps prepared by Polynesian or Indian hands that would compare favorably with mediæval representations of the same kind.

As a rule, cartography begins with road-maps. Peoples whose territory is a terminating point or is traversed by important trade-routes, and who perform a carrier-service, are accustomed as a matter of course to learn to depend upon drafted representations of their roads. Appolonius Rhodius says that such maps were used by the ancient Colchians of the Southwestern Caucasus and Northern Armenia, through whose territory ran the great caravan routes from the Black Sea to the East and South. Herodotus and Xenophon describe the great post-routes of the Persians, over which the royal orders were carried to all parts of the kingdom, as systematically laid out and provided with stations and inns, and arrangements for changing horses. The caravan-roads now mark the most practicable routes for railways; and the French might make good use of the itineraries of the Tuaregs in laying their tracks across the Sahara, if they were only accessible. That the sons of the desert, who are able to speed with unerring accuracy for hundreds of miles across the ocean of sand, possess at least the capacity to make a representation of their route, is shown by the statement of Duverrier, that the Sheik Othman drew in the sand for him a plan of the central range of Hoggar.

The accounts that have been given of the map-making of the negro races have a still higher interest for us. Stanley says that the Waganda frequently have recourse to drawings which they make upon the ground to render their imperfect verbal descriptions more clear. The sand of the sea-shore has, in fact, played a very important part in the beginnings of cartography. Travelers of widely different periods, whether speaking of the German coasts or of the shores of America and Asia, have made the same observation, that the coast people, in order to give a more distinct answer to any question about the roads and paths, have spontaneously made drawings in the sand of the stretch of country they were talking of. Examples in point may be cited from the Baltic coasts, from the Island of Jesso, and from Northern Siberia. Ainos and Tunguses have directed travelers in the same illustrative way.

The more intelligent ones divide the roads which they would represent into days' journeys, and designate mountains and islands with little piles of sand, and towns and fishing-stations with sticks. Kotzebue, Chamisso, and Beechey tell stories of the same kind of peoples of the great ocean. The inhabitants of Tahiti and the Marshall Islands give, by means of stones arranged on the beach-sand, a clear view of whole groups of islands, between which they point out the navigable channels. The islanders have also a kind of portable maps of their own designing, showing, by means of strings with knots tied in them, the direction of the principal currents. According to Captain F. H. Witt, the Micronesians of the Caroline and Marshall Islands make a frame of ribs of palm-leaves, across which they weave the blades to serve as the foundation for their map. The islands are then represented by fastening at the proper places shells or pebbles of sizes proportioned to the magnitude of the islands to which they are intended to correspond.

In some of the Australasian islands the tattooing of the body is made to bear a geographical significance. Lütke remarked in 1828 that on some of the Caroline Islands the chiefs had lines tattooed on their bodies, with each of which they associated the name of some island or group. Thus, these savages carried around with them on their own persons geographical directories that could not be lost—certainly one of the most original geographical and mnemotechnic devices of which we have any record.

These incidents point to a peculiar capacity or sense of the relation of directions on the part of the people of the islands of the great sea, which is manifested in many different ways. These people do not have the materials which we use for such purposes; but, when they are furnished with them and have learned to use them, they soon acquire facility in making maps according to our ideas. Their capacity to accomplish this can not admit of dispute, when it is remembered to what immense distances they are able to go straight with their little narrow canoes. Every European seaman must admire the skill of the Caroline-Islanders, who succeed in traveling with such sureness over the length and breadth of their group, through spaces in which one of the islands may be more than eight hundred miles from its neighbor. There are numbers, not of theoretical geographers, but of practical sailors, who are acquainted with the islands, and have observed the achievements of the natives, who will bear me out in this. There are now in existence a few maps made by Polynesians with European writing materials that afford a permanent testimony of the clearness of mind with which these "wild" people control their sea-voyages. The most famous of them is the one made by Tupaya of Tahiti, a man who went with Cook on his first voyage through the main part of the Australasian Archipelago. It comprises not less than forty degrees of longitude, extending from the Panmotu Islands in the east to the Feejee group in the west. While the most striking feature of this work is the great extent of what is correctly and plainly set down, some New Zealand maps attest the special knowledge the makers had of the details of their native land. One of these was compiled in 1798, before any European colony had been founded in New Zealand; another was published by Shortland in 1854.

The Esquimaux have contributed important service to the enlargement of knowledge by the aid they have given to the older and the more recent explorers, from whom their achievements in cartography have received special praise. They have supplied European and American sailors with most valuable directions by drawings on both sand and paper. They are accustomed to designate with great care all the projecting points of the land, even the smallest ones, but all of their works have an important defect, which strikes the eye at once. They can not comprehend the great changes in the trend of the land toward the different points of the compass; but represent everything as running generally in the same direction. The student must, therefore, make himself accustomed to this straightforward mode of projection, in order to understand them aright. Abundant evidence, nevertheless, exists of the value of these maps in perfectly unknown regions. C. W. Parry acknowledges his obligations to a remarkable Esquimau woman, Iligliuk, for a map by the aid of which he discovered the Fury and Hekla Straits, sailing north from Hudson's Bay. Dr. I. I. Hayes speaks of a rude map of the coast from Cape York to Smith's Sound, on which all the inhabited places of Western Greenland were marked, that was made for him by the guide Hans. Franklin states that in his second voyage the Esquimaux, when inquired of, drew the outlines of the coast on the sand, divided it off by days' journeys, indicated the islands and their size and shape by heaps of gravel, marked the mountains with sand and stones, and inhabited places with sticks, and exhibited so much anxiety to be correct as to consult with each other on points respecting which any of them had doubts.

An autograph map by an Esquimau of his own home may be seen in the Royal Hand-bibliothek at Stuttgart, where it is catalogued under the name of "Niakuntigok"; and I have noticed other drawings of Esquimau maps in Hall, and in the journal "Globus" for 1877.

Drake, in his "Book of the Indians," gives several examples of maps by the North American aborigines. The efforts of these people are of interest enough to deserve a more special account. Drawings in the sand are frequently mentioned as made by them; as, for example, by Mackenzie, by Lieutenant Whipple of the Kiowumis, and by Captain J. Jacob of the Haidas on Vancouver Island. The Indians have not, however, rested satisfied with these primitive methods of representation, but have, like some Esquimaux and Polynesians, made the great step of the discovery of portable maps, and have even made more advanced efforts in this art, and far more extensive applications of it, than the others. Their maps furnish correct data with reference to the roads and coast-lines, and also to whole districts, with the rivers, mountains, towns, and the connecting roads, and have the days' journeys carefully marked on materials of the most diversified character. Heckewelder and De Smet describe maps that were made with ashes and coal on pieces of bark and deer-skin; Hunter saw in Carolina plans of whole districts on the blankets of the chiefs, with the boundaries of the different hunting-grounds carefully marked off. The chiefs of many tribes were in the habit of keeping portable maps filed, and already attached great value to them when they first came in contact with Europeans, certainly before they had had an opportunity to learn the use of maps from them. Travelers of the seventeenth and the beginning of the eighteenth centuries, among them Le Clerc, La Hontan, and Lafiteau, attest this fact with a host of examples, and other notices of such maps are given by Copway and Schoolcraft.

A much greater advance in map-making had been made in Mexico and Central America centuries before the European immigration. The whole Aztec kingdom was registered and mapped off at the time the Spaniards came into the country. In the plat-books the crown-land was colored violet, the land of the nobles red, and the common lands yellow; and the plats were so carefully executed that they were to a certain extent accepted as evidence under Spanish rule. These books, a remarkable result of a highly developed civilization in an Indian state, were of great importance in processes, and it is possible to obtain satisfactory information from them even now. Thirty-six of the registry-maps are still left in the "Codex Mendoza"; Alexander von Humboldt publishes in his "Atlas of New Spain" a representation of a carefully delineated estate concerning which an action was brought; and Brasseur de Bourbourg and Prescott speak of maps in the archives of the Aztec princes, which represented in regular order the mountains, woods, rivers, cities, boundaries, roads, and coast-lines, and contained valuable statistical and other information on their margins. Alexander von Humboldt saw, in the hands of a native of a town near Tetlama, a geographical map that had been hidden in the woods from the Europeans, which was made before the landing of Cortez. The conquerors of Mexico themselves received from the king a plan of the coast with its rivers and capes painted on cotton cloth, and from the natives another map that indicated all the rivers, mountains, and large towns from Xikalanko to Nicaragua. A fragment of a very interesting historical document still exists in the library of the city of Mexico. It is the ground-plan of Tenochtitlan, the estate in which Montezuma II entertained his guest Cortez, and which the latter knew so well how to plunder. Bullock saw it, and had a copy taken of it, in 1824. Aubin had in his possession, in 1860, twenty-five leaves of the Mexican land-register, with portraits of the kings of the last period of independence, and texts added from the years 1539, 1573, and 1599, with what is more important for us, three maps by the last Aztec prince, Guatemozin. It was copied at his command, in 1533, from older maps, and contained data from 1361. Three other maps of the same brave but unfortunate ruler, which go back to 1438, were copied in 1704 by the royal Spanish interpreter, Manuel Mancio. Finally, Peter Martyr describes a similar map, painted on white cotton cloth, that was not less than thirty feet long.

Squier and Davis state that the Toltec states—Nicaragua, for instance—had books written on deer-skin, in which were marked by the elders of the towns, in black and red, the boundaries of the districts, the rivers, lakes, woods, and even single estates. In Peru relief-maps were made with skillfully drawn lines, and impressed with stone, clay, and straw. Garcilasso de Vega, in his "General History of Peru," composed at the beginning of the seventeenth century, gives a well-drawn plan of the city of Cuzco, with representations of the streets, squares, and brooks, which was made at Muyna; and he tells also of representations of entire districts. The beauty of these works is attested by several Spanish authorities. Balboa speaks of a plan of the besieged fortress, Pomacocha, which was sent to the war council at the capital. Bastian had made for the Royal Museum in Berlin a copy of the plan of an ancient Inca city which he saw at Cuenca, a picture of which was published in the "Zeitschrift für Ethnologie," in 1877. The squares and public places and the royal palaces were indicated by the arrangement of blocks of wood.

The Polynesians, the Esquimaux, and the Indians, have all thus given us the marks of the different degrees of advancement they have independently made in the use of this, the most important of geographical aids. In their ignorance of the art of writing, and their want of suitable writing materials, they have made use of the same primitive methods as the people of the German coasts still employ. When the progress from tribal communism to a formulated state-life and the transition from trivial, groping essays to a public provision for a system of written records are consummated, well-executed maps appear among the evidences of the degree of civilization that has been reached.—*Translated for the Popular Science Monthly from Das Ausland.*

THE GRANULE OF STARCH.

BY AN ANALYST.

THERE may not seem much in a grain of starch, and in point of bulk there *is* very little; but we shall endeavor to show that there is a good deal of interesting and valuable information to be derived from a careful study of the little granule.

We are all familiar with such commodities as flour, potatoes, Indian corn, sago, peas, and arrowroot, and are consequently to some extent acquainted with what starch is; for all these substances consist essentially of starch, along with water and some minor admixtures. If we take a slice of a potato, for instance, and rub it on a grater of any sort in a basin of cold water, the water will soon become turbid; and a drop of it examined with a microscope will be found to contain a number of minute oval granules, which would in time sink to the bottom of the basin, forming a white deposit. These are grains of starch; and so minute are some varieties that three thousand of them laid end to end would barely make an inch.

The starch of every plant differs from its neighbors both in size and shape, and this has a considerable influence on the character of the vegetable organ in which it is stored up; the hardness of rice, for instance, being due to the fact that rice-granules are extremely minute, with angular corners which fit closely and firmly together; whereas potato-starch is large and round, with considerable interspaces filled with water, and so forms a comparatively soft mass. But, notwithstanding their outward points of difference, in chemical composition the starches are all identical, consisting of carbon, hydrogen, and oxygen—exactly the same materials as sugar is composed of, and better known as the component elements of coal and water. Leaving the many varieties of starch in the mean while, let us consider one species, namely, that of wheat, because it is the most important in this country, forming the basis of our daily bread.

An ordinary grain of wheat, if sliced through the middle and examined as to its structure, will be found to consist of several layers, the outer a hard coating, which contains mineral salts, lime, sand, etc. Beneath this is a zone of matter very rich in gluten, the flesh-forming constituent of the wheat; while the central portion of the grain is occupied by a white, powdery mass, which is nearly pure starch. In manufacturing flour, the two outer layers, which together form the bran, are usually removed, leaving the white starchy flour of the central portion.

Let us now briefly consider the chief points in the chemistry of bread-making. If flour be worked up with water, it forms a sodden, insipid, indigestible mass; but, if heated to the temperature of boiling water, the starch-granules burst; and it is thereby rendered a little more digestible, although still forming a close, stiff, and not very palatable cake. Such is the character of unleavened bread, and of sea-biscuits, a slightly different form of the same thing. To be fit for digestion, starch must be dissolved or softened by boiling or baking; hence the reason why raw nuts are so indigestible as compared with the favorite roasted chestnuts; and hence one reason for cooking food, which mankind has been taught by experience, ages before chemistry could give a scientific explanation of the reason why. Cooking is, in fact, a partial digestion; and the same is the case with baking, both being preliminary aids to the changes which take place in the mouth and stomach before the food is in a fit state for the preparation of the blood. Accordingly, we bake our bread; and we bake it in the way we do because a soft, spongy loaf is more readily moistened and acted on by the saliva and the juices of the stomach.

There is a good deal in the chemistry of bread-making; and our bread might be much improved if bakers had a more intelligent understanding of the science involved in their business; for, although several improvements have been introduced of late years, the most of our bread is still prepared in the old fashion. The necessary quantity of flour is put into a trough with about half its weight of water, and sufficient salt and yeast or leaven, then thoroughly mixed up into what is known as the "sponge." (Here we may remark that the best flour takes up the largest quantity of water; and a rough test of the quality of two samples of flour may be made by comparing the quantity of water required to obtain a dough of similar consistency.) After the sponge is made, it is left for about five hours in a warm place to ferment, after which it is kneaded with the rest of the flour, and again left to rest some time. The dough is then weighed into lumps, which are put in tins, and set aside till they have risen to twice their previous bulk. It is to the yeast or leaven that the raising of bread is due, and the action is identical with that of the fermentation of beer. The flour contains a small amount of a nitrogenous substance which changes a portion of the starch into sugar; the yeast then attacks the sugar, splitting it into alcohol and carbonic-acid gas, the little bubbles of which try to escape from the mass of the dough, but get entangled by the gluten and gum which the flour contains; and thus every part of the bread becomes penetrated with little cavities. Eventually the fermentation would cease, and the bubbles of gas would find their way to the outside, thus leaving the dough much less light and spongy than we wish it to be; but the baker guards against this by putting it at the proper time into a hot oven, the heat of which at first increases the fermentation. In a few minutes, however, the temperature becomes sufficiently high to kill all the yeast-germs; the fermentation is thereby stopped; and, by continued heating, the starch-granules are burst and the mass is fixed in the porous form it has then attained. A little of the alcohol is retained in the bread; but practically almost the whole of it—in London amounting to some three hundred thousand gallons per annum—is driven off by the heat. During the baking, the starch of the outer portions of the bread has been browned by the heat, and thereby changed into a sugar known as dextrine or British gum; and perhaps this fact accounts for the fondness of some children and even grown-up people for crusts.

Of late years a system for making what is called aërated bread has proved very successful, and is free from the slightest objection. The dough is made by mixing the flour with water saturated with carbonic-acid gas, which on heating is expelled from the water, and thus distends the dough, producing a light, spongy bread, with no loss of starch or sugar, and without any injurious or objectionable ingredient having been introduced.

Having dealt with the baking of the bread, let us now briefly consider its further progress in being adapted for the wants of the body. As soon as a piece of bread is put into the mouth, an abundant flow of saliva takes place; and in fact it needs no actual tasting to induce this flow, for even the sight or smell of anything nice is quite sufficient to "make the mouth water," as we express it. The saliva is poured into the mouth by three pairs of glands to the extent of some twenty ounces a day. It consists in great part of water, with a little salt and a peculiar substance called ptyaline, which possesses the property of changing starch into sugar, the change being accomplished most completely when the starch is dissolved or baked, at a temperature of about 98° Fahr., the normal temperature of the body. Although this ptyaline is present in the saliva to the extent of only one part in five hundred, yet, on its presence and action, the heat, and consequently the life of the body, is largely dependent; hence the importance of avoiding any unnecessary waste of it, such as frequently and unnecessarily accompanies smoking. Hence, likewise, we see the importance of chewing the food slowly and thoroughly, that it may be all brought under the influence of the ptyaline; and thus we can understand how indigestion or dyspepsia may be caused by hasty chewing or by excessive spitting, the starchy portion of the food in either case lying in the stomach as an undissolved mass.

Bread-making we have already stated is a form of cooking. The heat of the oven has converted the outside of the bread into sugar, and the starch in the inside has in fact been boiled in the steam of the water which the dough contained, so that it has become capable of being readily converted into sugar. The porous nature of the bread favors this conversion; for the saliva easily penetrates through the whole of the spongy mass; and the change is still further assisted by the water which the bread contains to the extent of some forty per cent. Biscuits, on the other hand, being as a rule dry and non-spongy, are less suitable for ordinary use, although containing in the same weight far more food-material than bread.

It may surprise some of our readers to be told that the starch of bread has not the slightest nutritive property. Its sole office is a heat-producer; and, just like the coal of the engine, the starch or sugar is burned up inside us to keep up the temperature of the machine. It is the gluten, the sticky, tenacious matter in the grain, which is the nutritive, flesh-forming material; but in the present article we have no space to follow the changes which *it* undergoes in the system, for we are simply treating of starch at present; and we trust we have made it clear how it is changed into sugar, and thus made soluble and fit for absorption into the juices which keep the body at a uniform temperature and in good repair.

It is a common but mistaken notion that sago and tapioca are very nutritious. On the contrary, they consist almost wholly of starch, with only about three per cent of gluten, so that, unless cooked with milk or eggs, they form a very insufficient food. The same is the case with Indian-corn flour and arrowroot, which have scarcely a particle of nutritious matter in them, so that it is a great mistake to feed an invalid or a child on such materials. They are no doubt useful, as easily digested heat-producers; but they must be cooked with milk or eggs before they are of much use for actual nutriment; and many a child has been starved to death through its parents' ignorance of this fact. It is true, medical men often recommend arrowroot for those in delicate health, as it is of great importance to keep up the natural heat of the body with the least exertion of the digestive organs; but it can not be too widely known that arrowroot pure and simple is a mere heat-producer; and milk, beef-tea, soup, or other suitable flesh-forming food, must be given with it, if the child or invalid is to be kept alive. On the other hand, semolina, hominy, lentil-meal, pea-flour, etc., not being prepared by washing, contain a much greater amount of flesh-forming material than sago, arrowroot, etc.

The starches are largely used in several important manufactures. Dextrine or British gum is prepared by heating starch to a temperature of about 400° Fahr., and is preferred to gum-arabic because it is not so liable to crack or curl up the stamps or other paper prepared with it. Immense quantities of starch are used, too, in the manufacture of glucose or grape-sugar, which has exactly the same composition as starch, and is prepared by acting on the starch with sulphuric acid (oil of vitriol), which has the same effect as the ptyaline of the saliva. Linen rags are largely used for the same purpose, too; and, indeed, it is wonderful how few things are altogether useless at the present day. Old boots and horns provide some of our most brillianr colors; while dye-colors innumerable are made from the refuse of out gas-works; and the wash-heaps of our factories are proving mines of wealth, instead of mounds of rubbish.—*Chambers's Journal.*

SKETCH OF SIR WILLIAM E. LOGAN, LL.D., F.G.S.

JAMES LOGAN, the grandfather of Sir William, came to Montreal from the parish of Stirling, Scotland, about 1784, bringing his wife and two sons. He established himself as a baker in that city, the occupation he had followed at home, and was assisted in the business by his older son William, then a young man. After a few years, Miss Janet E. Edmond came to Montreal from Scotland, and was married to her cousin William. The third of their nine children, WILLIAM EDMOND LOGAN, the subject of this sketch, was born April 20, 1798. The first school to which he was sent was one kept by a Scotchman in Montreal; but, in 1814, he and one of his brothers were sent over to Scotland and placed in an advanced class in the Edinburgh High School. The studies of the school were mainly classical. During his two years here, young William was much of the time "dux" of his class, and won several prizes. In the mean time his father, leaving his oldest son to manage the business in Montreal, had removed the rest of the family to Edinburgh. During the academic year 1816–'17 William attended classes in logic, chemistry, and mathematics, at the University of Edinburgh. He continued here the diligence which he had manifested at school, and carried off the first prize in mathematics, "with the good-will of all the competitors."

Preferring to enter mercantile business rather than to continue longer at the university, he went to London in 1817, being then nineteen years old, to take a position in the counting-house of his uncle. But he did not give up literary pursuits, for, in a letter written to his brother in Montreal a few months later, he thus describes his avocations: "Part of the day I read Italian and French, write versions in those languages, and generally in the evening translate 'Gil Blas' with Alexander Gillespie, Jr., who, by-the-by, is the greatest companion I have here. Now and then I have a look at Homer and Cicero, and mathematics is not neglected. Indeed, I carry on a correspondence with one of my fellow-collegians, Mr. Cockayne, who resides in the north of England. He sends me propositions, which, after having solved, I return to him with the demonstrations, annexing at the same time propositions to exercise his knowledge of geometry. This, in my opinion, is a rational and useful means of keeping up an acquaintance. Sometimes the flute amuses me, and I hope you have not given up playing on that instrument." In his younger days, as his biographer tells us, Logan was an excellent correspondent. "But, not satisfied with writing often himself, he frequently urges his brothers or sisters to do likewise, and sometimes, by way of encouragement, praises the letters which he receives. . . . In this way, and by regularly causing the letters which he himself received to circulate among other members of the family, he aided in keeping alive that union and interest in family affairs which so often cease when the children grow up and become scattered."

Young Logan had abundant opportunities to gratify his musical tastes while in London, and his years there seem to have passed very pleasantly. He lived in his uncle's family, until the latter gave up his London residence, but he seems to have welcomed this change as giving him a chance to devote more time to business and to lead a quieter life. In 1826 he made a short visit to Paris, and wrote to his brother James some very lively impressions of the faculty for display of the French people.

A few years later, Logan's uncle became interested in mining and smelting operations in Wales, and young Logan was sent down to keep the accounts of the establishment. "But you may be assured," he writes, "I shall spare no pains to make myself master of every branch of the business; and, as it is of a scientific nature, I am pretty sure I shall like it." The study of the minerals with which his business was directly concerned—copper and coal—awakened in him an interest in mineralogy and geology. He studied the question of how the coal-seams were formed, and devoted a large share of his scanty leisure to making a geological map of the district. His drawings were offered to Sir Henry de la Beche, when the latter began his government survey in that region, and Sir Henry gladly availed himself of them, giving due credit to Logan. While he remained in its vicinity, Logan did much for the museum of the Royal Institution of South Wales, and held the positions of Honorary Secretary and Curator of the Geological Department. He presented to it valuable collections of minerals and metallurgical products, laboratory apparatus, drawings, and a collection of Canadian birds. Logan rapidly became known among British geologists, and in 1837 was elected a Fellow of the Geological Society. The next year his uncle died, and Logan gave up his position in the Morriston copper-works.

The problem of the formation of coal-strata, which had engaged Logan's attention, was at this time far from settled, one party firmly maintaining that the carbonaceous matter had collected as drift-wood collects; another, that the seams were deposited like peat in the swamps. "In these circumstances," says his biographer, Professor Harrington, "Logan had the sagacity to observe and turn to account a fact which has settled forever the question of the origin of coal, in favor of the theory of growth *in situ*. Under eighty or more coal-seams, which occur in the Welsh coal-field, the miners had observed the invariable presence of a bed of more or less tenacious and bleached clay, which they called the 'under-clay' of the coal, and which was often of practical importance as affording facilities for under-cutting the coal. The constancy of this fact Logan confirmed by his own observations, and added to it the further and important discovery that in all these under-clays there occurred abundance of remains of the peculiar plant known as *Stigmaria*, in such circumstances as to show that the plant was *in situ*, and not drifted. In February, 1840, Mr. Logan communicated his results to the Geological Society of London, in a paper entitled "On the Characters of the Beds of Clay immediately below the Coal-Seams of South Wales."

In his letters from Wales to his brother James, Logan had repeatedly asked for specimens of the Canada minerals, and had expressed the wish to examine for himself the rocks of his native region. Accordingly, in the summer of 1840, he left England for Canada. During his year's visit to America, he made geological studies in the neighborhood of Montreal, in Maine, and, just before his return, visited the coal-fields of Pennsylvania and of Nova Scotia. The results of two of his investigations he embodied in a paper entitled "On the Packing of Ice in the St. Lawrence, and on a Land-Slide in the Valley of the Maskinongé," which he read before the Geological Society of London in June, 1842. From the parts of this paper quoted by Thomas Keefer in his "Report on the Bridging of the St. Lawrence," George Stephenson is said to have obtained useful hints in regard to the site for his Victoria Bridge. His visits to the coal-fields were eminently satisfactory, for he found in every case the under-clay showing plenty of remains of *Stigmaria*. While on this trip he met Lyell, and had the pleasure of learning that that distinguished geologist was acquainted with his work, and deemed his results important.

The first Parliament of the united provinces of Canada in 1841 voted £1,500 for a geological survey. Logan was then in England, but his friends in Montreal, who had heard him express a desire to do this work, proposed his name to the Governor for director of the survey, and in the next year he was tendered the appointment. Then followed twenty-seven years of devoted labor in the almost untrodden field of Canadian geology. After two seasons' work Logan submitted a report of progress, the first of a series of sixteen government reports. The money for the survey was voted in small annual grants, and for short terms, and more than once was Logan obliged to talk and write almost constantly, for several months, to members of the Government, explaining and demonstrating to them the importance of carrying on the work. The first of these critical periods occurred in the winter of 1844–'45, when the first grant of £1,500 had been expended, together with over £800 of Logan's money. Finally, £2,000 a year for five years was granted, and, at the end of the time, the grant was renewed for five years more. An act in 1855 appropriated twice as much for the next five years, but this was afterward somewhat reduced. It required a large measure of courage and devotion to plunge into this work so earnestly as Logan did. "Of the topography of the Gaspé district," the first region examined, "little was known in 1843 beyond the coast-line; of the geology, practically nothing. Settlements were few, confined almost exclusively to the coast, and made up chiefly of fishermen. There were no roads through the interior, most of which was (and, indeed, still is) a wilderness, inhabited by bears and other wild beasts, or at best only penetrated, in certain seasons of the year, by a few Indians or lumbermen. The courses of most of the streams were unknown, and the precipitous mountain-passes untraversed. Such was the country whose geology Logan was now to investigate." Other inconveniences were coarse food and hard beds, camping in wigwams that kept out only part of the rains, frequent bruises from working among rocks, bites of insects, and the vulgar inquisitiveness of persons who could only conceive him to be a searcher for the precious metals or a lunatic. The following words of Mr. Murray, his geological assistant in Canada, descriptive of Logan's habit while in Wales, apply also to his longer labors in Canada: "Even at that early period, when every comfort of life was easily accessible, I observed his utter indifference to self-indulgence of any kind, or even such ordinary comforts as most people would be inclined to call indispensable necessities. After an early and very simple breakfast, he would buckle on his instruments, grasp his hammer, and, with map in hand, march off to the field, in which he would toil on without cessation, without thinking for a moment of food or rest, until the shades of evening gave warning that it was time to retrace his steps toward home, or to seek some temporary dwelling." Such a day Logan would supplement, in Canada, by writing up the day's notes and his journal in a wigwam, often working past midnight.

The winters, which interrupted field-work, by no means brought idleness to him. There were the geological specimens to sort, label, and arrange in cabinets, reports to write up, expense accounts to prepare, and maps to construct, work on which the smallness of the appropriations allowed only scanty assistance.

In 1850 the Provincial Government decided to send a collection of Canadian economic minerals to the London World's Fair of the next year, and Logan was sent in charge of the exhibit. During this visit to England, Logan was present at a meeting of the British Association, and read a paper entitled "On the Age of the Copper-bearing Rocks of Lakes Superior and Huron, and Various Facts relating to the Physical Structure of Canada." He was elected a Fellow of the Royal Society at this time, being "the first native Canadian elected for work done in Canada." He also served as one of the eight jurors in the Mineralogical and Metallurgical Department of the Exhibition. Logan was also one of the two Special Commissioners in charge of the Canadian exhibit at the French Exhibition of 1855, and here as before he worked almost incessantly for many weeks arranging his section. He was not suffered to go unrewarded, for he received the Grand Gold Medal of Honor for his map and minerals, and was presented by the Emperor with the cross of the Legion of Honor. Other honors were now bestowed upon him in rapid succession. On the 29th of the following January he was knighted by the Queen at Windsor, for services rendered at the two exhibitions, and about the same time he was informed that the Palladium or Wollaston medal—"the greatest honor the Geological Society has to bestow"—would be publicly presented to him at the annual meeting of the society. Other honors and testimonials were tendered to him on his return to Canada.

Sir William at once resumed his former labors and continued them until he was interrupted by another exhibition—that of 1862 in London. He was sent as Chief Commissioner from Canada, and was again made a juror; but the hurry in which his work had to be done, and the invitations that were showered upon him, were not to his taste, and he sought an early opportunity to return to Canada. In the next year his "Geology of Canada" was published, of which work Professor Harrington writes: "It was more than eight years since its preparation had been ordered by Government, and many thought that its publication ought not to have been so long deferred. But neither the country nor science lost anything by the delay ; for the volume was not a mere summary of the earlier reports of the survey, but a new book containing all the earliest facts concerning the geology of the country. The work is too well known to require any comment here, but it may be stated that, although published nearly twenty years ago, it remains to-day the most valuable book of reference on the geology and mineralogy of the Provinces of Ontario and Quebec." In 1864 Sir William went to England to attend to the final work on the large geological map of Canada and the neighboring States, which was to accompany his "Geology." He attended the meeting of the British Association in September, and read papers on the fossils of the Laurentian rocks—*Eozoön Canadense*—which he and Drs. Hunt and Dawson had been mainly instrumental in bringing to notice. The significance of this discovery may be indicated by a sentence from the presidential address of Sir Charles Lyell for that year : "We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created."

At the Paris Exhibition of 1867, the geology of Canada was well represented under charge of Dr. Hunt. Sir William was promoted by the Emperor of France to an officer of the Legion of Honor, and a few months later the Council of the Royal Society awarded him one of the two Royal Gold Medals of the year for his "geological researches in Canada, and the construction of a geological map of that colony."

In 1869 Sir William, finding that his private work demanded all his somewhat declining energies—he was then seventy-one years old—resigned his position as director of the Canadian survey. He continued geological work, however, in Canada and adjoining parts of New England for several seasons, his last investigations being made in the Eastern Townships in the summer of 1874. In August he sailed for England, intending to return in the spring, but during the winter, while he was staying in Wales with a sister, the disease which had been gradually coming upon him grew rapidly more serious ; he rallied somewhat in the spring, but never got really strong again, and died June 22, 1875.

"Those who had the good fortune to know Sir William Logan" (we quote from Professor Harrington's biography) "will remember him not merely as an enthusiastic geologist, but as a frank, true, and genial friend. Many a fellow-creature was cheered by his cheerfulness, helped by his kindly advice and sympathy, or in the more substantial way which ample private means rendered possible. In many respects his was a solitary life. Unlike his great contemporaries, Murchison and Lyell, he never enjoyed the sympathy and assistance of a wife. His over-active mind, no doubt, needed to be drawn from the geological grooves in which it ran, and if on returning to Rockfield, after the worries of the office or the hardships of the forest, there had been more of the attractions of home, his life would have been happier and possibly even longer than it was. . . . Earnestness and singleness of purpose were among the most marked features of Sir William's character. From the time that he began the geological survey until the day of his death, the great aim which was perpetually before him was to thoroughly elucidate the geology of Canada, and to render the knowledge acquired subservient to the practical purposes of life and to the advancement of his native country. He was continually beset with requests to examine and report upon mines in various parts of the country, but invariably refused unless he felt that the information derived would be of advantage to the public. Nor would he, on any such occasion, accept of remuneration for his services. Any *bona fide* attempt on the part of individuals or companies to develop the mineral resources of the country was sure of his encouragement and advice if asked for ; but the impostors who tried to palm off "salted" mines or impossible geological discoveries upon the unsuspecting public he despised, and always took an intense pleasure in exposing their schemes. . . .

"Sir William had little capacity for literary work, and, although he usually expressed himself with precision and force, his style was lacking in ease and gracefulness. Fine writing, however, was not his object, but rather to describe in simple language the results of observations in the field. . . . As he advanced in life, he found the work of composition more and more arduous. For some years before his death he contributed nothing to the literature of science, and even ordinary correspondence became increasingly distasteful to him."

Logan was a member of more than a dozen learned societies ; his degree of LL. D. was bestowed by McGill University in 1856, and that of D. C. L. by the University of Lennoxville the year before. Over twenty medals, and various other testimonials, show the esteem in which his work was held. His most important writings have already been mentioned ; some other papers were, "On the Footprints occurring in the Potsdam Sandstone of Canada," "On the Division of the Azoic Rocks of Canada into Huronian and Laurentian," "Considerations relating to the Quebec Group and the Upper Copper-bearing Rocks of Lake Superior," etc.

CORRESPONDENCE.

A CRITICISM AND A REPLY.

Messrs. Editors:

IN the realm of popular science a clear, piquant style is good, to unfold and adhere strictly to truth is better; but a union of these is the best of all. No one who has read Dr. Oswald's series of papers on health and disease in this "Monthly" can deny him the first attribute; but he must be superficial, indeed, who will allow him the second. I do not mean to say that all or even the larger part of his inculcations are false, but only that some of them are so glaringly contrary to fact that the special and cultivated observer can only tolerate the reading of them by the vigorous excellence of their surroundings.

It is not my intention to point out all the errors that have appeared in his long series of papers. I shall only refer to a few in his last article (July), entitled "The Remedies of Nature" for dyspepsia—a misnomer, by-the-way, as the remedies recommended are not Nature's, but Dr. Oswald's; as, for instance, "sleeping in a *cross-draught*," whatever this may mean, as a bulwark against dyspepsia.

On page 307 the doctor asserts that dyspepsia is not an hereditary complaint. If it is not, then there is no such thing. When consumption, cancer, and insanity, are spoken of as hereditary, the meaning is not that either of these diseases exists *per se* from the moment of conception, only that the tendency to them does. But the tendency to dyspepsia in some families is even more literally hereditary than the diseases named, for every careful and wide-observing physician knows that the offspring of some parents, almost from the moment of birth, manifests a facility for indigestion from the most trifling indiscretions. Observant mothers know that their own or neighbors' children, all of like habits and conditions of life, are strikingly unequal in digestive strength. Some of them can not eat this or that without severe suffering, others can eat of every unwholesome viand, and laugh at warnings; and this, not only in childhood, but more or less all through life. The difference is wholly inexplicable, except on the principle of heredity.

Our bright and spicy writer tells the dyspeptic "under no circumstances to resort to drug-exorcism." Only a person of superficial knowledge, of strong physique, and bigoted withal, who judges all others by his own personal equation, could discourse thus. Men and women will eat and drink, either with or without knowledge, what they ought not; as a consequence, the stomach rebels, and intense suffering ensues. Only a short time since I saw a woman who had been writhing every few minutes with terrible gastric cramps for ten hours. Clearly it was an attack of acute dyspepsia. To the suggestion of an emetic she answered that a vomit nearly killed her, and, besides, nothing could be on her stomach, as nothing had been eaten all day. But another paroxysm of cramp led her to exclaim, "Well, anything for relief!" In a few minutes she threw up nearly a gallon of fermenting food, that filled her chamber with the fumes of a fetid sourness worse than that of an August swill-tub. Half an hour after, she fell into a calm sleep. If humans will eat and drink what they ought not—eating, not for need but for pleasure, not as a means but as an end—the physician's duty is clearly to relieve suffering by the removal of its immediate cause, as by an emetic or cathartic. Of course, the homœopathic dogma (all dogmas in science are heretical) is to do nothing of the kind; to wait on Nature, and she will remove all the impurities of the alimentary canal herself. It is a source of surprise that these idealists, if they wish to be thought consistent, should ever use any soap and water to remove the impurities from their skins; they should wait on Nature, and she will scale the dirt off herself. Certes, skin-foulness is as nothing compared to bowel-filth, and a cathartic soap often lifts, as no skin-cleaning does, an oppressive incubus from the presence of organic decomposing matter in the intestines, which is death itself when a little of it finds its way into the blood. A grain of aloin thrown into the blood-current hypodermically will simply act as a purge; a grain of decaying animal matter similarly used will kill just as surely as a bullet through the lungs. Homœopaths magnify drug-poisoning five hundred diameters; but when they look for the poisons of diseases they reverse the microscope, seeing nothing at all.

Our lively doctor argues for fewer meals per day—even for the single-meal system—as the remedy for dyspepsia (page 312). Vaporific theorizing, without a scintilla of verification, is scarcely worthy of notice. After thirty years' reading and close practical observations, I have yet to learn of a man, not a sensational crank, who seriously proposed, much less gave instances in which it had been successfully employed, as a remedy for dyspepsia. Tens of thousands of practical scientists have tried and found just the opposite plan successful—to wit, eat only and as often as hunger prompts, but always abstemiously, on the principle that a weak stomach, like a weak body, can not manage one big load so readily as several small ones. Enough to nourish the body twenty-four hours is a pretty big meal. For the weak, divide the task to be accomplished, if a break-down by a supreme effort is undesirable.

The recommendation to the dyspeptic to adopt the habits of savages and ophidians is, to say the least, a display of supercilious conceit over Dame Nature, whom our writer professes so much to admire, when she so benignantly takes charge of the matter, saying, when athirst, water is needed; when we hunger, that food is. If men and women would only follow her monitions in this matter, and cease to drink when thirst is satisfied, cease to eat when hunger is, yielding not to the seductions of a *menu*—each course made more and more appetizing, so as to tempt a satiated appetite to commit the grossest excesses—half the dyspepsia in the land would disappear.

J. R. Black.

Newark, Ohio, *June* 25, 1883.

DR. OSWALD'S REPLY.

Messrs. Editors:

The friends of science owe you a vote of thanks for the unabridged publication of the foregoing epistle. Whether the orthodox school of therapeutics has much reason to thank Dr. Black for undertaking its defense, your readers may be inclined to doubt, but his letter is an encouraging sign of the times. As an attempt to suppress the propaganda of unorthodox tenets, it marks the ascendency of the third or controversial sophistry phase of argumentation. The primitive method was rude, though it had sometimes the advantage of practical conclusiveness. In the winter of 1682 the Spanish missionaries on the Rio Zelades in Yucatan reported a revival of irreligious tendencies among the aborigines of the district. Three weeks after, Colonel Perez Garcia invaded the diocese with a brigade of trained mastiffs. The natives had betrayed symptoms of skepticism, but the arrival of the four-legged dogmatists at once solved all doubts. The dangers of unbelief could no longer be questioned. The local Ingersolls were treed by hundreds, and the fervor of the revival almost surpassed the hopes of the propagandists. The scoffers were overtaken by the Nemesis of Faith, fugitives were recaptured and dragged back, breechless and howling; in short, to use an expression of the Rev. Joseph Cook's, there was "not a fig-leaf left to hide the shame of historical skepticism."

In the course of time the Garcia system was superseded by the personal-abuse method: "Professor X—— pretends to question the fact that Philip II possessed a duplicate skeleton of St. Laurentius. The professor's arguments are specious and might be worth refuting, if it were not well known that three years ago he married the daughter of a horse-farrier so notoriously addicted to the use of alcoholic beverages that at the present moment he is probably wallowing behind his stable in a state of scandalous intoxication." That settled it.

The misrepresentation plea, I hold, is a decided improvement upon the aforesaid methods. Like boomerangs, sophisms are crooked weapons, but they are occasionally apt to recoil in an unexpected manner, and may thus serve the cause of truth in spite of their constructor. Dr. J. R. Black betrays an intermittent tendency to relapse into the secondary system, but, on the whole, contents himself with the attempt to refute my tenets by misconstruing my arguments. He charges me with an habitual neglect of the duty "to unfold and adhere strictly to truth," and supports his indictment by the following specifications: He claims that, in repudiating the alleged hereditary transmission of dyspepsia, I disregard an indisputable fact, because "every careful and wide-observing physician" knows that in the children of some families a tendency to indigestion manifests itself almost from the moment of birth. Does our careful and wide-observing correspondent propose to deny that from the moment of birth millions of infants are both overfed and drug-poisoned? That a predisposition to various diseases may exist in the form of a latent tendency, I have often admitted; the point at issue is, whether such tendencies ever manifest themselves in spite of an hygienic regimen, and whether dietetic abuses, aggravated by emetics, cathartics, and paregoric, ever fail to accelerate their development. The monstrous death-rate of children in the institutes managed on the plan of Dr. Black's orthodox colleagues can no longer be explained by such convenient excuses as the fatality of an inherited disposition.

My predilection for non-medicinal remedies Dr. Black attributes to the strength of my physical and the debility of my mental constitution, and betrays an uncharitable disposition to aggravate the sorrows of my predicament by grudging me the use of soap and water. The voluntary renunciation of that cosmetic, he intimates, would prove at least my practical consistency. It is a source of surprise that our careful and wide-observing scientist has not yet learned to avoid the vulgar fallacy of confounding the artificial with the unnatural. Between the legitimate methods of assisting, imitating, and developing the tendencies of Nature and the audacious attempt to counteract her operations, there is all the *toto cœlo* difference of a duty and a mischievous presumption. Can an opponent of venesection not use a lancet to scrape the ink off his finger-nails, without incurring the reproach of inconsistency? Nature never fails to protest emphatically against the nauseous nostrums which the drug-monger employs under the pretext of relieving her embarrassments. Does she ever protest against soap and water? Does sapolio irritate the human skin? If not, a consistent anti-naturalist should cleanse his hands by means of a blister. In the opinion of our medical hierophant it will probably aggravate the iniquity of the "idealists" that the practical embodiment of their theories has proved a decided success. In the United States alone there are forty-six well-patronized hygienic sanitaria that restrict the use of drugs almost, or wholly, to the exceptional cases named on page 729 of "The Popular Science Monthly" for October, 1881. Drs. Schrodt, Maurice Nagy, James Knight, L. B. Coles, Abbott, Coleman, and the disciples of Graham, Alcott, and Isaac Jennings, have not recanted their tenets, and count their followers by tens of thousands. Unto all such Dr. J. R. Black ascribes superficialness, bigotry, and a sound physical constitution. The latter charge, I apprehend, can not be retaliated upon his own converts.

Hahnemann's heresies our critical observer imputes to an optical perversity. If his diagnostic spectacles enable him so distinctly to discern the "poison of disease," he ought to know better than to aggravate it by an additional poison. And if the doctor believes that the tenuous prescriptions of the homœopaths can not be considered as medicines, their success proves the very point I am contending for, namely, that in an infinite plurality of cases diseases can be better cured without any drugs at all.

Such "vaporific theorizing" as my plea for longer pauses between meals, Dr. J. R. Black thinks "scarcely worthy of notice." If the history of dietetics were not so far beneath the notice of a duly-ordained drug-dispenser, the doctor would perhaps know that many millions of the races who approach most nearly to the ideal of perfect physical and intellectual development adhered for sixty generations to the one-meal system, and that the plan of reducing the number of daily meals has been tested and urgently recommended by Drs. Haller,* Graham, Joel Ross, Dawson,† Dio Lewis,‡ C. E. Page,* and T. L. Nichols,† of London, as well as by thousands who have tried its efficacy for the cure of obstinate enteric disorders. All these men Dr. J. R. Black denounces as sensational cranks, savages, and ophidians, and accuses me of an inconsistent and "supercilious conceit over Dame Nature," for disregarding her "monitions in this matter." In his eagerness to achieve the glory of a *defensor fidei*, Dr. J. R. Black does not shrink from such trifles as logical solecisms. I have certainly never missed an opportunity to urge the importance of consulting the promptings of our natural instincts; but does the doctor propose to apply that rule to the cravings of a morbid appetency? Or have his "thirty years' reading and close practical observation" not yet taught him that the chronic hunger of a dyspeptic is as abnormal as the poison-thirst of a confirmed drunkard? "For the weak divide the task to be accomplished," says he—as if the assimilation of food were a mechanical operation. Dr. Black's decalogue needs a revision if he does not know that digestion is a chemical process, and can be better accomplished in a longer time (by prolonging the pause between meals) than by a division of labor. And what has the illiteracy of a South-Sea Islander to do with the competence of his hygienic instincts? Is the doctor's fund of valid arguments so scant that he has to resort to the expedient of an irrelevant charge? With the same logic the savage might refuse to accept the moral tenets of a short-sighted pale-face.

And Dr. Black's depreciation of the eupeptic ophidian is hardly less injudicious. No consistent follower of his school should allude with disrespect to the trade-mark of his craft—the Æsculapian pet that first suggested the art of utilizing our fellow-creatures by poisoning them.

Felix L. Oswald.

A HOMŒOPATHIC CORRECTION.

Messrs. Editors:

An article in your June issue, which attempts to deal with the question of quackery, refers at some length to the system of medical practice known by the name of homœopathy. I do not write for the purpose of exposing the fallacies or correcting all the misconceptions of the author; for I am not certain how far you would be willing

* "Ein Catholicon, eine überall gültige Regel in allen Krankheiten, ist die Zahl der täglichen Mahlzeiten zu reduciren."

† "It may be said, if we deprive the already wasted body of nourishment for any length of time, will we not run the risk of losing our little patient? To these questions I reply: *Starve the stomach! Give it rest!*"

‡ "I have tested the sufficiency of eating once in twenty-four hours, and have done work enough to put a younger man to his trumps if he had to do it. . . . I keep up my strength and have held in check my constitutional tendencies so that I have reached old age."

* "No person ever tried the plan and found reasons for abandoning it, except from considerations utterly remote from health."

† "The one-meal-a-day system will largely increase any person's working capacity."

to convert your monthly into a medium for the settlement of doctors' differences. I only wish to correct a misstatement of facts concerning the condition of practitioners of the homœopathic school in the Province of Ontario; in regard to which, the position I have held on the Board of Examiners and the Medical Council may justify me in speaking with authority. The misstatement is to the effect that "in Ontario, up to ten years ago, homœopaths were yearly registered by scores; since then they have to pass through the same courses and examinations as the regular students, in all but therapeutics and pharmacy. The consequence is, that in ten years there have only been two or three applications for examinations as homœopaths. Homœopathy is now dying a natural death."

1. Up to ten years ago, homœopaths were not "registered" (licensed, he means, for there was then no registering) by scores. Half a score a year was considered a large number. The old law required a longer course of study from homœopathic than allopathic students; and much longer than was necessary for graduation in a United States college. As a consequence, fully five sixths of our students settled across the line.

2. In the ten years following, under the new law, instead of only two or three homœopaths licensed for the whole period, there have been applicants every year—some as homœopaths, while others have passed the allopathic examinations. And, though the number of applicants may be less now than formerly, the diminution applies to students of all schools—the result of our extended course of study and rigid examinations. The proportion of allopathic and homœopathic applicants remains about the same.

3. The way "homœopathy is dying" in Ontario is illustrated by the fact that the President of the Medical Council, the *ex-officio* head of the medical profession, is this year an avowed homœopathist, and a graduate of a homœopathic college. And he has been elected to that position by a two-thirds vote of a body in which allopathic physicians have a majority of five to one.

As nearly all the statements regarding homœopathy in the article referred to have as much foundation in fact as those I have taken the liberty of correcting, it is evident that your contributor's assertions will need more than a single grain of salt to render them acceptable. Misstatements of facts are always made either in ignorance or in malice. Your contributor probably knows better than I the cause of those that have called forth my corrections.

CL. T. CAMPBELL.

LONDON, ONTARIO, *June* 25, 1883.

"OUR MARRIAGE AND DIVORCE LAWS."

Messrs. Editors:

GORDON A. STEWART, writing on "Our Marriage and Divorce Laws" in the June number of the "Monthly," in speaking of the causes for which divorces may be granted in different States, uses this language: . . . "In Connecticut, Indiana, Illinois, North Carolina, and Maine, there is any cause that a discontented and dishonest party may allege, or that a judge in his discretion, influenced by sympathy or corrupt motives, may approve."

As applied to Indiana this statement is wholly without foundation. In this State the causes for divorce are clearly defined by statute. No one is entitled to a divorce who can not show the existence of some one or more of the statutory grounds.

No discretion is vested in the judge, further than that of saying when the evidence is sufficient to prove the existence of the cause for which a divorce is asked. At one time Indiana had such a statute, but it was repealed many years ago. Mr. Stewart having thus (inadvertently, I presume) libeled our State, should make the "*amende honorable*" through the columns of the "Monthly," and will doubtless take pleasure in doing so when his attention is called to the matter.

R. W. MCBRIDE.

WATERLOO, INDIANA, *June* 20, 1883.

EDITOR'S TABLE.

THE DEAD-LANGUAGE SUPERSTITION.

THE celebrated defense of classical studies in college education delivered at the University of St. Andrew's, some fifteen years ago, by John Stuart Mill, produced a very powerful effect upon the public mind, and was thought by many to end all discussion upon the question. Mr. Mill had a great reputation, which was at that time at its full height. He was a man of extensive erudition, and fine mental accomplishments, and was, moreover, a radical reformer, and ranked high as a representative of modern ideas. Not being himself a university man, and standing as a leading liberal, it was naturally supposed that he would take the modern side in the great educational controversy between the rival claims of the old classics and the new science. But, to the surprise of nearly everybody, Mr. Mill came out the ultra-defender of the dead languages as against the living languages and modern studies, and went to the utmost extreme in his vindication of the traditional supremacy of the ancient classics.

It was recognized at the time that this was an anomalous and not fully explicable proceeding. We have it on good authority that, when Mr. Mill was inquired of as to his unexpected course, he excused it by saying that the scientific tendencies of the times are becoming too strong, and require to be checked—an explanation that still needed to be explained. Had Mr. Mill been himself less of a classicist and more of a scientist, less a devotee of the humanities and more a student of nature, he would have seen that these modern scientific tendencies are the inevitable results of a great evolutionary process of the human mind—a movement in the direction of higher knowledge—and no more to be withstood than the unfolding transformations of the natural world or the progress of human society.

But it was at that time too early to get the full explanation of Mr. Mill's position so as to understand his overwhelming bias in favor of the ascendency of dead languages and ancient literature in the collegiate preparation of young men. Not until the appearance of his "Autobiography" and the publication of the "Life of James Mill," his father, by Mr. Bain, was the secret of the situation fully revealed. It was of course known that James Mill was a man of great intellectual capacity and force, and it was believed that the son inherited from him these qualities in an eminent degree. But James Mill was a man who held very positive views on the subject of education, believed profoundly in its omnipotence, and resolved to show, in the case of his son, what it is capable of doing. He was, besides, an infatuated classicist, and a passionate admirer of the Greek language. And when we further remember that he was an iron-willed tyrant, and would not trust his son to other teachers, but himself became his tutor from babyhood to manhood, we can begin to appreciate the kind of influence to which young Mill was subjected. Crammed with classics in his earliest childhood, thinking in Greek at seven years of age, and overloaded with intellectual acquisitions of the highest order by his father's fanatical pedantry, the young fellow's faculties were kept upon the strain during the period of his bodily growth, until he was brought to the verge of insanity before he was yet of age. His strong mental constitution did not give way, but it was so warped and subjugated by his one-sided discipline that he was the last man living from whom to expect an unprejudiced judgment on the subject of mental cultivation.

When, therefore, Mr. Mill came to lay down the broad requirements of higher education, in his St. Andrew's discourse, he reasoned from his own remarkable experience, and insisted upon the inexorable predominance of the studies of which he had himself been made the victim. He went in for the ancient languages and the ancient literature as supreme, and relegated to a secondary place all the great results of modern thought. He ruled out from his curriculum the studies of history, of geography, of modern languages, and modern literature. Admitting the importance of science, he nevertheless assigned it a subordinate place in his scheme of education. Taking little account in his imposing plan either of the limitations of the human mind, the varying grades of human capacity, or the actual circumstances of human beings, he drew a scheme of culture that had but small application to the practical necessities of human life. His ideal university was, therefore, but a cloud-land romance. Its course of studies, patterned on his own comprehensive erudition, was little else than an elaborate recipe for making John Stuart Mills. He forgot that, whatever may be a man's native intellectual power, universality must be the eternal equivalent of superficiality, and he was himself a striking illustration of this forgotten truth. His acquaintance with science was so superficial that he was compelled to seek the aid of others in getting even the scientific illustrations needful for the exposition of his great work on logic. We do not go too far in saying that he lost his hold upon the age as a philosophic thinker by his want of command of the great scientific results of modern inquiry. He had been so long and so thoroughly steeped in the spirit of antiquity that he was disqualified for appreciating the grand import of modern ideas. He was a powerful student of human affairs, but from the antiquated point of view. He was in the Golden-Age, Paradise-Lost dispensation of thought in which the notions of the early perfection of mankind and the superiority of the ancients were contrasted with the degeneracy of the moderns, and so completely was his intellect possessed and perverted by this view, that he was disabled from appreciating the immense and epoch-making influence of the modern doctrine of evolution.

Yet palpable as were its exaggerations, and preposterous as were its estimates of the relative importance of different kinds of knowledge, the St. Andrew's address had an extensive and a very injurious influence. It was a godsend for the declining classical cause, for, although Mr. Mill condemned unsparingly the existing teaching of classics, its partisans cared nothing for that, so long as he conceded the predominance of classical claims. So his authority became a new bulwark for the defense of established abuses. It strengthened the hands of educational obstructives, and the specious arguments offered for the exaltation of ancient learning re-enforced all its arrogant and exclusive pretensions. The commendations of science went for nothing, as the magnitude of the classical claims left no room for them. Mr. Mill labored to extend the already excessive influence of dead-language studies in the colleges, and the power of his name was thus effectually arrayed against the rising demands of modern knowledge.

We have recalled this memorable discourse of Mr. Mill at the present time, because it is a landmark in the recent history of the controversy, and because since its publication the subject of dead languages in the colleges has had no such vigorous shake-up as has been given to it by Mr. Charles Francis Adams, Jr., in his telling address delivered before the Harvard chapter of the fraternity of the Phi Beta Kappa on June 28th. Mr. Adams is, of course, on the side of modern studies as against the classics. Into the argument as presented by Mr. Mill he does not enter, nor does he deny the transcendent benefits which some allege they have derived from the study of dead languages. But, not concerned with its ideals, he deals with the current classical education as a familiar fact, and tests it by its actual fruits. His point of view is that of common, well-to-do people, who demand the advantages of a higher education, but whose time of study is limited, and who must pass from the college to the labors and struggles of every-day life. Appealing to experience, to hard practical results, he finds himself compelled to condemn the system as a failure, a defeat of the true and highest purposes of education, an outrageous wrong to youth, and in its stubborn persistence against all the dictates of common sense a scandal to the intelligence of the age. Mr. Adams, moreover, proves his case. We venture to assert that no candid person can read this production, in connection with that of Mill, without recognizing that, to all the intents and purposes of the discussion, the American student of railroads has given a crushing answer to the English philosopher.

We are first of all glad to recognize that Mr. Adams has dealt with the subject with the freedom of entire fearlessness, and has set a much-needed example. He has not minced matters, but has boldly and bluntly said what a great many others think but hesitate to express. There is a good deal more intense conviction upon this matter than gets publicly uttered. Most men who have invested in classical education, and find that they have been sold, are anything but eager to acknowledge it. Having been cheated, they prefer to keep quiet about it. But Mr. Adams told the authorities of Harvard College to their faces that he had been victimized by their policy, and was there to arraign it on that very intelligible ground. In most explicit terms he characterized the worthlessness of the fundamental studies of that school, and which are the fundamental studies of most other colleges. But little further progress is to be made in the way of plain speaking when the staple of college study is openly denounced in the halls consecrated to it, and in the congregated presence of all parties to it, not only as a superstition, but as a superstition of the lowest and grossest sort. Greek and Latin, as pursued in our higher institutions, he pronounced to be nothing less or other than a "college fetich." It is among the native African negroes that fetichism is in most eminent vogue. A fetich is some object, no matter what—a tree, a mountain, a beast, a bit of wood, a lion's tail, an old bone—which the besotted native adores as possessed of religious potency, and to which he ascribes marvelous or magical power. A "college fetich" is, therefore, a study which is looked upon with a kind of stupid veneration, as capable of exerting mysterious and wonderful influences upon the minds of those devoted to it. The dead-language fetich is a matter of blind adoration. It is of but little use to argue against it—of but little use to reason with the fetichistic state of mind—for the peculiarity of any inveterate superstition is that it may be riddled with logic through and through, and its absurdity demonstrated over and over, without impairing in the slightest degree the mystical faith in its efficacy. Mr. Adams, therefore, confined himself mainly to an exposure of the results of the dead-language superstition, as he knew it and had suffered by it, in the college which gave him his education. His point of view was thus indicated: "To-day, whether I want to or not, I must speak from individual experience. Indeed, I have no other ground on which to stand. I am not a scholar; I am not an educator; I am not a philosopher; but I submit that, in educational matters, individual practical experience is entitled to some weight. Not one man in ten thousand can contribute anything to this discussion in the way of more profound views or deeper insight. Yet any concrete actual experience, if it be only simply and directly told, may prove a contribution of value, and that contribution we all can bring. An average college graduate, I am here to subject the college theories to the practical test of an experience in the tussle of life." Mr. Adams then describes how he entered the Latin School and learned two grammars by heart, and spent five years in mastering "the other rudiments of what we are pleased to call a liberal education," and then went through Harvard College, devoting himself industriously to all the regulation studies of which Latin and Greek were fundamental. Entering upon active life with his college preparation, he took hold of one of the large problems which has forced itself upon the thought of the present age with the following result: "I made for myself what might perhaps be called a specialty in connection with the development of the railroad system. I do not hesitate to say that I have been incapacitated from properly developing my specialty by the sins of omission and commission incident to my college training. The mischief is done, and, so far as I am concerned, is irreparable. I am only one more sacrifice to the fetich. But I do not propose to be a silent sacrifice. I am here to-day to put the responsibility for my failure—so far as I have failed—at the door of my preparatory and college education."

Mr. Adams charges that this failure is very far from being a thing of imagination or sentiment; but, on the contrary, it has been not only matter-of-fact and real, but to the last degree humiliating. He convicts his college of having refused to furnish him with that modern knowledge which is indispensable to effective work in modern life; of withholding from him the knowledge of those living languages which open communication with the world of contemporary thought; of wasting his youthful years upon dead languages which were never learned; of substituting a lax superficiality for thoroughness of attainment; of forcing its vicious system back upon the preparatory schools; and of adhering with superstitious tenacity to an educational policy fitted only to turn out incompetent smatterers, not half taught in subjects of very small importance. We quote some pointed passages of his indictment:

Now as respects the college preparation we received to fit us to take part in this world's debate. As one goes on in life, especially in modern life, a few conclusions are hammered into us by the hard logic of facts. Among those conclusions I think I may, without much fear of contradiction, enumerate such practical, common-sense, and commonplace precepts as that superficiality is dangerous, as well as contemptible, in that it is apt to invite defeat; or, again, that what is worth doing at all is worth doing well; or, third, that when one is given work to do, it is well to prepare one's self for that specific work, and not to occupy one's time in acquiring information, no matter how innocent or elegant, or generally useful, which has no probable bearing on that work; or, finally—and this I regard as the greatest of all practical precepts—that every man should in life master some one thing, be it great or be it small, so that thereon he may be the highest living authority; that one thing he should know thoroughly.

How did Harvard College prepare me, and my ninety-two classmates of the year 1856, for our work in a life in which we have had these homely precepts brought close to us? In answering the question it is not altogether easy to preserve one's gravity. The college fitted us for this active, bustling, hard-hitting, many-tongued world, caring nothing for authority and little for the past, but full of its living thought and living issues, in dealing with which there was no man who did not stand in pressing and constant need of every possible preparation as respects knowledge and exactitude and thoroughness—the poor old college prepared us to play our parts in this world by compelling us, directly and indirectly, to devote the best part of our school lives to acquiring a confessedly superficial knowledge of two dead languages.

In regard to the theory of what we call a liberal education, there is, as I understand it, not much room for difference of opinion. There are certain fundamental requirements, without a thorough mastery of which no one can pursue a specialty to advantage. Upon these common fundamentals are grafted the specialties—the students' electives, as we call them. The man is simply mad who in these days takes all knowledge for his province. He who professes to do so can only mean that he proposes, in so far as in him lies, to reduce superficiality to a science.

Such is the theory. Now, what is the practice? Thirty years ago, as for three centuries before, Greek and Latin were the fundamentals. The grammatical study of two dead languages was the basis of all liberal education. It is still its basis. But, following the theory out, I think all will admit that, as respects the fundamentals, the college training should be compulsory and severe. It should extend through the whole course. No one ought to become a Bachelor of Arts until, upon these fundamentals, he had passed an examination, the scope and thoroughness of which should set at defiance what is perfectly well defined as the science of cramming. Could the graduates of my time have passed such an examination in Latin and Greek? If they could have done that, I should now see a reason in the course pursued with us. When we were graduated, we should have acquired a training, such as it was; it would have amounted to something; and, having a bearing on the future, it would have been of use in it. But it never was for a moment assumed that we could have passed any such examination. In justice to all, I must admit that no self-deception was indulged in on this point. Not only was the knowledge of our theoretical fundamentals to the last degree superficial, but nothing better was expected. The requirements spoke for themselves; and the subsequent examinations never could have deceived any one who had a proper conception of what real knowledge was.

But in pursuing Greek and Latin we had ignored our mother-tongue. We were no more competent to pass a really searching examination in English literature and English composition than in the languages and literature of Greece and Rome. We were college graduates; and yet how many of us could follow out a line of sustained, close thought, expressing ourselves in clear, concise terms? The faculty of doing this should result from a mastery of well-selected fundamentals. The difficulty was that the fundamentals were not well selected, and that they had never been mastered. They had become a tradition. They were studied no longer as a means, but as an end—the end being to get into college. Accordingly, thirty years ago there was no real living basis of a Harvard education. Honest, solid foundations were not laid. The superstructure, such as it was, rested upon an empty formula.

The reason of all this I could not understand then, though it is clear enough to me now. I take it to be simply this: The classic tongues were far more remote from our world than they had been from the world our fathers lived in. They are much more remote from the world of to-day than they were from the world of thirty years ago. The human mind, outside of the cloisters, is occupied with other and more pressing things. Especially is it occupied with a class of thoughts—scientific thoughts—which do not find their nutriment in the remote past. They are not in sympathy with it. Accordingly, the world turns more and more from the classics to those other and living sources in which alone it finds what it seeks. Students come to college from the hearthstones of the modern world. They have been brought up in the new atmosphere. They are consequently more and more disposed to regard the dead languages as a mere requirement to college admission. This reacts upon the institution. The college does not change—there is no conservatism I have ever met, so hard, so unreasoning, so impenetrable, as the conservatism of professional educators about their methods—the college does not change; it only accepts the situation. The routine goes on, but superficiality is accepted as of course; and so thirty years ago, as now, a surface acquaintance with two dead languages was the chief requirement for admission to Harvard; and, to acquiring it, years of school life were devoted.

Nor in my time did the mischief end here. On the contrary, it began here. As a slipshod method of training was accepted in those studies to which the greatest prominence was given, the same method was accepted in other studies. The whole standard was lowered. Thirty years ago—I say it after a careful search through my memory—thoroughness of training in any real-life sense of the term was unknown in those branches of college education with which I came in contact. Everything was taught as Latin and Greek were taught. Even now, I do not see how I could have got solid, exhaustive teaching in the class-room, even if I had known enough to want it. A limp superficiality was all-pervasive. To the best of my recollection the idea of hard thoroughness was not there. . . .

Many of you are scientific men; others are literary men; some are professional men. I believe, from your own personal experience, you will bear me out when I say that, with a single exception, there is no modern scientific study which can be thoroughly pursued in any one living language, even with the assistance of all the dead languages that ever were spoken. The modern languages are thus the avenues to modern life and living thought. Under these circumstances, what was the position of the college toward them thirty years ago? What is its position to-day? It intervened, and practically said then that its graduates should not acquire those languages at that period when only they could be acquired perfectly and with ease. It occupies the same position still. It did and does this none the less effectually because indirectly. The thing came about, as it still comes about, in this way: The college fixes the requirements for admission to its course. The schools and the academies adapt themselves to those requirements. The business of those preparatory schools is to get the boys through their examinations, not as a means, but as an end. They are therefore all organized on one plan. To that plan there is no exception; nor practically can there be any exception. The requirements for admission are such that the labor of preparation occupies fully the boy's study-hours. He is not overworked, perhaps, but when his tasks are done he has no more leisure than is good for play; and you can not take a healthy boy the moment he leaves school and set him down before tutors in German and French. If you do, he will soon cease to be a healthy boy; and he will not learn German or French. Over-education is a crime against youth. But Harvard College says, "We require such and such things for admission to our course." First and most emphasized among them are Latin and Greek. The academies accordingly teach Latin and Greek; and they teach it in the way to secure admission to the college. Hence, because of this action of the college, the schools do not exist in this country in which my children can learn what my experience tells me it is all-essential they should know. They can not both be fitted for college and taught the modern languages. And, when I say "taught the modern languages," I mean taught them in the world's sense of the word, and not in the college sense of it, as practiced both in my time and now. And, here let me not be misunderstood, and confronted with examination papers. I am talking of really knowing something. I do not want my children to get a smattering knowledge of French and of German, such a knowledge as was and now is given to boys of Latin and Greek; but I do want them to be taught to write and to speak those languages, as well as to read them—in a word, so to master them that they will thereafter be tools always ready to the hand. This requires labor. It is a thing which can not be picked up by the wayside, except in the countries where the languages are spoken. If academies in America are to instruct in this way, they must devote themselves to it. But the college requires all that they can well undertake to do. The college absolutely insists on Latin and Greek. . . .

But I now come to what in plain language I can not but call the educational cant of this subject. I am told that I ignore the severe intellectual training I got in learning the Greek grammar, and in subsequently applying its rules; that my memory then received an education which, turned since to other matters, has proved invaluable to me; that accumulated experience shows that this training can be got equally well in no other way; that, beyond all this, even my slight contact with the Greek masterpieces has left with me a subtile but unmistakable residuum, impalpable perhaps, but still there, and very precious; that, in a word, I am what is called an educated man, which, but for my early contact with Greek, I would not be.

It was Dr. Johnson, I believe, who once said, "Let us free our minds from cant," and all this, with not undue bluntness be it said, is unadulterated nonsense. The fact that it has been and will yet be a thousand times repeated can not make it anything else. In the first place, I very confidently submit, there is no more mental training in learning the Greek grammar by heart than in learning by heart any other equally difficult and, to a boy, unintelligible book. As a mere work of memorizing, Kant's "Critique of Pure Reason" would be at least as good. In the next place, unintelligent memorizing is at best a most questionable educational method. For one, I utterly disbelieve in it. It never did me anything but harm; and learning by heart the Greek grammar did me harm—a great deal of harm. While I was doing it, the observing and reflective powers lay dormant; indeed, they were systematically suppressed. Their exercise was resented as a sort of impertinence. We boys stood up and repeated long rules, and yet longer lists of exceptions to them, and it was drilled into us that we were not there to reason, but to rattle off something written on the blackboard of our minds. The faculties we had in common with the raven were thus cultivated at the expense of that apprehension and reason which, Shakespeare tells us, make man like the angels and God. I infer this memory-culture is yet in vogue, for only yesterday, as I sat at the commencement-table with one of the younger and more active of the professors of the college, he told me that he had no difficulty with his students in making them commit to memory; they were well trained in that. But when he called on them to observe and infer, then his troubles began. They had never been led in such a path. It was the old, old story—a lamentation and an ancient tale of wrong. There are very few of us who were educated a generation ago who can not now stand up and glibly recite long extracts from the Greek grammar; sorry am I to say it, but these extracts are with most of us all we have left pertaining to that language. But, as not many of us followed the stage as a calling, this power of rapidly learning a part has proved but of questionable value. It is true, the habit of correct verbal memorizing will probably enable its fortunate possessor to get off many an apt quotation at the dinner-table, and far be it from me to detract from that much-longed-for accomplishment; but, after all, the college professes to fit its students for life rather than for its dinner-tables, and in life a happy knack at quotations is in the long run an indifferent substitute for the power of close observation, and correct inference from it. To be able to follow out a line of exact, sustained thought to a given result is invaluable. It is a weapon which all who would engage successfully in the struggle of modern life must sooner or later acquire, and they are apt to succeed just in the degree they acquire it. In my youth we were supposed to acquire it through the blundering application of rules of grammar in a language we did not understand. The training which ought to have been obtained in physics and mathematics was thus sought for long, and in vain, in Greek. That it was not found is small cause for wonder now. And so, looking back from this stand-point of thirty years later, and thinking of the game which has now been lost or won, I silently listen to that talk about "the severe intellectual training," in which a parrot-like memorizing did its best to degrade boys to the level of learned dogs.

But the case, as presented by Mr. Adams, was really much stronger than any individual experience could make it. He is descended from an illustrious line of scholars and statesmen — men eminent in affairs and of large national influence. His great-grandfather and his grandfather were Presidents of the United States, and his father represented this nation as minister to the English court at a very critical period in the relations of the two countries. These distinguished men were all graduates of Harvard College, and it must be assumed that they were capable of doing the best honor to their opportunities. But the representative of the fourth generation appeals to a family experience, extending through nearly a century and a half, in reprobation of the system which he had himself found so worthless and injurious. It was the same old story — Greek half-learned, good for nothing, and forgotten, while modern languages had to be acquired as indispensable implements of successful work in practical life. We can not give this interesting special history which so effectually clinches the case; but we quote the reference to the fourth and fifth generations, which shows that the system of fetichistic immolation is still practiced with desperate perversity at Harvard College:

I come now to the fourth generation, cutting deep into the second century. My father had four sons. We were all brought up on strict traditional principles, the special family experience being carefully ignored. We went to the Latin schools, and there wasted the best hours of our youth over the Greek grammar—hours during which we might have been talking French and German —and presently we went to Harvard. When we got there we dropped Greek, and with one voice we have all deplored the irreparable loss we sustained in being forced to devote to it that time and labor which, otherwise applied, would have produced results now invaluable. One brother, since a professor at Harvard, whose work here was not without results, wiser than the rest, went abroad after graduation, and devoted two years to there supplying, imperfectly and with great labor, the more glaring deficiencies of his college training. Since then the post-graduate knowledge thus acquired has been to him an indispensable tool of his trade. Sharing in the modern contempt for a superficial learning, he has not wasted his time over dead languages which he could not hope thoroughly to master. Another of the four, now a Fellow of the University, has certainly made no effort to keep up his Greek. When, however, his sons came forward, a fifth generation to fit for college, looking back over his own experience as he watched them at their studies, his eyes were opened. Then in language certainly not lacking in picturesque vigor, but rather profane than either classical or sacred, he expressed to me his mature judgment. While he looked with inexpressible self-contempt on that worthless smatter of the classics which gave him the title of an educated man, he declared that his inability to follow modern thought in other tongues, or to meet strangers on the neutral ground of speech, had been and was to him a source of life-long regret and the keenest mortification. *In obedience to the stern behest of his Alma Mater, he then proceeded to sacrifice his children to the fetich.*

LITERARY NOTICES.

Life of Sir William E. Logan, Kt., LL. D., F. R. S., F. G. S., etc., First Director of the Geological Survey of Canada. By Bernard J. Harrington, B. A., Ph. D. Montreal: Dawson Bros. Pp. 432.

Professor Harrington has performed an acceptable service in giving us the story of Sir William Logan's life, so full of interest in connection with the development and conduct of the Geological Survey of Canada, of which Logan was the first director and zealous supporter, from the date of his appointment to this service in 1842, until his death in 1875.

Born of Scotch parents in Montreal, in 1798, and educated under a Scotch master, in 1814 he was sent with his brother Hart to the High School of Edinburgh, then in the zenith of its reputation. In 1816 Logan became a student in the university, but his university life closed with his first year, and he then went to London to take a place in the commercial house of his uncle, Mr. Hart Logan, where he remained for about ten years. The letters of Logan, to his brother chiefly, during this period are full of genial humor, and picture the writer like a mirror, showing up the sweetness and manly spirit of a most charming character. Those of us who knew Sir William only in later life, when he had espoused Science as his only mistress, gain a new view of the man as he unconsciously betrays his loving nature in these genuine letters.

His geological life began when in 1831, at the age of thirty-three, by a change in his occupation he was placed in charge of a copper-smelting and coal-mining enterprise in Wales, where his uncle had embarked in a smelting process on the waste slags of Swansea. His duties here led him to renew and extend his acquaintance with scientific pursuits. In 1840 he revisited Canada and renewed the associations of his early life. The first mention of his survey of Canada grew out of a conversation Logan had in 1841 with the late Dr. William B. Rogers, whom he met in Philadelphia. The subject had been brought forward by Dr. Rae. in 1832, by a petition to the Provincial Legislature, but repeated solicitations for money for this purpose failed to gain the attention of the Government until 1841, when £1,500 was secured for the purposes of a survey. The strong support of Mr. Logan by De la Beche, Murchison, Sedgwick, Buckland, and others, left no question but that Logan was the best person to place in charge of this important work. His appointment was confirmed in 1843, and he entered immediately with the utmost zeal and devotion upon the duties of his office. It is impossible to read his letters and journals at this time without a strong conviction of his rare talent and skill in meeting and overcoming difficulties which to a less bold and determined explorer would have appeared insurmountable. Professor Harrington's narrative sets forth clearly the successive steps of the work and its organization. Space forbids us to follow these interesting details. The whole volume sparkles with the good humor and bright remarks scattered in Logan's journal and letters, making it a volume of unusual interest both for the general and the scientific reader. In his Canadian work he was ably aided by Alexander Murray, for mnny years his principal geological assistant; Billings, his able paleontologist; Hunt, his chemist and co-worker in structural geology for about a quarter of a century; and later Hartley, a young geologist of uncommon promise, too soon removed by death, not to mention others of merit.

On Work and Wages. By Sir Thomas Brassey, K. C. B., M. P. New York: G. P. Putnam's Sons. Pp. 284. Price, $1.

The experience of that celebrated railroad-contractor, Thomas Brassey, Sr., with large numbers of workmen of various nationalities, and in various localities in Europe, forms the nucleus of this book. The greater part, however, consists of the results of inquiries into the labor question by the author, his son. Strikes and trades-unions are the first subjects discussed, and then follows a chapter, largely made up of illustrations and statistics, in which it is shown that the rate of wages is regulated, not by the fiats of trades-unions, but by demand and supply. The distinction between the rate of wages and the cost of labor is next pointed out, and abundantly illustrated. A comparison in respect to efficiency of the laborers of several European countries is made, which places the English "navvies," in spite of their shorter hours and higher rate of wages, in a very favorable light. A chapter in regard to the "Influence of American Wages on the English Labor-Market" follows, in which the effect of the large emigration to this country is discussed. This chapter, evidently written before our resumption of specie payments, contains also an opinion in regard to "assisted emigrants," which is interesting as the expression of an English legislator several years prior to the present excitement. Co-operative establishments and boards of arbitration between employers and employed are two other important topics which are treated.

The Religion of Humanity. By William Frey. "Index" Publication-Office, 3 Tremont Place, Boston. Pp. 85. Price, 15 cents.

This little work by an able Russian, who was formerly a professor of mathematics in the East, but has adopted this country for his home, was first contributed in a succession of papers to the pages of "The Index," and, having attracted a good deal of attention, they have been reissued in this separate and more accessible form. Professor Frey takes up the fundamental questions in relation to the nature, basis, applications, and uses of religion, and, while criticising the view adopted by Herbert Spencer upon the subject, is more inclined to accept that of Auguste Comte. While repelled from Spencer's view, which confines religion to man's mysterious relation to the unknowable Power manifested in the universe, but which is beyond the reach of human intelligence, Professor Frey is attracted to the doctrine of Comte, which makes man, or humanity, the object of religious feeling, veneration, and worship. Being deeply concerned with the interests of humanity, and aspiring after a better state of things than now exists, and recognizing the great power of the religious sentiment, he sees in "The Religion of Humanity" the greatest means of future progress, and the only hope of any substantial improvement in the social condition of mankind. We are not prepared here to consider the grave issues involved in this discussion, but may cordially commend the pamphlet before us as an earnest contribution to the inquiry which, if not conclusive, will be found suggestive, and probably helpful to many who are seeking light upon a much confused and deeply perplexing subject.

The Cause of Variation. By M. M. Curtis. Marshall, Minn.: Published by the author. Pp. 115.

The author's answer to this problem is—labor. He instances the comparative fewness of the larger carnivora, which obtain their food easily, and the large numbers of wolves and other animals, which obtain subsistence only by ceaseless activity, as showing the effect of labor on the development of animals. He maintains, further, that suspension of effort causes proportional loss of consciousness. Intelligent acts are performed without consciousness, hence there is an unconscious intelligence inherent in every structure, giving evidence of form or design; moreover, this intelligence is capable of transmigration. Communities follow the same rule as individuals. "When labor is partially suspended among the individuals in such a community, or, owing to the invention of labor-saving machines and division of labor, becomes more simple, the community begins to manifest the characteristics of decay and dissolution." It would seem to be the author's belief that those who make a failure of this life are, after a term of purgation, to have another try at it, for he ends by saying: "From the fire we came, and to the fire we are going, unless we comply with the conditions of life and consciousness. The answer to the riddle fate would have us read is this: 'Unless ye labor ye shall perish.' If we can not comply with that, we shall probably continue to be warmed over until we can."

Notes on Evolution and Christianity. By J. F. Yorke. New York: Henry Holt & Co. Pp. 294. Price, $1.50.

The author puts forth this book as an aid to answering the question, "Is there in the teaching of Christ an originality so wonderful as to be accounted for only by the assumption of a special divine revelation?" The first chapter is devoted to a sketch of some Eastern religions which preceded Christianity. The second is mainly made up of quotations from Christ's teachings, and of similar passages in other writings, while the remaining chapter takes up the difference between natural morality and the religious systems of ethics. The author's estimate of Christianity is as follows: "The Eastern world was fortunate in possessing many great moral and religious teachers; and it was out of their doctrines, ever increasing in perfection as time went on, that was gradually and naturally built up the most complete and beautiful religion of all. Hence (we may say) it was *necessary* that, in the process of evolution, this development should be reached, and that Christianity should come: yet this is no reason why we need hesitate to add—but blessed be he through whom it came." Moreover, he considers that the evidence brought forward tends to show "that much of Christ's doctrine was necessarily of only temporary and local value; but that the Church has greatly hindered the progress of knowledge and scientific morality by insisting that her founder's teaching is final on all points," and "that science is now proving the origin and nature of man to be entirely different to those assumed by religious teachers, and thereby contradicting much that is essential to their doctrines."

Eve's Daughters; or, Common Sense for Maid, Wife, and Mother. By Marion Harland. New York: John R. Anderson and Henry S. Allen. Pp. 454. $2.

A book of sound principles on the instruction and training of girls and women with reference to the principal function of their life. That it has met a large demand and approval by the public is attested by the fact that it is now in its twentieth thousand. The subject of the book is the training and treatment of woman, in respect chiefly to her physical well-being and moral culture, in every age and condition of life—as an infant, as a girl at play, as a school-girl, "young lady," wife, and mother. The infant is commended to the mother's personal nursing and care, and to an enlightened *régime*, in order to give which the mother must seek the necessary knowledge. For the girl are claimed the freedom of action that will secure to her the best development, and the instruction and the sincerity of instruction that will best help her to make herself a true and sound woman. As the school-life period approaches, and the critical period of the woman's life with it, more attention is required to secure a proper development of the physical and mental functions than even in infancy, and the subject receives a correspondingly greater particularity of treatment. The calling of the woman to be a housekeeper and the trainer of a new family and the bearing of her education to those ends are given their proper prominence. We have also chapters on what women who have grown up to be young ladies should do for their mothers, on dress, on the cure of gossip, on the period of marriage and the duties of the expectant mother. The book is a woman's book on a woman's subject, in which the plainest truths are presented in the most forcible manner, yet with the most fully refined delicacy; and it is a book that will help women, and in helping them will help the human race.

Legal Provisions respecting the Examination and Licensing of Teachers. Washington: Government Printing-Office. Pp. 46.

This pamphlet, published by the Bureau of Education as one of its "Circulars of Information," gives summaries of the rules prevailing in the several States for ascertaining the qualifications of teachers preparatory to giving them licenses. While the Commissioner of Education has no desire to call undue attention to examinations, and deprecates the cramming and the danger of making them an end in education which it is likely to induce, he hopes to secure a good purpose by showing how it has seemed best to the people of the different States to determine whether the teacher has the qualifications required; for which no better general way seems to have been found than some system of examination.

Bacteria and the Germ Theory of Disease. By Dr. H. Gradle, Professor of Physiology, Chicago Medical College. Chicago: W. T. Keener. Pp. 216. Price, $2.

Since this book consists of medical lectures, the treatment of the subject is naturally technical rather than popular. It is a presentation of the results so far attained in researches as to the nature of germs, and their action as agents of disease.

School-Books on Physiology and Hygiene. By Stanford E. Chaillé, of the University of Louisiana.

Having received many requests for advice respecting the best school text-books on hygiene, Dr. Chaillé examined the various books in the market, for comparison with one another and with his own standard of merit, which was that they should give predominance to teaching the care and proper use of the organs and the preservation of health. Of twenty books regarded as living candidates for favor, three were found fairly suitable for children ten or twelve years of age, while the others were more or less adapted to the comprehension of youth of different greater ages. Of the more advanced works, Draper's, Dalton's, and Huxley and Youmans's "are excellent," and the two latter and Foster's primer (primary) "bear the unmistakable stamp of the master's hand," and illustrate the rule "that even the most elementary books can be better written by distinguished experts." The pervading fault of most of the books is that they pay too little attention to hygiene.

The Evolution of the American Trotting-Horse, pp. 5; and The American Trotting-Horse: why he is and what he is, pp. 28. By Professor William H. Brewer, of Yale College.

Professor Brewer regards the trotting-horse as essentially a development of the present century, and as still in process of evolution. His training has been stimulated by a combination of influences. The ancients did not have "trotters," and did not want them, because, not possessing light spring-wagons, they knew nothing of driving for pleasure, and for riding they preferred animals of more even gait. A little attention seems to have begun to be paid to trotting at about the time of the close of the Revolutionary War; the first mention of a "trotting-stallion" is found in 1788. The first definite notice of trotting on the course is in 1806, when Yankee trotted a mile in two minutes and fifty-nine seconds. At about this time a prejudice, resulting in the enactment of prohibitory laws, was developed against horse-racing (competitive running), and trotting-matches against time were introduced. A demand for trotters sprang up in the French West Indies; and light spring-wagons were invented, and, as they became fashionable, the taste for fast driving increased. These and kindred circumstances favored the development of the trotting-horse, and it has gone on speedily. In 1806, 2·59 was the fastest time that had been made by trotting; 2·40 became the synonym for speed in 1824. In 1843, one horse, Lady Suffolk, had trotted a mile in less than 2·30; in 1882, 1,654 horses had made that record, and the fastest time had been reduced by Maud S. to 2·10¼.

Natural Cure of Consumption, Constipation, Bright's Disease, Neuralgia, Rheumatism, Colds (Fevers), etc. The Origin, Prevention, and Removal of Disease. By C. E. Page, M. D. New York: Fowler & Wells. Pp. 278. Price, $1.

The author maintains that bad living is the primary cause of the diseases named; that no mere accident of exposure, like those to which they are commonly ascribed, is competent to produce them unless the system has already been made peculiarly sensitive to them by habitual overloading of the stomach, living in bad air, or indolence; and that they are susceptible of being cured by adopting and adhering to a "natural" treatment and *régime*. In all this Dr. Page agrees fully with Dr. Oswald, and quotes him freely. He gives several remarkable examples of wonderful cures which he knows of having been effected by following the principles he lays down. Whether the course he recommends will be quite as effective, in all cases, as he seems to believe it will be, or not, he has laid down principles which may be followed with profit, and the following of which may relieve many cases regarded as desperate; and he has given the public a most valuable manual of hygiene.

"The Medico-Legal Journal." Vol. I, No. 1, June, 1883. Published under the Auspices of the Medico-Legal Society of New York. Pp. 118. Price, $3 a year.

This is claimed to be the only journal in any part of the world devoted exclusively to the science of medical jurisprudence. It will publish the leading papers of the Medico-Legal Society, and a summary of its transactions and contributions from all sources on subjects and questions appropriate to its sphere. The present number contains a portrait of Dr. George W. Beard, who was a leader in projecting the journal; the inaugural address of President Clark Bell, of the Medico-Legal Society, in which is embodied a review of the progress of medical jurisprudence in the several countries of the world; reports on coroners, medical examiners, amendments to the lunacy laws of New York, and on the Pennsylvania lunacy laws, and miscellaneous matters.

Van Loan's Catskill Mountan Guide for 1883. With Bird's-eye Views of the Mountains, and Maps. Catskill, N. Y.: Walton Van Loan. Pp. 126. Price, 40 cents.

Besides notices of the principal resorts and attractions in the mountains, with directions for reaching them, and directories of hotels and boarding-houses, arranged by towns, the "Guide" contains some well-considered and condensed notes, intended to assist in geological observations in the Catskill region. The whole would be a valuable and desirable acquisition to tourists, but for the sprawling advertisements that are intruded among the reading-matter. In a book to which a price is attached, the two kinds of matter should occupy their separate pages.

Political Economy. By Francis A. Walker. New York: Henry Holt & Co. Pp. 490. $2.25.

This volume is the fifth of the "American Science Series," the principal objects of which are defined to be "to supply the lack of authoritative books whose principles are, so far as practicable, illustrated by familiar American facts, and also to supply the other lack that the advance of science perennially creates, of text-books which at least do not contradict the latest generalizations." The list of the works to be included in the series shows that the publishers have made it a rule to go to authors whose names carry authority, and who speak as original investigators, having their facts at first hand. Professor Walker's discussion, in this volume, of the questions included under the general title of political economy in their varied and complicated aspects and relations is full and rich in citations of authorities and in illustrations, and covers such a multiplicity of topics that it would be impossible, in an ordinary notice, to give even an outline of it. It is conducted with such clearness as to make the book quite readable and readily understood. After the introductory chapter, or part, in which the "Character and Logical Method of Political Economy" are considered and its claims to be ranked as a science and its relations with other branches are discussed, the whole subject is topically divided and treated under the several heads of "Production," "Exchange," "Distribution," "Consumption," and "Some Applications of Economical Principles." The numerous questions growing out of the labor agitation, the subjects of the currency, paper money, bi-metallism, protection *vs.* free trade, and other economic topics now vital among us, receive attention in their appropriate places.

"Mastery." Useful Pastimes for Young People. A Weekly Magazine. New York: Mastery, 842 Broadway. Pp. 16. Price, 7 cents a number, $3 a year.

The character of this publication is well indicated by the subordinate title. It is intended not only to amuse and instruct, but also to direct the natural bent of its readers to some practical work; and the numbers we have seen of it seem well adapted to these purposes. In two of them we have a story illustrating the magical effects that may be wrought through simple applications of modern scientific discoveries; papers relating to natural history, astronomy, and physiology; and lessons and suggestions regarding various arts and sports with which youth may find it pleasant—and perhaps profitable—to amuse themselves.

A Visit to Ceylon. By Ernst Haeckel. Translated by Clara Bell. Boston: S. E. Cassino & Co. Pp. 337. Price, $2.

A book from an author who has had such an influence upon the scientific thought of his countrymen as Herr Haeckel has exerted must have a value of its own, even though it be not directly scientific. The "Visit to Ceylon" records the impressions of a tourist; yet not of the ordinary tourist, who skims over a country and takes the merest superficial view of everything, but of a traveler whose mission is scientific, and who expects to make a study of all that he sees, and to draw a lesson valuable to students and to mankind from every object he meets. The impressions are recorded here. The studies will come afterward, and the fruits of them, probably, be given to the world in volumes which will be heavier in proportion as they are of more solid value. Professor Haeckel, as may be inferred from the character of his mind, saw more than common tourists do, and, in one direction at least, more intelligently. To him, in Ceylon—a country of tropical luxuriance, contrasting strongly with cold and frugal Germany—everything was fresh, new, and full of blooming life. These qualities are exhibited also by his narrative, which is brilliant in color, warm with admiration, and diversified with the lively effusions of an imagination which might have made a poet had it not been bestowed upon a student of prosaic biology.

The Maintenance of Health. A Medical Work for Lay Readers. By J. Milner Fothergill, M. D., M. R. C. P. New York: G. P. Putnam's Sons. Pp. 366. Paper. Price, 60 cents.

A work that was first published several years ago, but which is so thorough in its treatment of the subject, and contains so much that is of practical value, that it still remains one of the best books of the kind in the market. We have already given full notice and commendation of the two previous editions, the larger and expensive one, and the more popular edition in 12mo; so we need only mention the appearance of this cheap edition, and say that the publishers deserve the thanks of the public for issuing it.

PUBLICATIONS RECEIVED.

United States Hay Fever Association. 1883. Portland, Me.: Hoyt, Fogg & Donham. Pp. 30.

The People's Power; or, How to wield the Ballot. By Simeon Stetson. San Francisco: Hinton & Co. 1883. Pp. 63.

Johns Hopkins University Studies in Historical and Political Science. Herbert B. Adams, Editor. III. "Local Government in Illinois," by Albert Shaw, A. B.; and "Local Government in Pennsylvania," by E. R. L. Gould, A. B., pp. 37. IV. Saxon Tithing Men in America. By Herbert B. Adams, Ph. D. Pp. 23. V. Local Government in Michigan and the Northwest. By Edward W. Bemis, A. B. Pp. 25. Baltimore: Published by the University. 1883.

The Factors of Civilization. Vol. I. Atlanta: J. P. Harrison & Co. 1883. Pp. 347.

Bulletin of the American Museum of Natural History, Central Park, New York. Vol. I, No. 4. The Atlantic Right Whales. By Joseph Bassett Holder. W. C. Martin, printer. 1883. Pp. 38, with Plates.

The Modern Polytechnic School. Inaugural Address by President Charles O. Thompson. Terre Haute, Ind. 1883. Pp. 27.

The Stuart Period. From a Medical Standpoint. By R. L. Macdonnell, B. A., M. D. 1883. Pp. 23.

The Geology of Philadelphia. By Professor H. Carvill Lewis. 1883. Pp. 21.

Lake Agassiz. A Chapter in Glacial Geology. By Warren Upham. Jones & Kroeger, Printers. 1883. Pp. 25.

Statistical Tables from the History and Statistics of American Water-Works. By J. J. R. Cowes. "New York Engineering News." 1883. Pp. 120.

Seventh Annual Report of the State Board of Health of Wisconsin. 1882. Madison Democrat Printing Co. 1883. Pp. 265.

On a New Genus and Species of Blastoids. By Charles Wachmuth; and Descriptions of some New Blastoids from the Hamilton Group. By W. H. Barris. Springfield, Ill.: H. W. Rokker, printer. 1883. Pp. 21. Illustrated.

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Human Proportion in Art and Anthropometry. By Robert Fletcher. Cambridge, Mass.: Moses King. 1883. Pp. 37, with Plates.

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POPULAR MISCELLANY.

A Cod-Mountain in the Sea.—The "conference" at the Fisheries Exhibition was opened with a lecture by Professor Huxley, in which he said: "Those who have watched the cod-fisheries off the Loffoden Isles, on the coast of Norway, say that the coming in of the cod, in January and February, is one of the most wonderful sights in the world; that the cod form what is called a 'cod-mountain,' which may occupy a vertical height of from twenty to thirty fathoms—that is to say, one hundred and twenty to one hundred and thirty feet in the sea; and that these shoals of enormous extent keep on coming in great numbers from the westward and southward for a period of something like two months. The number of these fish is so prodigious that Pofessor Sars tells us that when the fishermen let down their loaded nets they feel the weight knocking against the bodies of the codfish for a long time before it gets to the bottom. I have made a computation which leads to this result, that if you allow each fish four feet in length, and let them be a yard apart, there will be in a square mile of such shoals somethiug like one hundred and twenty million fish. I believe I am greatly understating the actual number, for I believe the fish lie much closer. These facts about the cod apply also to the herring, for not only Professor Sars, but all observers, who are familiar with the life of the cod when it has attained a considerable size, tell us that the main food of the cod is the herring, so these one hundred and twenty million of cod in the square mile have to be fed with herring, and it is easy to see, if you allow them only one herring a day, that the number of herring which they will want in a week will be something like eight hundred and forty million."

Copyright in China.—A pamphlet on this subject, by Dr. D. J. Macgowan, has been published in Shanghai, and from the copy sent us by the author we extract the following: "One finds not infrequently on the title-pages of Chinese newly-published books a caution against their unauthorized publication, in some instances threatening the forfeiture or destruction of all blocks that may be cut for their printing, showing at once that literary property is liable to be stolen, and that redress is afforded to authors thus wronged. The penal code, however, will be searched in vain for an enactment on the subject of copyright. Chinese law has never conceived it necessary to specify that particular form of robbery which consists in despoiling a scholar of the fruit of his toil, any more than to name the products of husbandmen and artisans as under the protection of law, all alike being regarded as property by natural right. The offending publisher is arraigned and punished under that section of the code which takes cognizance of larcenies of a grave character, the penalty, to which one who prints and sells an author's works without authority is liable, being one hundred blows and three years' deportation. This right of exclusive publication by an author of his works is held in perpetuity by his heirs and assigns. It is not the custom with Chinese authors to make arrangements with publishers, that being undignified. They have their books cut and printed on their own premises, and then sell them to the trade, usually at twice the cost of publication. Manuscript novels and other ephemeral books are sold to publishers, but in such a case neither author nor publisher can prosecute a printer for bringing out a rival edition. Among the subjects which this new era brings to the consideration of Chinese statesmen, that of international copyright may be included. Cheng Ch'engchai, an artist and also a poet, has lately published several hundred of his choice pictures, accompanied by stanzas, the fruit of a life of toil. There is some prospect of his literary harvest being blighted by the appearance of his work at four dollars a set—the author's charge being eight dollars. The pirated copies come from Japan. In Japan the rights of authors are regarded in the same light as in China, but, as a license must first be obtained before a book can be published, the prevention of copyright infringements is more facile there than in China. It is well known that the Japanese Government have long been maturing a copyright law, and the time is favorable, therefore, for these two empires to concert measures for increasing the security of literary property.

Spontaneous Combustion.—Many fires, which appear to be of mysterious origin, can with great plausibility be referred to spontaneous combustion. Such was probably the cause of a fire which destroyed the carriage-shops at Forest Hill, Maryland, a year or two ago. This is indicated by the fact that, shortly after the shops were rebuilt, a hole was burned through one of the floors and the establishment narrowly escaped destruction a second time from the spontaneous combustion of a rag saturated with Valentine's patent wood-filling, which had been left in the paint-room overnight. Rags similarly saturated had been carelessly left in the old building just before the fire. To test the liability of this substance to take fire, a cloth was saturated with it and put in a tin bucket. Combustion began within a few hours afterward. Lamp-black is extremely liable to take fire spontaneously, particularly if a small quantity of oil is in contact with it. It can not be safely wrapped up in printed paper on account of the danger from the oil in the ink. A tub of loose lamp-black in a carriage-shop in England was set on fire in consequence of the presence of a palette-knife on which a little oil had been left. Even the dry paint which accumulates on the blades of these knives near the handle is sufficient to cause ignition. It is, however, only the small quantities of oil that are dangerous; the peril is greatly reduced if the lampblack is saturated with oil. The danger of the spontaneous combustion of coal in cargoes is generally recognized by shippers and insurance-men.

Chiriqui Funerals.—M. Alphonse Pinart has recently given an account, before the Ethnographical Society of Paris, of the burial-places and funeral customs of the Dorasks, a people of the Isthmus of Darien, whom he regards as of Mexican origin. The burial-places, called *huacas*, which he claims to have discovered and excavated, are most abundant in the valley of Chiriqui, though they may be found in some other places. They generally lie at the foot of little hills, and are always marked by the presence of stones covered with figures and inscriptions. They are shaped like a well, the entrance to which is marked by a cross of stones, some twenty feet, more or less, in diameter, and are from six to thirty feet deep. At the bottom are excavated niches, corresponding with the four points of the compass, in which are deposited the bones and the articles that are buried with them—garments, vessels of most perfect shape and finish, and ornaments of gold, either solid or mixed with copper, representing animals, and undoubtedly of artistic value. The bones in these tombs are always broken, in accordance with a custom which prescribes the breaking of them as one of the peculiar features of the funeral rites. On the death of one of the Indians, the body is wrapped in a cotton shroud, and, after a short ceremony with a funeral oration, is borne to a solitary place in the forest, where it is laid upon a kind of scaffold covered with branches of trees, and left for a year. At the expiration of this period, the *kanuru*, a functionary expressly designated for this duty, and who is the only one that can perform it without having to undergo a costly purification, goes to the spot and prepares the corpse for the final ceremonies. Removing the limbs, he collects the bones, cleanses them from all adhering flesh, and breaks them up, together with the skull, and compresses the fragments into a small packet no larger than a new-born child. Having performed this duty, he calls his assistants, who have been waiting in the vicinity, and they bear the packet to a kind of catafalque, around which funeral services are held through parts of three days. At sunset of the third day the *kanuru* goes alone with the body, the dresses, and the ornaments that have been provided for the sepulchre, to the family tomb. No white man has ever been permitted to witness this part of the ceremonies.

Capacity of Brazilian Indians.—An anthropological collection, illustrative of the life of the savage tribes of South America, particularly of Brazil, is now on exhibition in London. Besides the scientific and artistic value of the cabinet, the collector, Senhor C. Ribeiro, seeks to commend the value of the country for colonization, and to remove prejudices against it. Among other things, he wishes to show that the Botocudos Indians are not the dangerous savages they have been reported, and that the specimens of their handiwork—useful articles of straw and bark, tastefully made head-dresses of feathers, and ingeniously fashioned weapons of war and the chase, decorated in geometrical figures—point to a capacity for civilization. Hitherto these Indians have had the advantages of civilization presented to them too often only with arguments of fire and sword; but Senhor Ribeiro asserts that they may be easily induced to work, and that with kind treatment and proper direction they might be made instrumental in the development of the natural wealth of their land.

John Duncan, the Weaver-Botanist.—John Duncan, the Scotch weaver and botanist, to whose scientific merit attention was drawn about two years ago, just in time for public recognition to make his dying days more comfortable, gained a thorough knowledge of botany and formed a valuable herbarium in the face of formidable difficulties arising from poverty and laborious occupation. He had also some knowledge of astronomy, learned something of Latin, so that he might understand botanical terms, and even tried Greek. In his pursuit of knowledge he bore privation cheerfully, denying himself almost the necessaries of life to buy books, and carrying on his studies in a loft above a stable, lighted only by an unglazed hole in the door, where he lived without fire or candle for fear of burning the thatch. His love for plants began to develop when he was about ten years old, and out on farm-service. "I just took a notion," he used to say, "to ken ae plant by anither when I was rinning aboot the braes. I never saw a plant but I lookit for the marrows o't" (the like of it); "and as I had aye a guid memory when I kent a flower ance, I kent it aye." He read in the "Herbal of Nicholas Culpepper," imbibed that quaint author's doctrine of the effect of astrological influences on plants, and was led from it to study astronomy as far as he could go without mathematics. When forty years old he fell in with a gentleman's gardener of the village who was also a scientific botanist, and was introduced by him to the regular study of the science. Before long he had learned enough to help his friend in the formation of a herbarium. For many years, at the season when weaving was dull, he was accustomed to go about doing harvest-work and studying the flora of Scotland, while he earned a little extra money; and he turned these excursions to such good account that, when in his old age he handed over his collection to a friend to be catalogued, as a preliminary to presenting it to Aberdeen University, it contained 1,131 specimens of the 1,428 species that form the flora of England and Scotland. A selection was made from this collection, and 750 specimens were finally presented to the university. Up to his seventy-third year, Duncan was able to earn his own living by work at the loom. Then work became scarce and his strength feeble, and he was forced to seek parochial relief. Finally attention was called to his case in "Nature," in January, 1881, and a subscription was made for him. The story of his life has been told by Mr. W. Jolly, in a book which has just been published in London.

A Smoke-consuming Furnace.—Mr. P. H. Jackson, of San Francisco, has patented a device for securing the more perfect combustion of coal by, first, securing the removal of the carbonic acid which arises from the fire, and, if allowed to remain mingled with the other products, interferes with their further combustion; and, second, by causing the hydrocarbons and other combustible products to be drawn under the furnace and perfectly mixed with atmospheric air before passing through the fire again. The carbonic acid is eliminated through the action of the affinity of carbonate of soda, which is placed in a chamber above the furnace, whence an outlet is provided for the escape of any surplus of acid. The hydrocarbons are drawn down under the furnace through a pipe at the side of the stove, by the suction of a strong current of atmospheric air, which is made to flow to feed the fire through a chamber into which the lower end of the pipe abuts.

Curves of Mortality in London and New York.—Dr. John W. Tripe, President of the Society of Medical Officers of Health, England, has observed, from a comparison of the mortality returns of London and New York, that the curve representing the prevalence of scarlet fever is for New York entirely opposed to that for London. Thus, the lowest death-rate from this disease happens in New York between the end of July and early in October, when the mortality from it in London is greatest. Again, the curve of lowest mortality in London falls in February, March, and April, reaching its lowest point when the mortality is greatest in New York. "We are therefore," Dr. Tripe remarks, "driven to the conclusion either that the same meteorological changes which appear to increase the disease in London decrease it in New York, or, that the mortality per cent of attack is greater at one period of the year than at another. Similar opposing curves are noticeable as regards whooping-cough. These are by no means satisfactory results to have arrived at after so much labor. On the other hand, the curves of mortality from small-pox, measles, diphtheria, typhoid fever, diarrhœa, phthisis, bronchitis, pneumonia, heart-disease, and apoplexy closely correspond in both these great cities."

Suggestions about Bathing.—When and under what conditions a bath will be most beneficial is an important question. The important point is to secure a speedy and healthful reaction, or return of the blood to the surface, and all the conditions should be arranged with reference to that end. Obviously, says the "Lancet," it is not right to dare the dangers of a chill either when undressing or by immersion in the cold water. In most cases a sweating surface indicates some measure of exhaustion already set in; and it is unwise to bathe when copious perspiration has continued for an hour or more, unless the heat of the weather be excessive or the sweating has been induced by loading with clothes rather than by exertion. When much perspiration has been produced by muscular exercise, it is unsafe to bathe, because the body is so fatigued and exhausted that the reaction can not be insured, and the effect may be to congest the internal organs, and notably the nerve-centers. The last gives cramp. If the weather be chilly, or there be a cold wind, so that the body may be rapidly cooled at the surface while undressing, it is not safe to bathe. Under such conditions, the further chill of immersion in cold water will take place at the precise moment at which the reaction consequent upon the chill of exposure by undressing ought to take place, and this second chill will not only delay or altogether prevent the reaction, but will convert the bath from a mere stimulant to a depressant, ending in the abstraction of a large amount of animal heat and congestion of the internal organs and nerve-centers. The aim must be to avoid two chills, and to make sure that the body is in such a condition as to secure a quick reaction on emerging from the water, without relying too much on the possible effect of friction by rubbing. The actual temperature of the water does not affect the question so much as its relative temperature in comparison with that of the surrounding air. It ought to be much lower than that of the air. These maxims receive a striking re-enforcement from the case of a young soldier who a few days ago plunged into the river near Manchester, England, after having heated himself by rowing. He was immediately taken with cramps, and was drowned. When taken out, his body was found "twisted," and the vessels of his head showed every evidence of congestion. Quintus Curtius relates that Alexander the Great attempted a bath in the Cydnus on a very hot day, when all sweating. "Hardly had he entered, when his limbs became suddenly stiff, the body pale, and vital heat seemed by degrees to abandon him. His officers received him almost expiring in their arms, and carried him almost senseless to his tent.

Satisfying Religious Scruples.—Dr. Francis Day, formerly inspector-general, stated, in a recent lecture on the fisheries of India, that while as Buddhists the Burmans profess a religious horror of taking the lives of the lower animals, they are immoderately fond of fish-diet, and pretend to console their consciences, while indulging in it, that the death of the fish must be laid to the fishermen, and can not be charged against them! The prospects of the fishermen in the next life appear, however, to be most dreadful, for the temples have pictures of terrible and artfully contrived tortures to which they will be condemned. The *poon-*

gees, or priests, are supposed to be, as is their duty, particularly diligent in teaching the wickedness of eating fish, but they like to eat them; this is illustrated by the story of a fisherman on the Irrawaddy, who built a monastery in the hope of earning the highly-prized title of founder of a religious home. Many poongees came to visit him, but none of them staid long, until at last one came who seemed to find the quarters and the fare to his liking. The fisherman one day asked this holy man anxiously the question, "Why, my father, do not the poongees approve my monastery, for none but yourself have remained over the going down of two suns?" The poongee told him it was because he broke the law by depriving fish of life. "True," answered the fisherman, "but, were I not to do so, how could I supply your table with fish, or how could I live were I to give up my employment?" The only reply he could obtain was, "Better to fast while keeping the law than to feast while breaking it!" The disciple took the priest at his word, and refrained from fishing for three days, giving his guest in the mean time only vegetables for his meals. On the fourth morning, when the same fare appeared, the poongee said, "My son, when you fish the river, does your net extend all across, permitting no fish to escape, or is a portion of the river free for those which select to pass to one side?" "Not all across, but only one third of the way," he answered. "Well, then, my son," said the priest, "I have been seriously considering the subject, and have arrived at the conclusion that, if you leave room for the fish to ascend or descend the stream, and they will not avail themselves of it, but rush headlong into the net, the fault is theirs, and not yours. Even Gautama blessed the hunter who met him when he was hungry, and supplied him with venison. This was accounted as a meritorious act, although he must have killed a deer to obtain it. So go, my son, and procure me some fish, for I am hungry." From that day the priest consumed his fish in quietness, and refrained from inquiring whence it had been procured.

Some Newly Remarked Instincts.—Mr. Charles S. Clarke, of Peoria, Illinois, recently related, in a lecture before the Scientific Association of that city, an incident, the key to which, if it is found to be of general application, may disclose a hitherto unnoticed principle of our organization. A child had been lost in the hazel-bushes near its home, and, after all the neighbors had failed to find it in the course of a day's search, an old trapper was called in to assist. He marked out with flags a rough circle of about two miles in diameter, starting from the bushes and bearing to the left toward the house; then set the company he had collected in a line along the radius of the circle, and moved them so as to examine the ground all over. The child was soon found. When asked the reason of his proceeding, he replied: "It was very simple. Probably you know that lost people always go round in a circle, but may be you don't know that they always circle agin the sun (from right to left)." "No," replied the speaker, "I have never heard that." "Well, they do," the hunter said, "and every Indian and trapper from here to the mouth of the Columbia will tell you so. Lost men or women will always make the circle within three miles in diameter, and children in two, unless they are led away by a trail or stopped by a stream." In the course of the same address, Mr. Clark also gave the following example, illustrating how much the senses can be cultivated: "While we were talking, two young dogs had gone to a small eminence, a few rods from the old man's cabin, and, with their noses in the air, would at short intervals utter a low, warning cry. The trapper soon noticed it, and, calling to an old dog in the cabin, he said, 'Dave, go up yonder and see what those youngsters are making a fuss about.' The dog, after reaching the place and standing a moment with outstretched neck and distended nostrils, gave a clear but low warning notice, such as I had never heard from a dog before. 'Is that so, Dave?' said the old man. He immediately went to the same place and began to sniff the air, much after the manner of the dogs. 'Sure enough, Dave,' he said, 'you are right.' 'What is it?' I asked. 'The prairie is on fire,' he said, 'some thirty or forty miles northwest from here! I must set a back-fire on the other side of the creek, or my cabin and bees will be in ashes before morning, should the wind raise; and, by-the-way,' he said, 'you go back by the way you came, and tell the people to set back-fires at once, and have them send word to the settlements below.' Before starting I tried my sense of smell, and, although I imitated the attitude of the trapper and the dog, I could detect nothing but the sweet October air." The warning given by the dogs was justified in the event.

NOTES.

Mr. Herbert Spencer is taking a long vacation in Scotland, occupied with his favorite recreation of salmon-fishing. A paragraph in "Mind" announces that he has declined the honor of election to the French Academy, on grounds of principle.

Herren Fischer and Rudolph have produced by the action of chloride of lime on acetaniline at a temperature of 270° C. a new coloring-matter of a brilliant yellow, which they call *flavaniline*. It has an especially brilliant appearance, with a remarkable green fluorescence on silk fibers.

Professor Stephen Alexander, Professor Emeritus of Astronomy at Princeton, New Jersey, died June 26th. He had been connected with the college at Princeton since 1840, first as Professor of Astronomy, and afterward of Astronomy and Mathematics.

A discovery is announced by the "Union Médicale" which promises to throw considerable light on the subject of prehistoric man. While running a gallery in a coal-mine at Bully-Grenay, a subterranean cave was broken into, in one chamber of which were found six fossil human bodies—a man, two women, and three children—together with implements, and fragments of lower animals. Another chamber contained eleven human bodies, precious stones, and numerous other articles, while on the walls were drawings of combats between men and huge beasts.

According to legends of colonial times, seals were formerly common in Long Island Sound, Red Rock in the estuary of the Quinepiac River being their favorite resort. A few are still seen or caught every year. Mr. H. C. Hovey states, in the "Scientific American," that more than the usual number have been seen during the recent cold season. Two fine specimens were caught on the 11th of April, near Guilford, Connecticut.

Professor O. C. Marsh, of Yale College, has been chosen a member of the Munich Academy of Sciences, Bavaria.

Dr. Bowditch, of the National Board of Health, objects to dependence on sewerage for the sanitation of sea-side resorts, that the sewers will leave the refuse matter where it is liable to be brought back to the shore by returning tides. He commends the method adopted at an hotel at Cape May Point, of systematic deportation of sewage material. The cess-pools are emptied every morning by means of odorless excavators, and their contents are conveyed to the hotel company's farm, where they are deposited in trenches with sea-weed and covered with earth, to be converted by the next spring into excellent manures.

Mr. Russell, a skillful observer at Carson City, Nevada, is convinced that the impressions in the sandstone there which have been talked of as human footprints, are really the tracks of an edentate, the morotherium. The mud where the tracks occur was so soft that the animal's foot sunk into it, pushed a ridge upward two or three inches higher than the outside level, and came out with a mass adhering to it. Consequently no marks of claws or skin-creases are to be looked for.

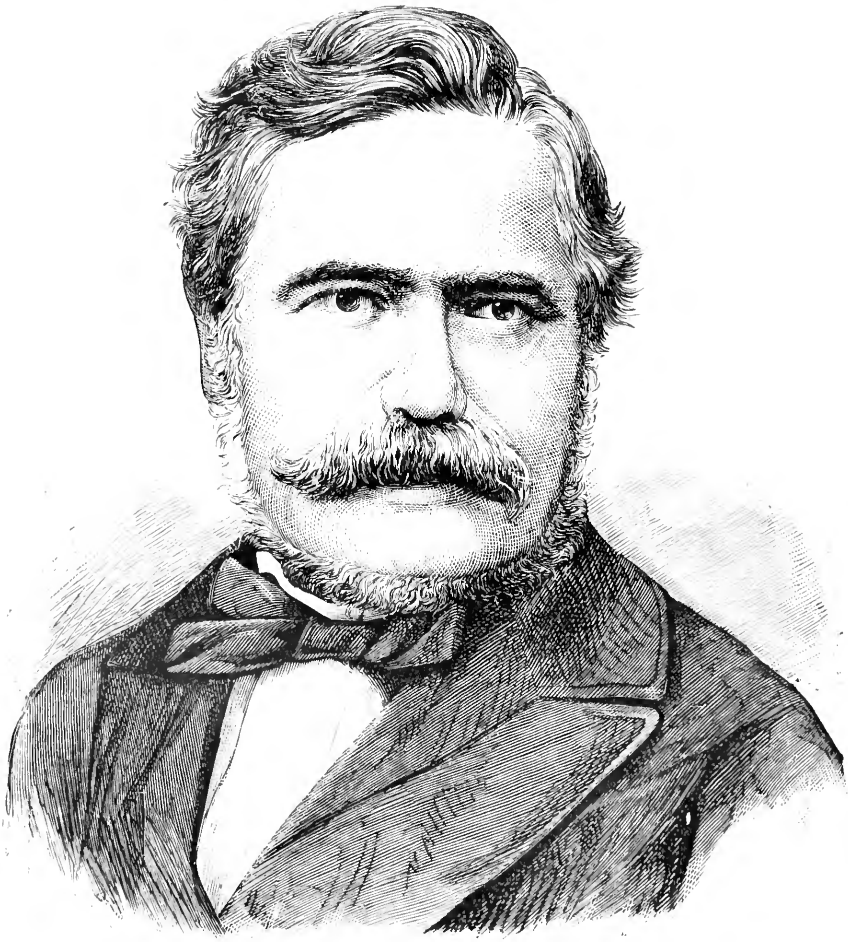
M. Gay-Lussac, son of the celebrated chemist, and himself an able chemist and metallurgist, has recently died, at the age of sixty-three.

In testimony to the value of M. Pasteur's researches, the French Government has increased his pension from twelve thousand francs to twenty-five thousand francs yearly, and has made it payable to his wife if she should outlive him.

Baron Nordenskiöld was to start from Sweden, May 20th, on an expedition at the expense of his old friend Oscar Dickson, for the exploration of Greenland. He believed that the interior of that country, which is generally thought to be a vast plain of ice, is partially free from ice during the summer, basing his opinion on the warmth of the winds from the interior, and will endeavor to reach it. He will also seek for traces of the old Norse colonies, which have been lost since the fourteenth century.

Dr. Michael Foster has received the appointment to the new chair of Physiology at Cambridge, and Dr. A. Macalister to that of Anatomy.

The Academy of Natural Sciences of Philadelphia has recently come into possession of the William S. Vaux mineralogical and archæological collection. The mineralogical department includes more than six thousand trays of specimens, many of them of rare beauty and perfection, and is valued at $40,000; while the archæological collection is estimated to be worth at least $10,000.



MAX VON PETTENKOFER.

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MATTER LIVING AND NOT-LIVING.

By PAUL R. SHIPMAN.

THE Victoria Institute, or Philosophical Society of Great Britain, has published, in pamphlet form, a paper by Professor Lionel S. Beale, in which that eminent physician and microscopist attacks, with free assertion and aspersion, the doctrine of the identity of living and not-living matter. Dr. Beale is himself a member of the Victoria Institute, and, if one may judge from the *imprimatur* which the society has set on his paper, he is esteemed a spokesman worthy of its name, if not a foeman worthy of anybody's steel; and no doubt the paper has proved acceptable to those for whom it was intended. It may be worth while, therefore, in the interest especially of this excellent class, to examine what he has to say.

Dr. Beale, it might better be mentioned at once, has a theory of his own, or at least of his adoption, with which he confronts the theory of his aversion; and it will conduce to clearness, as well as brevity, if we first look at the opposing theories side by side, premising that Dr. Beale expressly lays the question of their relative merits before the tribunal of science, whose jurisdiction in the case he thereby acknowledges. Let us at the outset, then, regard the two theories as he sets them face to face.

Dr. Beale opens the discussion by confessing that he finds himself among the "very small number" who "have objected to the physical view of life as untenable *in the present state of scientific knowledge*," a qualification which in the course of his paper he repeats and reiterates, and which means, if it means anything, that the capacity of physical causes in this relation has not yet been explored exhaustively, and that the view in question may become tenable in the progress of scientific knowledge. "The living world," Dr. Beale proceeds to say, in the face of this significant admission, "is absolutely distinct from the non-living world, and, instead of being a necessary outcome of it, is, compared with the antiquity of matter, probably a very recent addition to it—not, of course, an addition of mere transformed or modified matter and energy, but of transcendent power conferred on matter, by which both matter and its forces are controlled, regulated, and arranged, according, it may be, to laws, but not the laws of inert matter." This additional agent is, of course, our old acquaintance—the *vital force*. Dr. Beale adds: "It may be freely admitted that, if we attribute to vital power certain phenomena of the living world which have not been, and can not be, explained or accounted for by any physical laws yet discovered, we thereby assume an agency which we are unable to isolate or demonstrate, and the existence of which we can not in any way prove. On the other hand, it is only fair to observe that, if we assume that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy; and prophetic assumptions of every kind are contrary to the spirit of science. . . . But is it not in accordance with reason," he concludes, "to assume the existence of a peculiar power to account for phenomena which are peculiar to living beings, which differ totally from any known physical phenomena, and which can not be imitated—and is it not contrary to reason to prophesy that such phenomena will one day be explained by ordinary forces or powers?" Such is his statement of the case, and such the argument by which he supports his side of it.

A few words, I think, will suffice to show the invalidity of the argument. The question, fortunately, hinges on a point which science has determined definitively.

A genuine hypothesis, in the scientific sense, is capable of proof or disproof; for an hypothesis capable of neither must always remain an hypothesis, and, instead of leading to an explanation of phenomena, serves to block the way to it. I may say here, parenthetically, that too much verbal respect, as it seems to me, is usually paid by scientific thinkers to assertions of this transcendent sort; strictly speaking, an assertion, of which it is said that it can be "neither proved nor disproved," is disproved by denying it, for the denial, being of equal validity with the assertion, nullifies it, leaving zero as the logical result, and an assertion reduced to zero is effectually disproved. But to return. An unverifiable hypothesis, as incompetent to lead to certainty, has no reason of being; and, consequently, science pronounces it illegitimate. But the hypothesis of a *vital force*, Dr. Beale admits, is unverifiable. It assumes "an agency," he owns, "which we are unable to isolate or demonstrate, *and the existence of which we can not in any way prove*." It is, therefore, illegitimate on his own showing.

Moreover, a genuinely scientific hypothesis does not assume an unknown cause, much less an unknowable one, before the inadequacy of known causes has been proved, for, till then, the necessity of an additional cause can not appear. The maxim which imposes this condition on hypotheses, known in philosophical literature as Occam's razor, is declared by Sir William Hamilton, who calls it the law of Parcimony, to be "the most important maxim in the regulation of philosophical procedure, when it is necessary to resort to an hypothesis." Its soundness is questioned by no one. But Dr. Beale, as we have seen, admits by plain implication, repeatedly, that known causes have not yet been proved inadequate to explain the phenomena of life. His cautious statement is that they are inadequate "*in the present state of scientific knowledge.*" Wherefore, as he must also admit, his assumption of a hyperphysical agent violates flatly the law of Parcimony ; it falls under the first stroke of Occam's razor. It is thus doubly illegitimate, on his own showing.

Finally, the hypothesis, if admitted, would not explain the phenomena, since it merely refers them to a power of which confessedly we can know neither the existence nor the laws, assuming to explain that which we do not know now by that which we can never know or so much as represent in thought ; and it goes without saying that an hypothesis which explains nothing is good for nothing. In branding it with illegitimacy, science but renews the stigma that common sense had set on it.

The hypothesis, it follows, has no standing in the court of science, which rules it out at the threshold ; and to the court of science, be it remembered, Dr. Beale has appealed. One thing, then, is certain : whatever may be the merits or demerits of the hypothesis which he opposes, the hypothesis which he espouses has no merits at all. It is radically vicious, and wholly inadmissible. So far from being "in accordance with reason," it is in flagrant defiance of it.

It remains to inquire into the remaining hypothesis. If we may credit Dr. Beale, it is as spurious as his own. "If we assume," he tells us, "that phenomena peculiar to life will some day be explained by physics, we certainly act in a manner which is not sanctioned by science—we assume, we prophesy ; and prophetic assumptions of every kind are contrary to the spirit of science." That depends on the character of the assumptions. If, like his hypothesis, they are incapable of proof or disproof, besides gratuitously multiplying causes, and explaining nothing after all, they undoubtedly are contrary not only to the spirit but to the letter of science ; but, if they fulfill the conditions of a legitimate hypothesis, in lieu of violating them at all points, as his own assumption does, they as undoubtedly are in strict harmony with science. It would be passing strange if they were not. If "prophetic assumptions of every kind" were in truth "contrary to the spirit of science," that "star-eyed" creature would be more contrary than the privilege of her sex allows, for it is by "prophetic assumptions" that she has won her chief triumphs, nearly everything which is now certainty having once been assumption. When Copernicus divined that the planets revolve around the sun; when Kepler suggested that the planetary orbits are ellipses; when Newton proposed the law of gravitation, and, later, the identity of gravitation with the central force of the solar system; when Huygens conjectured that light is propagated by undulations; when Harvey, in the profession of which Dr. Beale is an ornament, supposed that the blood flows from the left side of the heart into the right through the arteries and veins; when Locke asserted that heat is motion; when Franklin assumed that lightning and electricity are one; when Dalton affirmed that elements combine in definite, reciprocal, and multiple proportions; when Leverrier announced the existence and position of a planet outside the orbit of Uranus; when Faraday conceived the principle of definite electro-chemical decomposition—they each and all indulged in what were "prophetic assumptions," until in due time the assumptions were proved and the prophecy accomplished. And so, for the most part, with the rest. Wherever, indeed, there is an inquisitor of nature, whether observer or experimenter, there is likely to stand behind him some hypothesis, more or less shifting, more or less defined, more or less probable, which guides his inquiries and shapes their results; and what is generally true of the experimental sciences is true in greater degree of the sciences in which experiment is impossible or possible only within a narrow range, such as astronomy, biology, psychology, sociology. The truth is, without "prophetic assumptions," science would need either omnipotent insight, to see through every problem at once, or that omnipotent blindness which enables its happy possessor to solve every problem, as Dr. Beale would solve the problem of life, by referring it out of hand to some agency beyond the bounds of human knowledge; but, as science is endowed with neither, it has, in general, no other course, certainly no better course, than to proceed tentatively by "prophetic assumptions," careful only, though rigorously careful, that these shall fulfill the acknowledged conditions of a legitimate hypothesis. As for such "assumptions" as Dr. Beale's, they are not "prophetic," it is true, but only because they forever renounce the hope of explanation. Science rejects them, as we have seen.

Let us see whether or not the hypothesis of the evolution of living from not-living matter encounters the same fate.

To begin with, the hypothesis, it will not be denied, is verifiable, for it assumes only a certain competency in the properties of matter, which, if it exists, is capable of proof under possible conditions, and, if it does not exist, is capable in like manner of disproof; so that in the end the assumption must lead to certainty or step down and out. Such being the case, it fulfills the first condition of a legitimate hypothesis.

The hypothesis, in the next place, assumes no special cause, known or unknown, physical or hyperphysical, but accepts that which, by universal consent, is not only the cause of inorganic phenomena, but the invariable concomitant, if not the cause, of the phenomena of life. It does not multiply causes with or without necessity, and hence is philosophically clear and clean. Occam's razor may pass over and around it without meeting with a pilous stub.

And, lastly, inasmuch as the assigned cause is real, and as the final verification of the hypothesis must consist in deducing the phenomena from it, the hypothesis, when verified, will of necessity explain the phenomena not merely in their completeness, but to the exclusion of all other explanations. It is one of those fortunate cases, not too common in the history of science, wherein the explanation of the phenomena is the demonstration of the hypothesis.

In the judgment of science, therefore, the hypothesis as such is without spot or flaw. So far from being "contrary to reason," it is in perfect accord with it.

From all of which it appears that the converse of Dr. Beale's opinion of the two hypotheses is true. His terms of praise and dispraise were well chosen, but, as it turns out, he mixed them badly before applying them. So much for the opposing theories as theories.

Having seen that, from the scientific point of view, the hypothesis which Dr. Beale espouses is thoroughly illegitimate, and that the hypothesis which he opposes is thoroughly legitimate, we have now to look at the existing evidence in support of the latter; and here we shall strike Dr. Beale's criticisms, for here their incidence logically falls. With how much force they fall we shall presently see.

When two series of phenomena shade off into each other by insensible gradations, the philosophical presumption is that both series have been generated by one cause; and it behooves him who would overcome this presumption to draw the line of demarkation between the series, and prove that the phenomena on the opposite sides are so different that they could not have had a common origin. Organic and inorganic phenomena, I need not say, thus shade off into each other; but no one has been able, though many have made the attempt, to draw a line of absolute demarkation between them, much less to prove that the two series, as arbitrarily distinguished from each other, must have proceeded from different causes. Toward the proof of this the first step has not been taken, and it is safe to say that it never will be; it is barred by the indissoluble continuity of natural law. Meantime the presumption stands in more than its original strength.

A kindred presumption, throwing a kindred burden on the shoulders of whoever would rebut it, is the presumption that causes which increase an aggregate are competent to originate it. The forces which determine the growth of a crystal, to exemplify, are the forces which produce its embryo; and the like holds true of all other aggregates below the vital ones. Why not of these also? The forces which determine the growth of a plant or animal are physical forces; any assumption to the contrary, remember, even Dr. Beale avows that "we can not in any way prove." Why can not physical forces, in this case as in others, originate what they develop? It is for him who denies that they can do both or either to show why. This has never been done; and, till that which Dr. Beale admits to be unprovable is proved, never will be. The denial is a bald negation, leaving the presumption to stand, like the allied one, strengthened by a fruitless contradiction.

But we are not left to philosophical presumptions, insurmountable though they are. The evolution of living from not-living matter, it should be borne in mind, is an essential part of the hypothesis of evolution at large, and shares evenly in all the evidence, direct and indirect, which supports the general hypothesis, and which, against rooted predispositions of every kind, and amid the continual uproar of detraction and abuse, has revolutionized the thought of our time, putting Dr. Beale and his school of thinkers, but lately in an overwhelming majority, in a minority that he fairly terms a "very small number," and taking the chair of authority, as he ruefully complains, not simply in the laboratory and the closet, but in the study and the school, and, he might have added by "prophetic assumption," the Church, that loving mother of most of us beginning dimly to perceive that evolution founds science and religion on the self-same basis, and, in place of being the enemy of either, is the truest friend of both. The evidence which, in the course of a single generation, has wrought this marvelous change in unwilling minds, and the more distinctly in the higher minds, goes in its full strength, I repeat, to support the special hypothesis in hand. Manifestly, the leaders of thought, in both hemispheres, estimate this evidence differently from Dr. Beale. It is truly irresistible to an open and enlightened mind.

Furthermore, the earth, we should not forget, is her own biographer; and in the geologic chapter of her authentic sketch is recorded a time when life did not exist within her limits. Life on the earth had a beginning, then. This is not denied. Nor is it denied that up to the beginning of life all terrestrial phenomena were the effects of physical forces.

So much is conceded by every one, Dr. Beale not excepted. And, now came life. Whence did it come? Whence does it come? Physical forces, undeniably, are the constant antecedents of life; which, moreover, varies in fixed correspondence with determinate variations in them. This Dr. Beale must likewise concede, or assail the foundations of his art. But it is an axiom in scientific inquiry that anything, upon whose variations the variations of an effect are uniformly consequent, is the cause or connected with the cause of that effect; and, since the physical forces accompanying life are connected with no other cause except the Ultimate Cause, it results that they are the proximate cause of life—the only cause, that is to say, which the human intellect can grasp, and with which accordingly science has to reckon. If we reject this conclusion, we reject with it the methods of science, and along with these science itself. But science is our chosen arbiter.

Nothing in reality is lacking to crown the hypothesis with demonstrative proof but to discover the law of co-operation of the physical factors uniting in the production of life, and deduce the phenomena from it; although to furnish this may well tax the highest resources of science for an indefinite future. And yet some happy feat of induction or deduction, or of both combined, may furnish it to-morrow. Meanwhile, the hypothesis as it stands, it is hardly too much to say, exacts the acquiescence, if it does not secure the assent, of every mind at once unbiased and not uninformed. The cause of life is known. The law of the cause alone is unknown. This law, as to which no hypothesis has yet been formulated, is strictly the only aspect of the subject open to hypothesis; so that, while the hypothesis supplied has passed beyond the hypothetical stage, the hypothesis required has not definitely reached it. In this logical interregnum, however, the vacating hypothesis, obviously, must still rule the discussion. But let us hear Dr. Beale.

"Bear in mind," he admonishes us, "that no state of matter known, no mere chemical combinations, no mechanical contrivances, no machinery ever made, can be caused to exhibit phenomena resembling in any really essential particular those which are characteristic of every form of living matter that exists in nature." This admonition may be just, and I am disposed to think it is, if qualified by that reference to "the present state of scientific knowledge" which the learned professor often makes, but which he here apparently fails to "bear in mind"; yet, with this qualification, it is not indisputably just, seeing that Dr. Bastian, one of the foremost experimenters of the age, contends that he has surmounted the difficulty which Dr. Beale declares to be an impossibility. Whether Dr. Bastian has achieved this result or not, the impossibility of achieving it has not been proved; on the contrary, the possibility, with the advance of scientific knowledge, has grown clearer. A few years ago, Dr. Beale might, with equal justness, have delivered this same admonition to us in respect to organic compounds of every sort; but meanwhile chemistry, in the face of the assumed impossibility of making any of them, has, in fact, made hundreds of them, therein surpassing the creative power even of animal life, which in general is powerless to form them, but appropriates them ready made from the vegetable world, in which they are compounded out of their elements; and, if chemistry can produce organic matter, it may, when further developed, produce organisms, or, what would be of equal significance, formless protoplasm. It is on the way, and pressing forward. While impossibilities, akin to Dr. Beale's present impossibility, are falling right and left under the strokes of science, who shall say that this one, too, may not ultimately crumble beneath the strenuous but reverent assault? Whether the achievement is possible or impossible, however, the derivation of life from not-life at some time, if not at this time, under conditions provided in the laboratory of Nature herself, is certain: the fate of the hypothesis is not by any means involved in that of the experiment.

"No specimen of any kind of matter which is actually passing from the non-living to the living state, or which can be shown to establish any connection between these absolutely different conditions of matter," Dr. Beale asserts, "has been, or can be at this time, brought forward." Discounting the expression "absolutely different," and noting with satisfaction the qualifying phrase "at this time," it must be observed that the assertion remains, nevertheless, in some degree inaccurate. Not to mention that all living matter is constituted by not-living elements, there is good reason to believe that the molecules of those colloidal compounds which together form living matter are constituted by molecules of the not-living crystalloids, and it is beyond dispute that the same substance, as silica, may pass, under varying conditions, from the crystalloidal to the colloidal state and back again, for which reasons, among others, the colloid may be pointed to as a "kind of matter" which, if not "actually passing from the non-living to the living state," can at least be said to "establish" some "connection" between these "different conditions of matter." Be this as it may, it "has been brought forward" as such, and by no less honored an investigator than Professor Graham, whose discovery of the law of the diffusion of gases, to say nothing of his profound researches on the diffusion of aqueous solutions, should have made his name familiar to Dr. Beale. "The colloid is in fact," says Professor Graham, "a dynamical state of matter, the crystalloidal being the statical condition. The colloid possesses *energia*. It may be looked upon as the primary source of the force appearing in the phenomena of vitality." Whatever Dr. Beale may think of the colloid, it serves at any rate to check his broad assertion, and at the same time to indicate how sharply experimental science is pressing upon the problem of life. "At this time," however, the pregnant movement has but fairly begun.

"But the fact," Dr. Beale insists, "that this living matter, as is well known, is invariably derived from matter that already lived, is a serious difficulty which presents itself to the mind at the outset of the inquiry." Here, again, our professor omits the important qualification to which he is committed. "Living matter" is "invariably derived from matter that already lived," so far as our experience goes, if we leave out of the account Dr. Bastian's experiments; but our experience at present, aside from those interesting but unfinished researches, does not stretch away to the beginning of life, and it is unphilosophical to extend a merely empirical law beyond the limits in which it has been found true by observation. It was once believed, for instance, that all swans are white, and, what is more, the belief was sustained by the uniform experience of mankind for thirty centuries; but it turned out to be erroneous, all the same. That the black swan of *archebiosis* has not been seen is no proof that it may not be seen, if we push on to its presumptive haunt by the shaded springs of life; and, in the interval, we can be sure only of what we have positively seen. But of this there of course can be no doubt. The famous maxim, *All life proceeds from life*, is indeed necessarily true of all the more specialized forms of life, because the proceeding of any one of these directly from inorganic matter would necessitate a leap over the intermediate forms; and Nature, as in our day is realized more vividly than before, does nothing by leaps. The maxim, though reached inductively, may be explained deductively; it is itself, thus limited, a corollary from the general law of evolution. But, with forms of life having little or no specialization, and only a few removes or one remove from inorganic matter, the case is plainly different. Respecting these, induction, so far as it has yet gone, and deduction, so far as it can now be applied, agree in pointing unmistakably to their origin in the unorganized matter from which they are scarcely distinguishable, and from which they differ in every respect vastly less than from the more specialized forms arising out of them, and immeasurably less than the human adult differs from the human embryo. Of these lowest forms, exhibiting life almost or quite without organization, the maxim not only is not necessarily true, but is necessarily untrue. It applies, as it must ever apply, to living things in general, but not to those living things which exemplify the bottom characteristics of the group. *Omne vivum ex vivo* was not written of the type. If it were, *ex nihilo nihil fit* could not be written too.

"According to the material contention," avers Dr. Beale, "everything owes its existence to the properties of the material particles out of which it is constructed." Whereupon he rather scornfully asks, "Who would think of asserting that in the properties of brass and iron or steel we shall find the explanation of the construction of a watch?" Nobody; with this interrogatory Dr. Beale knocks over a man of straw set up with his own hands. What he calls "the material contention" is really that every phenomenon owes its existence to the properties of matter; but this contention his crucial instance does not meet, for denying that a watch owes its existence to "the properties of brass and iron or steel" is not denying that it owes its existence to material properties, acting under special conditions, in special combinations, according to special laws, and emerging into a special organism, with the capability of watch-making: he answers what is asserted by denying what is not asserted. The fallacy, however, may suggest the clew to a better comprehension of the reality. Why do not "brass and iron or steel" manifest the phenomena of watch-making? For essentially the same reason that primitive man did not manifest them: because in these metals, as in primitive man in an immensely less degree, the synthesis of forces is too simple and unevolved, it being a law of matter that every state of material forces not only is derived from preceding states, and manifests phenomena peculiar to itself, but that the more complex and evolved the state, the more complex and evolved the phenomena. In this law, speaking broadly, we have a key to the source of life. Oxygen, hydrogen, carbon, and nitrogen, uncombined, present, for example, one state of material forces, which manifests one set of phenomena; water, formed by the combination of oxygen and hydrogen, is another state, less simple, and manifesting less simple phenomena; alcohol, resulting from the union of oxygen, hydrogen, and carbon, is another state, more complex, and manifesting more complex phenomena; carbonate of ammonia, consisting of oxygen, hydrogen, carbon, and nitrogen, is another state, more complex still, and manifesting phenomena of corresponding complexity; and protoplasm, containing the same elements as carbonate of ammonia, but united in higher multiples, and uniting under conditions unknown though not unknowable, is simply another state, more complex than any of the others, and manifesting the phenomena of life, which, it deserves to be noted, are no more peculiar to life than the phenomena of alcohol are peculiar to alcohol, or the phenomena of water peculiar to water. The peculiarity is the peculiarity of every state alike, as could hardly be otherwise, unless a thing could be itself and at the same time something else.

In the lower states of matter this law offers no difficulty; but, as the successive states become more and more removed from the elementary state, exhibiting phenomena more and more removed from the elementary phenomena, it grows, first indistinct, next unperceived, then unimagined, till at length, culminating in life and mind, it eludes definite conception in the bewildering complexity of the phenomena, and its consummate product, puffed up by the height to which it has raised him, turns round and disowns it altogether, perversely kicking over the ladder by which he ascended, and proudly asserting his right to pose upon nothing. Yet the law is none the less operative at every stage, from nebula to consciousness, and in itself is as comprehensible in the last stage as in the first. That one synthesis of forces should issue in life is at bottom not more wonderful than that another synthesis should issue in water. The two manifestations are equally comprehensible up to a certain point, beyond which they are equally incomprehensible, a mystic chasm, soundless yet crossed by a step, bounding equally every atom of the wide universe; only, in so simple a thing as water, the step whereby we cross this ever-recurring interval need not be often repeated, and the approach is comparatively open, whereas, in life, to say nothing of mind, the step is to be taken such countless times, in such countless directions, within such countless chambers, passages, recesses, that no wonder the broadest and loftiest intellect of our time, or of any time, stood baffled at the threshold of the labyrinth until he had fashioned the clew of Evolution to guide him through its windings; but the step, though infinitely multiplied, is one and the same, spanning ever the same fathomless chasm, and the faculties which enable us to take it once render us competent to repeat it indefinitely. We thread the maze by a developed use of the powers by which we enter it, treading always over, but never into, the meshes of infinity. The real difficulty, as already implied, is that our present knowledge and intellectual training do not match the complexity of the higher phenomena, which, notwithstanding their astounding complexity, differ from the lower only as a problem in the calculus differs from a sum in addition and subtraction. Fundamentally, there is no difference in the phenomena, and no break: all are interconnected by one unbroken chain of causation. As the watch-maker is developed from primitive man, so is life developed from primitive matter, and the gap between these is no more impassable and no less than the gap between those, or, for that matter, than between the simplest compound and its elements, or between the atoms of the elements themselves. The interval in every case is essentially identical. If it makes life mysterious, it makes mysterious every other thread in the texture of things. The mystery is the same throughout; and so is the only explanation with which the wit of man can embroider the somber secret.

Dr. Beale has nothing more to say with which we need concern ourselves. He is, as I have said, a physician of eminence, and, I may add, a microscopic observer of approved accuracy; but as a philosophical critic he is not a success. I have treated him with courtesy, out of respect for the proprieties of serious discussion rather than for his deserts. The tone of his paper is not candid or respectful; its spirit is derisive; and the body of it is composed chiefly of a tirade, not conspicuous for judgment or comprehension, against the decay of modern thought and the dogmatism of modern scientists, among whom he generously singles out Professor Huxley as a scape-goat, and, laying both hands on his laureled head, confesses over him, with much unction but no fair words, all the iniquities of the children of light, and halloos him, crowned with the shining burden, into a land not inhabited by members of the Victoria Institute. But all this I pass by. It is tempting, I confess, but space or the lack of it, if nothing better, delivers me from the temptation. On the title-page of Dr. Beale's pamphlet is inscribed: "The New Materialism; Dictatorial Scientific Utterances, and the Decline of Thought." Of this inscription the first part might stand, fitly enough, for the title proper, and the last part for the characteristics of the paper, were it not that its "dictatorial utterances" happen not to be "scientific," and that its "thought" exhibits not so much "decline" as destitution. However, I am not inclined to deal severely with the distinguished professor, and accordingly content myself with flinging back the title-page into his teeth.

HOMŒOPATHY AS A SCIENCE.

By EDWARD BAYARD, M. D.

"Philosophy and science are so related as to constitute a unity."—"The Relations of Mind and Brain," Calderwood.

MANY of the most important discoveries of the psychologists were rejected by the physiologists, because they could not be proved by their law—and conversely with the psychologists. These contending forces have been brought into lasting alliance by Professor Calderwood. It is believed that as close a relation can be established between Nature's laws and those of homœopathy.

Vaccination, as the sole and sure preventive of small-pox, is one of the great, dominant, fixed facts of the old school. Here is the open and avowed application of the law of cure by similars, *similia similibus curantur*. If it be a law of cure in one case, by what logical process can it be demonstrated to fail in all others? Those most conversant with Nature's laws assert, and truly, that she makes no exceptions: the law of gravity; that water seeks its own level; that the pressure of water is equal in all directions; that sound ascends; that heat expands. It was this universality of the law of Nature which enabled the great naturalist, Cuvier, to construct a whole skeleton from two or three bones. So, with equal certainty, if necessary, could the skeleton of the homœopathic law be evolved from this single bone of its structure—vaccination. Starting from different stand-points, the old and new schools have progressed in the same direction, to diminished doses, both in size and repetition. This is concededly due in the old school to the influence of homœopathy, in the new it is the growth of its own experience.

Messrs. Bell and Laird, in their admirable monograph on diarrhœa, say: "There is indeed a somewhat prevalent opinion that the strength of the dose makes up for want of due care or knowledge in selection. This may be stated in mathematical terms, as follows: If the thirtieth potency of arsenic is equal to a complete knowledge of the drug, one fifth of a grain of arsenious acid is equal to complete ignorance of it. Stated in this, its true form, we grant it."

Homœopathy, as a science, is the law of the vital force; the body is but the mechanism upon which it operates. The dissecting-knife has laid bare to the astonished gaze of the student a perfect organism, while the operating-table presents the companion picture of an organism in total ruins dominated by the vital principle. What, then, is disease—typhoid, pneumonia, scarlet fever? No; disease is the impairment of the equalization of the vital force, and it finds expression where the organism is weakest.

What is cure—to take physic for typhoid or scarlet fever? No; to cure is to locate the center of the disturbance, the diseased nerve-cell, and restore the equilibrium.

How do you do this? In spite of its many ramifying influences, the nerve-cell preserves, to the close and exact student, its individuality, often veiled under the apparently familiar features of others, but still recognizable by the differentiating mind. It is this similar of state and remedy which the homœopathic physician, who knows and applies the law, seeks in the patient and in the materia medica; when found, the means of restoring the equalization of the vital current is found with it.

As there is but one nerve-center of a disease, so is there but one remedy.

The system has always a tendency to resist, by reaction, the morbific cause which disturbs it. The similar stimulates reaction. When you put your hot hand into hot water, and take it out and wipe it dry, by the law of reaction it becomes cool. So, if to the frost-bitten ear or hand you apply snow or ice, by the law of reaction the frozen part burns under its stimulus. The power of resistance, which is reaction, is the strength of the constitution, or is the constitution itself. It is this law of reaction under which homœopathy works, by its similars stimulating the additional resistance necessary to aid in nature's cure.

If you go out into excessive cold, and the power of resistance is equal to the demand, you turn red; if not, and this power is overwhelmed, you turn white. And the same difference is markedly observable among those who take sea-baths. By the law of reaction they vary in color from that of a boiled lobster to the livid hue of death, graduated and shaded off by the loss of the power of resistance. All cures are sought by homœopathy under this law, and depend for their success upon this power of resistance, and it is of vital importance that this power be not diminished, for without it there can be no cure. Outside of medicine this law of reaction in the system is recognized as an accepted fact. It is the law of cure, and the study of this law is a science, and that science is homœopathy.

The reason why scarlet fever, measles, chicken-pox, and small-pox do not, as a general rule, recur in the system is that, at the first attack, the system has reacted so strongly against these diseases as to be proof against a second attack. The reaction has so strengthened the system to resist the particular form of morbific influence that it will not readily yield to it again.

"Homœopathy is another form of quackery," says a writer in the June number of "The Popular Science Monthly." It might be objected to his method of treating the subject that no *a priori* argument can suffice in the forum of reason where practical tests and material results may be had, by any one so in love with the truth as to seek it, by going frankly to eminent homœopathic physicians and obtaining permission to study their treatment in a given number of cases, and, with a mind disabused of prejudice, carefully examining and noting each case and giving the results of such observations. There would then, at least, be some facts which would give currency to the alloy of mere argument.

There is certainly no more reason, viewed from a logical standpoint, why the inducing of symptoms or sufferings different from those produced by disease should prove more efficacious in cure than a remedy which produces similar symptoms. It may be so; but the mere assertion does not establish it. The question is one of fact; it does not belong to the domain of reason. However absurd the theory of one school may appear to a disciple of the other, the question remains, Which system cures?

It is asserted that infinitesimal doses, a decillionth part of a grain, can not cure. This statement is based upon the assumption that a dozen, or twenty, or more grains, given by the allopathic school in single or quickly repeated doses, are necessary to effect a cure, and that so given they do cure, which is to assert that allopathy is the only true standard and measure of cure, and that any material deviation therefrom is error. But, if the premise be denied, the conclusion fails.

Of the uncertainty of cure by allopathic remedies, let one of the most eminent of that school speak—that man of attainments and ability, Sir John Forbes. In his work entitled "Nature and Art in Disease," a solemn legacy to his younger brethren, he says:

"And yet what is the character of the results obtained under this system" (homœopathic) "of imaginary medication in the cure of diseases? When fairly weighed do not these results exhibit, if not quite as large a proportion of cures as ordinary medicine, still so large a proportion as to demonstrate at once the feebleness of what we regard as the best form of art and the immense strength of Nature in the same office. . . .

"The favorable results obtained by the homœopaths—or, to speak more accurately, the wonderful powers possessed by the natural restorative agencies of the living body—demonstrated under their imaginary treatment, have led to several other practical results of value to the practitioners of ordinary medicine. Besides leading their minds to the most important of all medical studies, that of the natural history of diseases, it has tended directly to improve their practice by augmenting their confidence in Nature's powers, and proportionately diminishing their belief in the universal necessity of art, thus checking that unnecessary interference with the natural processes by the employment of heroic means, always so prevalent and so injurious. It has been the means of lessening in a considerable degree the monstrous poly-pharmacy which has always been the disgrace of our art, by at once diminishing the frequency of administration of drugs and lessening their dose. . . .

"In a word, almost every drug in our overflowing materia medica, whether inert or active, has been on one ground or another copiously prescribed in every variety of disease under the supposed sanction of this pseudo-specific on empirical indication. Nor let it be supposed that this empirical practice is one of the past day only. It is at this very time in as great vogue as ever, although its employment may be often veiled under the technicalities of newer science.

"Nor is it confined to the ignorant or inexperienced among us, but adopted and followed by men of the greatest abilities and greatest eminence in the profession. . . .

"As in religion and politics, and in those departments of knowledge which are not of a positive or demonstrable kind, early and long-continued education, comprising not merely direct instruction, properly so called, but the influence of habitual example, deference to seniority and superiority, unconscious imitation, etc., induce conventional belief of the strongest kind—strong as demonstrated truth itself—and create a sort of wizard circle of power, beyond which the mind of the disciple, however bold, scarcely ever dares to wander. So in medicine, the great majority of practitioners retain the same doctrines and pursue the same practice which they learned in the schools, or, if changing both doctrine and practice, as time and fashion dictate, hold fast, at least, the great fundamental doctrine impressed upon the very core of their professional hearts—viz., that the interference of Art is essential in all cases, and therefore never to be foregone. It need not, therefore, surprise us that it is only a very small minority of medical practitioners who, in ordinary circumstances, can see in disease the true workings of Nature through the artificial veil which conventionalism and professional superstition have thrown over them. . . .

"The conviction of the great autocracy of Nature, in the cure of diseases derived from this source, is much more widely spread among the senior members of the profession than is at all believed by the great body of practitioners. . . . The number of cases that recover and would have died had Art not interfered is extremely small."

These trenchant words from Sir John Forbes carry great weight as a commanding critic in his own profession. Had his strictures upon his brethren and their practices come from an alien pen, they would undoubtedly have been attributed by the allopathic school to malevolence and ignorance; and, doubtless, Sir John Forbes will not escape the same fate, because, if his statements are true, those of whom they are spoken are incapable of perceiving or admitting their truth.

But, conceding the allopathic to be a correct or a possible system of cure, it by no means follows that because it requires large doses to create different symptoms or sufferings, it likewise requires doses of equal quantity to create *similar* symptoms to those to which the system is already so greatly predisposed.

The atomic dose will, however, bear a much closer and more severe test than has been applied to it. It is an approved and well-known fact that a person of iron will will battle long and successfully with a disease which baffles the aid of the most skillful physician, and it is said that his will sustains him. By that is not meant that he leans upon his will as upon a staff, nor that the immaterial, the will, comes in actual contact with the material, the disease; but that the will, acting through the brain, rouses up in the system material resistance to the disease, and effects a cure or prolongs the fight. How much brain would one have to eat in order to obtain a decillionth part of a grain of the will-power which operated in the system in effecting a cure or battling with the disease? The will operating through the brain moves one joint of the little finger, then two, then three, and so on until it moves by one operation of the will the whole fourteen joints of the five fingers, which act in unison at one motion. Yet it is clear that each additional joint moved resulted from the impression made upon a larger area of the nerve-centers in the brain. Assuming for the sake of argument that the correct method of cure is to arouse in the system a direct reaction against disease, and that this can only be accomplished through the brain, it follows that the remedy, which in form is best adapted to act upon the brain, is the best so far as mere form is concerned; and if the immaterial, the will, can produce such positive physical results, the quantity of the medicine operating upon the brain is not required by any law of physics (or physiology) to be many times greater than the nerve-cell, which is the body to be operated upon; especially must this be true when the object sought is not to overwhelm the nerve-center, but simply to stimulate it to increased action.

Professor Calderwood, in his "Relations of Mind and Brain," says of the nerve-cells in the brain: "These are so numerous as to baffle calculation. From the number seen within a small section under the microscope, it is reckoned that there must be many thousands of them in the human brain." Of the nerve-fibers he says: "In the brain itself they are sometimes as minute as a twelve-thousandth part of an inch," and that the smallest of the nerve-fibers in the eye are from $\frac{1}{30000}$ to $\frac{1}{50000}$ part of an inch in diameter. As an adaptation of means to end, a decillionth part of a grain, broken up into many still more minute particles, does not appear to be so much out of proportion to the nerve-cell or to the ducts, the nerve-fibers, as the two, four, six, or more grains given by the allopaths.

The stench contained in a few drops distilled by a skunk attains a potential existence in the air for not less than five hundred feet in every direction. Taking one thousand feet cubed as a minimum, we have one billion cubic feet of air saturated with the smell. Not only is this space filled once, but it is kept filled for an hour, radiating out indefinitely into space; from which it is clear, according to our critic, that a passer-by, an hour afterward, deceives himself by a supposititious shock to the sense of smell caused by the decillionth part of the drop of skunk-odor. But the involuntary clapping of the hand to the nose affords conclusive proof that both the sensor and motor nerves have been sensibly affected.

That in a chemical laboratory there is no appliance so sensitive as a diseased nerve, does not argue the inefficacy of the atomic dose, but proves the want of adaptation of the chemical apparatus to deal with the subject.

Hahnemann's method of trituration is urged as an argument against his principles, without showing that it has anything to do with the principles, or that it fails to accomplish the object sought. The work is now done with great exactness by machinery.

It is said that since the discovery of the *Sarcoptis hominis*, or itch-insect, the dogma about psora being such a powerful factor in the causation of diseases has fallen to the ground; that is to say, that those who supported this theory have been, by this discovery, forced to abandon it. Why? Evidently because the theory is inconsistent with the itch-insect. But who proves it? Is the disease the cause of the insect, or the insect the cause of the disease? Do maggots breed carrion, or carrion maggots? Was Hamlet trying to shift the responsibility of Polonius's death from himself to the worms?

"Now, Hamlet, where's Polonius?"

"At supper."

"At supper! Where?"

"Not where he eats, but where he is eaten. A certain convocation of politic worms are e'en at him."

That is, the worms killed Polonius.

But it is clear that Hamlet was not so mad as that, for he said, "For if the sun breed maggots in a dead dog, being a god-kissing carrion—"

So will psora breed the *Sarcoptis hominis*, but so will not the insect breed the itch. Being but the effect, it can not produce the cause. It is not its own *causa causans.*

Homœopathy has suffered, and is likely to suffer, more from its friends than from its enemies.

Persons who adopt it as an easy means of gaining a livelihood are apt to fail, and fall back upon the allopathic school, with its nosology and procrustean prescriptions. Few are those in any calling who have either the frankness to confess or ability to perceive the cause of failure to be from within. The convenience of a name for every disease is apparent. It relieves from further investigation. How little Dr. Shepherd knows of the laws of homœopathy may be demonstrated by a single sentence. He says: "Hahnemann paid no attention to pathology or cause of disease, but only sought for symptoms. For instance, in a case of dropsy, the cause, whether it be from the heart, the kidneys, or the liver, is not inquired into, but *the symptom dropsy is treated*."

It is clear that the writer here uses the term "cause of disease" as synonymous with the part affected, which is to confound cause and effect, and he substitutes his own nosology "dropsy" for the group of symptoms which indicate, not dropsy, but the remedy to be selected. The fact that the heart or kidneys or the liver is affected does not indicate or prove that the one affected is the cause of disease. It proves that the disease has affected that part, and it follows by an inexorable law that the part affected can only be cured by removing the cause. It is this inversion of cause and effect, of disease and its point of attack or expression, this ignorance of Nature's laws, which induces the allopath to attempt to cut out the core of what he calls cancer; thus trimming the branches of this mighty disease, to strengthen it at the roots, seated deep down in the system. It is like cutting down a locust, and producing a forest from the roots. How can a school, which has been a thousand years dissecting dead bodies to discover the vital principle, hope to free itself from its dogmas? As well might it be expected to discover the electric fluid by dissecting a yard of telegraph-wire. Professor Calderwood, who is not a homœopathist, demonstrates, as a scientist, from the discoveries of the foremost physiologists and psychologists, that, by tracing up all of the group of symptoms along the nerve-fibers, we will reach a common nerve-center in the brain, differing in area and location with differing groups of symptoms. This nerve-center is operated upon by certain sensor nerves. The whole object of the homœopathic physician, who is true to the law, is to trace these symptoms to a common nerve-center, and then to select a remedy which, acting upon that nerve-center, will, on the line by which Nature cures, stimulate a reaction, and thus restore the equilibrium, which is perfect health.

The law of Nature's cure is, by rousing up reaction against disease, to restore the disturbed forces to their exact counterpoise, where action and reaction are equal. The allopathic method of creating a new disease to cure the old one is a violation of this law, and at the very outset the regular school must begin by an apology or an excuse, either that Nature has denied to men the means of executing her laws, or that man is ignorant of the means she has placed at his disposal.

As an abstract question, preference must be given to that method of cure which creates the least disturbance in the system, and, as a consequence, leaves it less liable to relapse or a second attack; which does not by antagonizing the vital forces reduce or destroy its economies; which does not work by rule of three; as the remedy is to the disease, so is the constitution to the condition of the patient when the disease shall have left it. Convalescence in homœopathy commences when the correct remedy begins to act. In allopathy, when the remedy and disease have left the patient prostrate, then Nature takes the matter in hand. It is a common error with the ignorant traducers of homœopathy that the higher the potencies or its remedies the weaker they become, as one weakens wine by adding water. It is sufficient answer to quote the following high authority, who discloses the true purpose and effect :

"If it be conceded that the vital principle is identical with electricity, the action of dynamized medicaments becomes easy of comprehension ; for in these preparations we have material substances subdivided to a degree that enables them to penetrate the most delicate tissues of the body."—(Dr. Currie's preface to Jahr's "Homœopathic Manual.")

The writer's assertion, that "homœopathy, being a system utterly void of any scientific foundation, is now dying a natural death," receives, to say the least, doubtful support from the animated debate which has been progressing so vigorously in the New York County Medical Society of the regular school in reference to consultation with homœopaths, where the exclusionists accused the more liberal brothers of having an itching palm for the fat fees which now find their way, without chance of tax, to the pockets of the homœopathic physicians, while the argument by the liberal members is that as now homœopathy has progressed and its disciples have a thorough medical education, there is no longer any reason why they should be treated as quacks and impostors. So far as noted, the alleged moribund condition of homœopathy had escaped their observation.

What shall be said of the pretensions to be enrolled with the sciences of that school which has progressed from one stage of universal disease or cause and remedy to another — typhoid, malaria, miasm germ, bleeding, calomel, morphine, quinine — by discarding nearly all that its pioneers held most dear ; which, before it can build, must tear down ; which retreats from the necessary labor of that scientific investigation which by great diligence and skill eliminates every remedy but one as useless or hurtful, to take refuge in a nauseous mixture of several powerful drugs, administered upon the hit or miss blunderbuss principle — those drugs which are neither allopathic nor homœopathic to the disease, doing more potent injury than the one (which by hap-hazard has some relation) can do good, as Sir John Forbes says, "the monstrous poly-pharmacy which has always been the disgrace of our" (the allopathic) "art"?

It may well be doubted whether homœopathy will ever have enrolled under its banners the same number of practitioners as the regular school. The nearer we approach to an exact science, the fewer are its votaries. The conditions admit fewer. In it there are no formulated diseases nor formulas for prescriptions. It is differentiation as opposed to classification or generalization. The effect, expression, or impression of disease, is not mistaken for disease as a cause. Subject one hundred persons of both sexes and various ages to a cold rain and then to a burning sun, and you will have as many different states as persons. The disturbance of the vital force has found expression in a hundred different forms. It is in the province of the homœopathic physician to locate the center of disturbance, and then to select as the remedy, by a process of elision from the many similars in the materia medica, the one which most nearly coincides with the expression of the disease or symptoms. When this process sometimes involves the most experienced and skillful physician in a profound study of one, two, and three hours and of re-examination as the expression changes, requiring due weight to be given to each symptom, both relatively and positively, and then to assume the grave responsibility of administering a single remedy and awaiting the result, it will be readily seen that those who are faithful to the law, and able to administer it, will be few.

By operation of the will a strong man liberates from a nerve-center of his brain nerve-energy which, acting along the motor nerves, liberates in its turn sufficient muscular energy to fell an ox. Here the immaterial, the will, has produced a most powerful material result. Suppose for a moment that the nerve-energy had been misdirected, as in case of shock from mental causes, and had all been expended within the man, who would answer for the result?

In the heroic struggle which Nature, unaided, makes against disease, the assistance from Art necessary to speed the cure may in a great majority of cases be set down in decimals, as follows:

Nature	·999
Art	·001

and it will be pretty safe to say that, whenever the proportion is against Nature, there will be no cure.

It is the $\frac{1}{1000}$ which Art is called upon to throw into the scales and make them equal. If she adds more, she destroys the balance.

The atomic dose is adjusted to restore the balance. It is the infinitesimal fraction Nature needs to make the unit health.

If you accept the germ-theory of disease, and attribute to the atomic germs, floating impalpable in the air, or carried long distances through the mails on highly calendered writing-paper, from mere contact with the hands of diseased persons, the power of communicating disease and completely overwhelming the vital power, causing death, you can not logically deny to the atomic dose all aid to the vital power in resisting and defeating the attack of the atomic germ of disease simply because the dose is atomic. Nature, unaided, in a vast number of cases, successfully resists those diseases which are attributable, by those who maintain the germ-theory in disease, to atomic germs. The number of disease-germs does not matter, as is evidenced by the communication of disease by letter where the number must necessarily be limited. The atomic dose is but a stimulus to Nature. Nature cures, aided or unaided. The atomic dose but excites in a greater degree those powers of reaction and resistance of Nature already set in motion by disease—which is a disturbing cause. Nature always seeks to restore the equilibrium of her forces.

THE LIVER-FLUKE OF SHEEP.

By BYRON D. HALSTED, Sc. D.

THE object of this paper is to briefly summarize the present knowledge of the liver-fluke, causing the much-dreaded and fatal "rot" in sheep. Professor A. P. Thomas, of Balliol College, Oxford, has completed his long and extended researches on this parasite, which have been carried on under the direction of the Royal Agricultural Society of England. Professor Thomas's concluding report appeared in the last issue of the "Royal Agricultural Journal," from which the leading facts here given are drawn and the engravings borrowed.

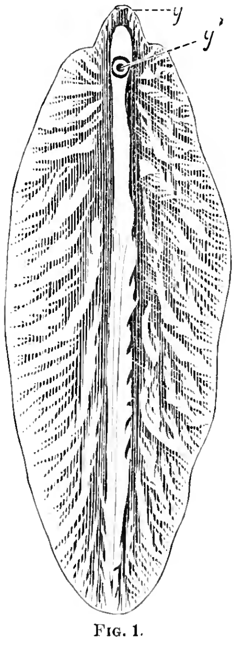

Fig. 1.

The liver-fluke, shown twice the natural size in Fig. 1, is a sucking-worm related to the common leech, and known to zoölogists as *Fasciola hepatica*. It has the shape of a privet-leaf, is pale brown or flesh-colored, and from an inch to an inch and a third in length. There is a short projection at one end, and at its tip, *y*, is a sucking-mouth by which the fluke can attach itself to the surface of the bile-ducts of the sheep. A second sucker, *y'*, is situated at the place where the head joins the body. These flukes are found in abundance in the livers of sheep and other animals infested with the "rot," and produce vast numbers of eggs. Each of these eggs under proper conditions gives rise to an animal "which is never like its parent, never does become like it, and never lives where its parent lives." It will be seen that in the liver-fluke we have an example of what is known among naturalists as an alternation of generations.

The eggs, one of which is shown in Fig. 2 very highly magnified, are about $\frac{1}{200}$ of an inch in length, but may be made visible to the naked eye by shaking some of the dark-brown contents of an infested bile-duct in a glass of water and holding the vessel up to the light. The line marking off the lid of the egg may be seen near the right end,

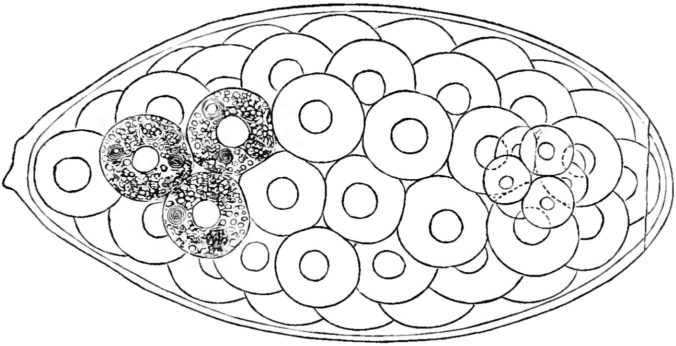

Fig. 2.

and a little to the left is the embryo in its early state of development. It is surrounded by large granular masses, which serve as food. Only three of these masses, at the left hand, have been fully drawn. In one case Professor Thomas found seven million eggs in the gall-bladder of

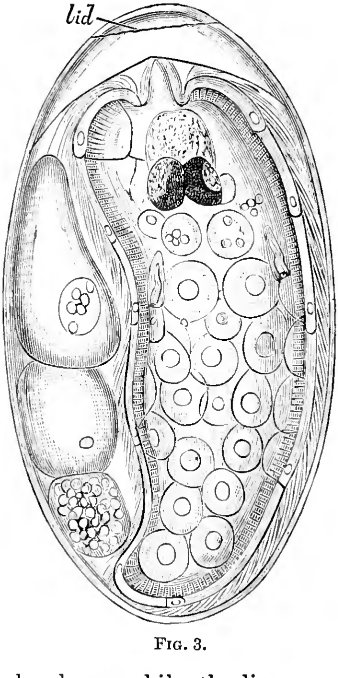

Fig. 3.

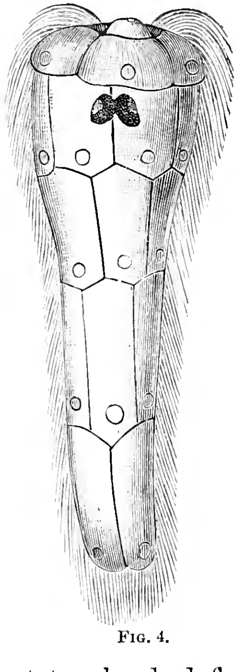

Fig. 4.

a single sheep, while the liver contained about two hundred flukes. The number of eggs produced by a single fluke may be safely estimated as half a million. No further changes take place in the egg while it remains within the infested sheep. The eggs are, however, naturally washed away by the bile into the intestines, and finally pass from the sheep and are distributed with the droppings. If the eggs fall upon wet land, further changes take place during warm weather, and an embryo is formed. Fig. 3 shows a fluke-egg with the embryo fully formed within the shell. The body of the embryo is covered with cilia, by the motion of which the young trematode is propelled through the water. Both of the engravings (Figs. 3 and 4) are highly magnified. In swimming, the broader end is directed forward, and in its center is a projection, used as a boring-tool. The embryo has very simple eye-spots, which render it sensitive to light, and aid it in finding its future home. When the swimming embryo comes in contact with any object, it feels about, and, if not suited to its wants, starts off again. If the object met with is the snail (*Limnæus truncatulus*), shown in Fig. 5, it at once bores into it. In boring through the shell of the snail, the peg-like projection is extended, and the embryo spins around rapidly by means of the cilia. The natural place for the further growth of the embryo is in or near the lung of the snail, and when once lodged there its eye-spots and cilia disappear, and the body becomes oval in shape. Figure 6 shows the embryo while the changes are taking place. When the changes are completed the animal is called a *sporocyst*, meaning a sac of germs. The sporocysts live at the expense of the snail, and will, in July weather, reach their full growth, $\frac{1}{40}$ of an inch, in a fortnight. Fig. 7 shows a full-

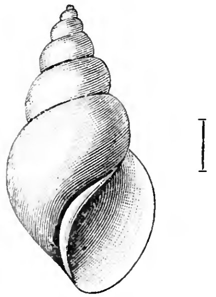

Fig. 5.

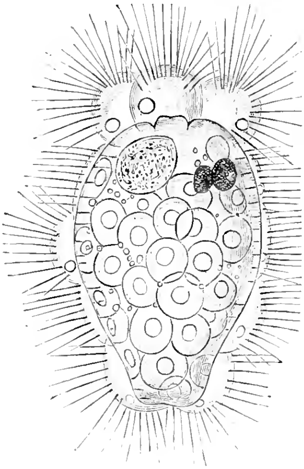

Fig. 6.

Fig. 7.

grown sporocyst, or first generation of the liver-fluke. It contains a number of germs, the lower one of which is ready to hatch out. This is the second generation, and is named *redia*, after Redi, the celebrated anatomist. The young redia, when ready, breaks through the wall of the parent, and the wound thus formed closes up, and the remaining germ rediæ continue to grow. The sporocysts also multiply by simple division, thus causing still greater increase in the number of parasites in the snail. A young redia is shown in Fig. 8, with the contents forming into the third generation of the liver-fluke. A full-grown redia is seen in Fig. 9, much magnified. Some of the germs of the *cercaria*, as they are termed, may be seen within the redia. Each of these germs develops into a tadpole-like animal, with a slender tail. A redia may produce a score of the cercariæ, which escape from the parent through a special opening and then wriggle their way out of the snail. The free-swimming life of the "tadpole" does not last long, and after coming to rest it draws its body into a small sphere, and exudes a gummy substance, which protects it from injury. These encysted cercariæ are destined to find entrance to the liver of the sheep and then develop into the full-grown fluke. Fig. 10 shows a free cercaria as seen swimming in water, and in Fig. 11 is seen a portion of grass upon which three cysts are fastened. The cysts remain attached to the herbage of the pasture, and are swallowed by the sheep in feeding upon the ground. If the cysts are not picked up by the sheep within a few weeks, the young flukes which they contain will perish. It has been determined that two hundred or more cercariæ may descend from a single fluke-egg, and, if the rediæ give rise to a generation of daughter-rediæ, a single egg may produce more than a thousand cercariæ. "Not only does the race of the liver-fluke multiply and increase abundantly in the sheep by producing myriads of eggs, but there is a further and great increase of the forms within the snail. If only the greatest degree of ordinary increase were reached, a single fluke might give rise to more than a hundred million descendants in the next generation of liver-flukes proper inhabiting the sheep. But, fortunately for farmers, the chances are enormously against any such disastrous increase."

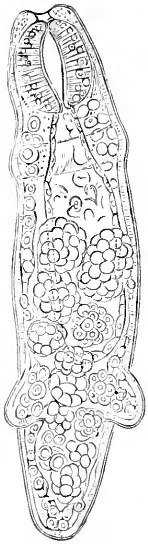

Fig. 8.

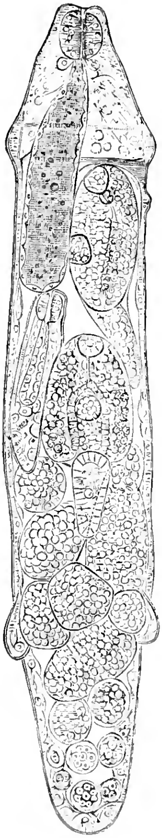

Fig. 9.

Professor Thomas has determined that at least six weeks elapse, from the time the encysted cercaria is swallowed by the sheep, before the fluke is fully grown and begins to lay eggs. The flukes do not always pass from the sheep in summer-time, as was once thought by leading veterinarians. There is no time of year when sheep-livers

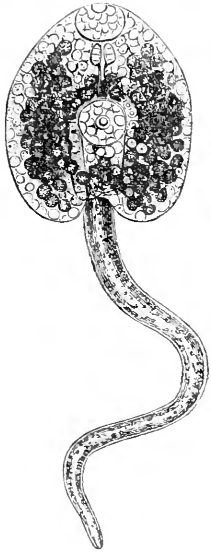

FIG. 10.

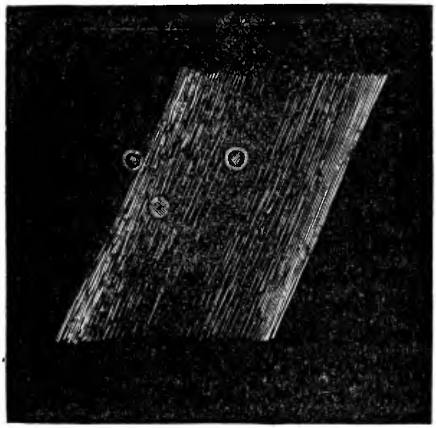

FIG. 11.

containing flukes can not be obtained. Cases are known where the flukes have been known to live for more than a year.

The summary of the life-history of the liver-fluke is given as follows: "The adult fluke in the liver of the sheep produces enormous numbers of eggs, which are distributed with the droppings of the sheep. If these eggs have moisture and a suitable degree of warmth, they continue to live, and in each is formed an *embryo*. The embryo leaves the egg and swims in search of the particular snail (*Limnæus truncatulus*) within which its future life and growth take place. The embryo bores into the snail, and then grows into the form which is called a *sporocyst*. The sporocyst gives rise to the second generation. This generation is known as the *redia*. The rediæ in turn produce the third generation, which has the form of a tadpole, and is called *cercaria*. The cercariæ quit the snail and inclose themselves in envelopes or cysts, which are attached to the grass. When the grass to which the cysts adhere is eaten by sheep or other suitable hosts, the young liver-fluke comes out of the cyst and takes up its abode in the liver of its host, and the fatal circle is thus completed."

The fluke-disease alternates between a kind of snail and the sheep. One sheep can not contract the "rot" directly from another member of the flock, and one snail can not take it from its neighbor. The sheep drop the eggs, and hatching, the embryos, find the snails, and the snails after nursing the young flukes through three generations distribute the tadpole cercariæ, which convey the infection back to the sheep, and it there inhabits the liver and causes the disease.

The Prevention of the Rot.—Now that the life-history of the fluke is known, it is not difficult to comprehend the conditions necessary for its existence. There must be: (1) Fluke-eggs on the ground; (2) wet ground or water during warm weather—(3) the snail *Limnæus truncatulus* (?); and (4) sheep allowed to feed upon the infested ground.

Under the first condition it may be said that wherever fluked sheep are kept we shall have fluke-eggs. In some districts flukes are always to be found, and where the conditions are the most favorable a sudden outbreak may be expected. The disease sometimes appears in quarters where it was previously unknown, and may have been introduced in manure containing fluke-eggs, or adhering to the feet of cattle, dogs, or men. The eggs and young flukes (embryos) may be conveyed by running streams, floods, etc. Other animals than sheep are infested with the parasite, and rabbits and hares may be the means of introducing the plague. The production of the fluke-eggs may be prevented by killing the sheep so soon as they are found suffering from the "rot." If there is a suspicion that a flock is attacked, one of the members exhibiting the strongest signs may be killed and its liver examined. If rotted sheep are kept, they should be on dry ground, where the fluke-eggs can not fall on wet land, or be swept into brooks by the descending rains. The manure of infested sheep should not be placed on wet land, and the livers of rotted sheep ought to be destroyed or deeply buried.

The remedy for the second condition is a simple one, but not always easy of application. Wet land should be thoroughly drained, and, besides preventing the rot, it will greatly improve the pasturage. When draining can not be done, lime or salt may be scattered over the surface. These substances will destroy the embryos, the more developed encysted form of the fluke, and the snails which serve as hosts. The salt or lime should be applied in early summer, when the young flukes are present in the greatest numbers.

There seems to be only one snail in England which is host to the young flukes, and the accounts of Professor Thomas in exposing other species of *Limnæus* to the embryos of the fluke are most interesting. The *Limnæus truncatulus* (Fig. 5) is said not to exist in the United States, though several other kinds of snails belonging to the same large genus are found here. It is probable that with us some other species than *Limnæus truncatulus* serves as the host of the intermediate forms of our liver-flukes. Draining the wet land will reduce the number of snails; and dressings of lime or salt, as above mentioned, also destroy them. The lime should be scattered especially on or near marshy places and along ditches. If a pasture has been flooded, it is well to use the lime to destroy snails which may have been brought down from infested areas.

If there is suspicion that a lowland is likely to give the "rot" to sheep, the best plan is to not allow them to feed upon it. In seasons of excessive moisture it may be impossible to keep the flocks on dry pastures. Salt, as a preventive, may be used in a second way. It acts injuriously upon the germs when fed to the sheep, and it also improves the general health of the animal. In addition to the salt, use dry feed as much as possible. The sheep should not be allowed to graze too closely, for the snails, as a rule, keep near the ground.

If all farmers would unite in carrying out the above preventive measures given by Professor Thomas, the losses from a fatal disease would be greatly reduced. Rabbits and hares are an obstacle to the total extermination of the "rot" in sheep.

The literature of the liver-rot in sheep is specially interesting in the light of our present knowledge. Jennings, in his work on "The Horse and other Live-Stock" (1866), says: "The malady is unquestionably inflammation of the liver. These fluke-worms undoubtedly aggravate the disease and perpetuate a state of irritability and disorganization, which must necessarily undermine the strength of any animal. . . . The sheep, having a little recovered from the disease, should still continue on the best and driest pasture on the farm, and should always have salt within their reach." Youatt, in his work on sheep, in 1848—back of which date it is not worth while to go—wrote at length upon the "rot." He located the disease in the liver, and states that it has existed from the earliest period of agricultural history. His description of a diseased sheep was full and quite accurate, but the cause was unknown to him. He says, without qualification, that it is inflammation of the liver. The full-grown fluke is too large an object to escape notice in the examination of an infested liver, and therefore was known to Youatt and the veterinarians of his day, but was considered the consequence instead of the cause of the "rot." They believed that the "rot" was connected in some way with the soil, it being confined to wet seasons and to sheep which fed on marshy lands. "It has reference to the evaporation of water, and to the presence and decomposition of moist vegetable matter." In other words, the gases arising from decomposing organic substances cause the "rot." Randall, in his "Sheep Husbandry," states that this view at that date (1860) was universally received by scientific veterinarians. H. Clok, V. S., in his "Diseases of Sheep" (1869), says the "rot" is analogous to "fluke," and is produced by many causes, among which "grazing on marshy or sour meadows" is a leading one. In speaking of the fluke, he says, "The worms are found spontaneously, like all other worms of the viscera, and the opinion that they are introduced into the body with the food, drink, etc., must be considered erroneous."

With the first symptoms of the liver-fluke in sheep there is a tendency to fatten, and animals intended for the shambles have been purposely rotted in order to increase their fattening properties. A celebrated stock-man in England used to overflow his pastures, and, after the water was run off, turn on his sheep which he was preparing for the market. These animals became infested, accumulated flesh rapidly, and by this manœuvre a gain of some weeks was obtained. The practice is certainly questionable, if not positively vicious.

The writer claims no originality in the present paper, and only acts the part—and that imperfectly—of a middle-man in science.

CYCLONES AND TORNADOES.

By GEORGE CLINTON SMITH.

CYCLONES.

TOWARD the western portion of the United States, along the twenty-fifth parallel of longitude, lies a vast tract of sandy, arid country, known to the earlier geographers as "The Great American Desert." It is true, the limits of this great area have become circumscribed by the onward march of civilization, but the sandy waste is still there, and must ever remain. Still farther westward, the Rocky Mountains rear their lofty, snow-crowned heads in one continuous chain, three thousand miles in length. Rich in mineral wealth, the delight of tourists, and the home of a prosperous people, these mountains have a different and equally valuable office to perform in the exercise of an important influence upon the climate of our continent. Were they to be removed, the entire territory west of the Mississippi River would soon become an arid, lifeless desert.

All storms, of any magnitude, that visit the United States, except the tropical hurricanes which sometimes touch the southern coasts, have a common origin in or near the Rocky Mountains. Here the first barometric depression is felt, preceded by a rising temperature, caused by the warm winds moving northward over the sun-heated sands of Arizona, New Mexico, and Western Texas. These warm, rarefied currents of air are met by cooler currents passing over the snow-clad peaks of the north; a cyclonic storm is formed, usually small at first, which begins its journey eastward, gradually developing in energy and area as it goes. After leaving the mountain-ranges, there is but little precipitation for the first few hundred miles; as it advances, it usually widens from north to south, but the line of travel of the storm-center can be readily predicted by the Signal-Service observers, and its location at any time fixed by the lowest reported reading of the barometer.

During the journey of the storm eastward or southeastward, the wind in advance of it will be easterly, blowing off an area of high barometer into the low; and the barometer will continue to fall. Toward the north of the storm, the wind will be north; and to the south of it the wind will blow from the south, frequently causing what are known on the Western plains as "sand-storms"; while, if the storm occurs during the winter season, the wind and snow in the northern portion is called a "blizzard." In the rear of the storm the wind will be westerly, shifting to northwest, frequently blowing a gale; the barometer will rise and the temperature will fall, sometimes rapidly, and clearing weather will follow.

Thus it will be observed that the true axis is the "storm-center," and that the storm revolves on this axis as it moves forward in an easterly, northeasterly, or southeasterly direction. This is the true cyclone. It may be only a few hundred miles in diameter, or its influence may be felt from British America to the Gulf of Mexico. It may be accompanied by what are known as local showers or storms; or the rains may be general, and of several days' duration. The greatest precipitation is frequently in advance of the storm-center, and may be either rain or snow, depending upon the season of the year and the temperature. During the spring and summer months the area of low pressure is usually accompanied by precipitation in the form of local showers, or thunder-storms, of more or less severity, in which case the strongest air-currents move with the local storm-cloud, and are known as simply high winds, sometimes approaching the severity of a hurricane, but seldom extending over any considerable area of territory.

The true cyclone usually travels from the Rocky Mountains to the Atlantic coast, in nearly a straight line. Sometimes the distance is traversed in four days and nights, exceeding the speed of a railway express-train; but frequently the progress is slow, and the time required much longer, depending largely upon the atmospheric conditions met with in the vicinity of the Great Lakes.

Frequently, while the wind may be blowing from the southeast or northeast, or between these points, the storm is approaching from an opposite direction, and pushes out its cloudy streamers, or "feelers," hundreds of miles in advance. There is, then, no such thing as a "northeast storm," as far as the interior of this continent is concerned.

TORNADOES.

The origin and movement of continental cyclones being understood, we naturally turn, next, to the investigation of tornadoes. These seem to occur most frequently in the Western States, and are usually confined to the territory between latitude 35° and 45° north, and longitude 10° and 25° west. They are purely local in effect, although their cause may be remote; always depend upon and frequently accompany the meteorological conditions developed during the progress of the cyclone proper across the country. They may occur near, or in advance of, the cyclonic storm-center; or they may appear near the outer edge of the general disturbance, hundreds of miles away. They usually develop within the area of highest temperature, and are often preceded by a brassy sky, and hot, gusty winds, sometimes followed by a sultry atmosphere and an ominous calm. They occur most frequently near the close of the day, their general direction being from southwest to northeast. They vary much in size and force, but all have the same general characteristics in regard to appearance and action; being a funnel-shaped cloud, heavily charged with electricity, that goes bounding and whirling along in close proximity to the earth's surface, dealing death and destruction wherever it touches. The generally accepted belief is, that tornado-clouds are formed suddenly, by the meeting of warm and cold currents of air; or, by the union of a positive with a negative cloud, a partial vacuum being formed, constitutes the axis around which the cloud begins to whirl, gathering strength and increased velocity as it goes.

As the tornado now sweeps onward in its course, it rises and falls with a series of bounds, and, with a swaying motion, describes a zigzag course, now forming a chain of loops, and again shooting off on an obtuse angle, varying in the speed of its forward motion, which may be anywhere from ten to thirty miles an hour. At the same time it is rapidly whirling on its axis in the opposite direction from a screw, or the hands of a clock, the air revolving around the vortex necessarily attaining a speed of several hundred miles an hour. First widening, then contracting, now bounding above the tree-tops, and again descending to sweep the earth bare of every object within its reach, the aërial monster surges onward. The largest forest-trees, mere playthings in its grasp, are plucked up by the roots, or snapped off like pipe-stems; substantial buildings are first crushed like egg-shells, then caught up in the vortex and the *débris* carried sometimes for miles, before it is again thrown off by centrifugal force, and falls by gravitation anywhere, everywhere, as soon as released from the monster's grasp.

It is difficult accurately to describe the tornado's appearance and work, even for those who have been eye-witnesses, or who have personally passed through the horrors its coming brings. While accounts differ as to its appearance and behavior, as witnessed from different points of observation and under different circumstances, all substantially agree that it is cone-shaped, its motion rotary, that its apex resembles fire and smoke, and that vivid lightning and heavy rain-fall usually accompany it. In rare instances, electricity, in the form of St. Elmo's fire, will precede the vortex, and a white, steamy cloud will follow. It will be observed that the form of the tornado-cloud is nicely illustrated by the "proof-plane" used in teaching natural philosophy. The small end of the plane is most heavily charged with electricity, and, the nearer it approaches to a perfect point, the greater will be the accumulation: a high tension is caused, and the electricity must escape by some conductor. So, in the tornado-cloud, the smaller the point or stem, the greater the force exerted when it meets the earth.

The bounding or swaying motion of the tornado can be illustrated by the experiment of the "electrical puppets": the cloud above forming the upper plate, and the earth beneath the lower one. All light objects between are drawn up, then thrown down—being first attracted, then repelled.

While the tornado, on its course, possesses four distinct motions—as previously stated—there seems little doubt that the central force, or the one exerting the greatest power, is purely electrical, although the outer surface of the vortex be composed of wind moving at a rate of speed that can scarcely be comprehended.

So many readers are already familiar with statements frequently made regarding the tornado's strange freaks, that a few illustrations only will be given.

Mr. C—— states that, during the tornado which visited Sangamon County, Illinois, on May 18th of the present year, while himself and family had taken refuge in the cellar, a sulphurous smell prevailed, a ball of fire burst above them, and they were severely burned about the face and neck, but otherwise uninjured, although the house was torn from over their heads.

The family of Mr. T——, who had also sought shelter in a cellar from the same storm, were covered with a gummy substance, which would not wash off! This substance might have been formed from the sap of trees and juice of leaves, combined with the moist, heated atmosphere. In passing over the track of the tornado, the writer observed two large elm-trees torn out by the roots; one had fallen to the east, the other to the west, and the tops of both were firmly interlocked. A short distance from these, a white-oak tree, thirty inches in diameter, was broken off and lay upon the ground, the top toward the west; on top of this lay another large tree, which had stood in a northwest direction from the first. The rotary motion of the destructive force was here clearly proved. A thrifty young maple-tree, twelve inches in diameter, stood apart from other trees, near the edge of the storm's track. About six feet from the ground the bark was peeled entirely off for a distance of two feet. No broken limb, or other missile, lay near the tree, and its top was uninjured! Could this effect be produced by wind? Was it not, more likely, caused by concussion?

In the same tornado a whole orchard was swept away; the large trees carried one fourth of a mile, stripped of their bark and smaller limbs, and completely plastered with mud. A wagon-tire was torn from the wheel, straightened out, and driven into the side of a building. A flock of geese were plucked of their feathers, which were deposited in a hedge-fence, giving it a complete coating.

Credible persons testify to having seen a horse carried over the roof of a barn, and again let down, without receiving serious injury. A child's necklace, with locket attached, was picked up in the village of A——, having been carried by the storm from W——, eight miles distant! Mr. and Mrs. T——, living in L——, were both killed, and their house destroyed by the tornado. A vest belonging to Mr. T——, containing valuable papers and a sum of money, was found in the town of P——, twenty miles away, and restored to the relatives of the deceased owner!

Wagons, agricultural implements, and household furniture, will be carried a long distance and broken into fragments by the tornado, while delicate mirrors and sets of glass-ware may be spared. The giants of the forest will be torn to splinters, while the modest flowers beneath them are left blooming as sweetly as if nothing had occurred!

The belief has obtained to some extent that tornadoes follow subterranean veins of water. That they are repeated in certain localities, have a fondness for belts of timber and small water-courses—provided they run in the right direction—there can be no doubt. They also travel over a portion of country previously moistened by rain. This rule has but few exceptions.

The increasing frequency and severity of these visitations (notwithstanding what may be said to the contrary) compel the writer to believe that radical changes are taking place in our atmosphere and climate; that the construction of great railroad-belts across the continent and the erection of a vast network of telegraph and telephone wires exert an influence upon the atmosphere, by disturbing the equilibrium of electric forces. The fact that tornadoes do not closely follow railroad and telegraph lines is not sufficient to disprove the soundness of this theory; and, whether true or false, the fact of the climatic change remains, and opens a vast field for further exploration by the electrician and the meteorologist.

Long-range predictions and weather forecasts may be safely indulged in, if made in a general way; but, when confined to fixed dates and certain localities, they have usually proved a hollow mockery, and brought ridicule upon the authors.

The United States Signal Service has proved to be quite reliable in its observations and predictions of approaching storms, and should receive due credit for its service rendered in protection of life and property. The benefits might be still further extended by a system of railway-express signals, operated in connection with it and by the direction of the Government observers at the different stations. Unfortunately, however, the warnings of this Service can not reach all concerned in time to be of value, nor can it protect in the hour of danger: as witness the tornado which visited the States of Texas, Mississippi, and Louisiana, on the 22d of April, in the present year, by which over one hundred persons lost their lives; also those which swept over a portion of the States of Missouri, Illinois, and Wisconsin, on the memorable evening of May 18, 1883. By this storm, sixty-five persons were killed and two hundred wounded in the State of Illinois alone; and yet the percentage of lives lost was small compared with the immense value of property destroyed.

As the matter now stands, the tornado seems to remain a problem that baffles science—a veritable despot in the economy of nature. The puny arm of man is powerless against it; no structure he can rear will successfully resist it, coming off unscathed in the conflict; and no device his mind can plan will turn it aside from its chosen course. Experience has amply demonstrated that the safest place in the hour of such danger is found in some subterranean retreat.

HOW THE EARTH WAS PEOPLED.

By M. le Marquis G. De SAPORTA.

II.

IT follows from the exposition given in our former article that man, issuing from a "mother-region" still undetermined, but which a number of considerations indicate to have been in the North, has radiated in several directions; that his migrations have been constantly from north to south; and that they have given rise to races the more ancient of which went farthest and were the most inferior. The superior races were those which, migrating later and becoming localized in peculiarly favorable climatic conditions, have risen gradually to what we call civilization.

M. de Mortillet has occupied himself with this progress, and, persuaded that existing mankind is only a resultant, and the last term of a series of successive transformations, distinguishes between several men, as tertiary man, quaternary man, existing man. The man of the ancient quaternary, the Neanderthal, the Denise, and the Canstadt man, appear to him so different from the historical type, that not only does he separate them from it, but he creates for the times anterior to the quaternary a human or pseudo-human category of a particular order. There were, in his view, "precursors of man," to which he applies the significant name of *anthropopithecus*, or "man-monkey," because he believes they preceded man in the scale of beings, and constituted an intermediate type between the living anthropomorphic apes and man. We should then have to deal with a creature high enough above the gorilla and the chimpanzee to know how to cut flints and use fire, low enough not to be able to rise above that industrial grade and become a real man; or with a race standing to the Bushman and Tasmanian as they seem to stand to us. Theology does not absolutely repel this view, for it discusses the possible existence of pre-adamites. Religion even seems disinterested in the question, for the Abbé Bourgeois, whose discoveries have given rise to M. de Mortillet's anthropopitheecuses, and who has not rejected the theory, has always passed for a soundly orthodox priest, while he is known to be a keen observer. Nothing is against an impartial examination of the question. Only the objections may be offered to his views that no one has ever seen an anthropopithecus, the structure and characteristics of which have been worked out by pure reasoning alone, and that the distance that must have separated the precursor of man from man himself is calculated upon the extremely uncertain basis of the distance between quaternary and existing man.

According to M. de Mortillet's admission, quaternary man was himself gradually modified. "His blood," he says, "was infused into the new race, and may even reappear by atavism in our own times." The question is reduced to one of learning whether there existed in Europe, alongside of the miocene anthropomorphs of St. Gaudens, a primitive and rudimentary man of unknown physical qualities, who had industrial instinct enough to cut flints for his use. We are thus brought to the inquiry whether the instruments collected at Thénay by Abbé Bourgeois, and those discovered afterward in Portugal, in more recent but unquestionably tertiary formations, are authentic, or are not simple flakes and natural fragments that have been confounded with articles intentionally fabricated. Thénay, where the earlier of these flints were discovered, is in the Lower Miocene, an inferior formation to that of Sansan, in which the anthropomorphic fauna we have spoken of were included. The existence of the rhinoceros at the time of its formation is still in doubt, the mastodons had not yet appeared, the elephants were still far off; the hipparions, the predecessors of the horse, were not to make their appearance till long afterward. The marsupials had disappeared, and the carnivora were represented only by ambiguous types. None of the animal forms that were to accompany the earlier steps of man, and which he would have to contend against or tame, had showed themselves. Yet man is to be placed, in this rudest condition of nature, already in possession of fire! There is certainly little *a priori* probability of this. To be convinced of it, we need more evidence than has yet been presented to us—a few flints among many thousands of others, that may have been intentionally chipped. This is a little, but not enough, in view of the improbabilities which accumulate, against our putting faith in such indications.

The tertiary flints of Portugal are not calculated to add strength to the conviction. They come from an unquestionably tertiary fresh-water formation of the recent Miocene age. The Portuguese flora of the age was characterized by the presence of elms, poplars, cinnamon-trees, saponarias, and tamarinds, which testify to a mild and equable climate throughout Europe, in which man would have found conditions most favorable to his development. When, however, we undertake to establish his existence there, we have in evidence only a deposit of sandstone mixed with silicious pebbles, partly disaggregated, which have been submitted to subsequent erosions and atmospheric influences that sufficiently explain the numerous fragments scattered over the ground from which those believed to have been intentionally cut have been sifted after a long search. M. Cazalis de Fondouce, who was a member of the Prehistoric Congress at Lisbon in 1880—a man of acknowledged competence in such matters—visited the miocene beds of Monte Redondo, and justifies his reservation of opinion on the character of the very few flints which it is possible to assimilate with those of the Moustier period, by reference to the denudations and disturbances the beds have suffered. It is not impossible that the stones were cut by man. One of them appears to have been taken from a bed that had not been disturbed; but, if this is admitted, is it not better to wait, than to attempt to solve so great a problem at once and without direct proof? M. de Mortillet is himself wise enough not to affirm directly anything but the authenticity of the instruments. He adds that their small size leads him to believe that the beings that made them, if of proportionate dimensions, were not and could not have been real men. The doubt which he admits respecting the creatures whose intervention he invokes, we extend to the instruments, and wait for the results of future discoveries to resolve it.

Acceptation of these relics as evidences of a tertiary man is made more difficult by the bright light of the following period, which M. de Mortillet calls "Chellean," from the station of Chelles, near Paris, which he regards as typical of it. Man reveals himself in this epoch with an evident industry—primitive, for it presents only a single category of instruments, which are, however, so clearly characterized by their form and size that the most prejudiced mind could not fail to recognize them at once as belonging to the same race. The deposit of Chelles is even more characteristic than that of St. Acheul, where similar instruments have been found in so great numbers. The *Elephas antiquus* of Falconer, the probable ancestor of the Indian elephant, and the predecessor of the mammoth in Europe, is found exclusively at Chelles, associated with human implements, while at St. Acheul the mammoth is more frequently found, although the other species is not absent. Thus, Chellean man saw two species of elephants merge one into the other. Probably, also, the climate changed insensibly and became colder, without disturbance to his habits or his industry. In the long run, however, the action of the physiological and biological events of which Europe became the theatre had an influence on quaternary man; and the Chellean race, passing into that of Moustier, gradually changed its habits, while it learned to fashion other instruments. There need have been nothing abrupt in this evolution, which was the product of the exigencies of a climate gradually growing more severe. At the beginning, the animals, plants, and air were those of Northern Africa, and the conditions for human existence were of the best. The Chellean man lived in the open air, or possibly under light shelters, but did not resort to caves, and was not accustomed to bury his dead. These facts explain the abundance of instruments of that age in alluvial deposits, their absence from the caves, which served as places of refuge in the following ages, and the extreme rarity of bones. The great numbers of the implements found in different parts of France give the idea of an active population of considerable density, whose peaceful extension was not interrupted during long ages by any unfortunate event. The race may be traced by means of identical instruments, except that the materials vary according to the resources of the different countries, in Spain, Portugal, Italy, Algeria, and Egypt, and even at the Cape of Good Hope; and, in North America, in the valley of the Delaware, New Jersey, and the Bridger Basin, Wyoming. The uniformity of the instruments is a most striking feature. Always the same in design, they were made to serve for more than one use—a merit, probably, in the eyes of the men who chipped them out, but a sign of inferiority in the race which, for thousands of years, knew how to make these and no other tools. They were not, according to M. de Mortillet, real hatchets, as they have been commonly called, but simply a tool (*coup de poing*), to be held bodily in the hand, and used according to the need, as hatchet, knife, chisel, or gouge. The weapon of the race was a club, and of that all traces have, of course, vanished.

The slow development of the division of labor seems to have been reserved for the following age, that of Moustier, which joins closely upon the Chellean age, and, while less perfect in details, evidences more skill and rapidity in processes, and a more utilitarian spirit. Its implements are more varied and specialized in their forms. The climate had become more severe; the glaciers were approaching their greatest extension; and "Moustierian man" was obliged to take refuge in caverns, where the relics of his industry are as frequent as those that occur scattered over the soil. In other respects the race and epoch of Moustier seem to have been simply a prolongation of those of Chelles. Only man, under pressure of new necessities, experienced wants he had not previously known. He had to be more industrious. Large animals had become more numerous; he had to arm himself for defense, and became a hunter.

As no pains were taken to give the dead a permanent burial, we can not expect to find many bones of these most ancient races. Possibly their dead were exposed, as those of some Indian tribes are now, and that would be an additional reason why their remains should have utterly disappeared. Leaving out the doubtful relics, M. de Mortillet finds only a very few bones that can possibly be ascribed to the

Chellean epoch. They belong to the race which MM. de Quatrefages and Hamy have determined, from purely anatomical considerations, as the Canstadt race, after the skull found at that place associated with elephants' bones in 1700. This skull, the Eguisheim skull (near Colmar), the fragments from Denise, the Neanderthal skull, and the *la Noulette* jawbone, are all that we have of it, and they are, it must be acknowledged, very little. They are enough, however, to give the clew to its general features, and to show its inferiority to the Bushmen and Australians, more marked, according to M. de Mortillet, than the differences between those races and the Europeans. M. de Mortillet believes that the Neanderthal man was violent and pugnacious, and goes so far as to deny him articulate speech. But we can not indulge in such bold conjectures on so little evidence. We know nothing more of the primitive European man, or of his fate. His simultaneous extension over so large a number of points gives occasion for the thought that originally, at least, he represented, not a particular race, but the common stock, in which modifications were destined to be made according as it became localized and specialized under the influence of the extremely varied conditions of the medium in which it found itself at different places. The Neanderthal man was, then, the original of what has followed. Advancing toward the south, he has peopled the earth, and been divided into local races and tribes. The Moustier epoch illustrates in Europe the stage following the first one; and the periods following that of Moustier, which M. de Mortillet has named Solutrean and Magdalenean, from the typical stations at Solutré and la Madeleine, correspond with the times when man, having localized himself, underwent gradual transformations, assuming in different respects the specific characteristics that distinguish those races, developing aptitudes as diverse as the places in which he fixed himself, and stopping at unequal and successive steps of the ladder which he was destined to climb, but which was to lead him to the full exercise of his noblest faculties only on condition of his reaching its highest rounds.

The Solutrean age was only one of rapid transition to the Magdalenean, and appears to have represented a local rather than a secular development. Both ages are the expression of the increasing cold of the glacial period, during which the huge pachyderms gradually disappeared under the growing rigor of the climate, and the reindeer and horse multiplied to take their places. The reindeer came down to occupy Central Europe, without reaching the southern regions, in numerous varieties, all of which, however, were allied to the existing reindeers of Lapland. Of the horse, at least twenty thousand, possibly forty thousand skeletons, have been found at Solutré. Neither of these animals was then domesticated, and the dog was still unknown. Man secured animals by hunting, either killing them on the spot or binding them to take home. The mammoth had become a kind of legendary being, hidden in the deepest forests, an object of curiosity, abundant enough to furnish ivory, and to provoke the man of the time to execute drawings of him. In fact, the man of this age had made great progress. The division of industrial labor had become efficient. The cutting of the flints had attained great perfection and delicacy, and a new branch of industry had been added to it; bone was worked, with ivory and reindeer-horn. Both the instruments and the substances of which they were made were now specialized. We have seen points of javelins and darts artistically worked on both faces, and prepared for handles; the scrapers were no less appropriately fitted to the use to which they were exclusively applied. Of bone were made needles, harpoons, and at last purely ornamental articles, sculptures, and engravings. Some of the representations give us curious details concerning the man and the animals of the epoch. The reindeer, bear, and mammoth were figured. The man is always naked, or appears to be. We distinguish the figure of a woman, whose body seems covered with hair; but this may only indicate garments of skins. One of the figures represents a man walking with a club over his shoulder. Men also become differentiated by localization, and the Magdalenean man offers us one of the earliest instances in Europe of this effect. The Solutrean race, whose spear-heads are so finished, and the more recent and more artistic race of the caves of Périgord, whose simple designs and efforts in sculpture we admire, show us the first essays of that spirit of initiative and of relative progress, which, after localization, conducted some of them to material inventions and ideal conceptions, and by these to the region of that supreme culture of all our faculties which we call civilization.

As M. de Mortillet shows, the man of la Madeleine was a hunter, active, ingenious, and susceptible to sentimental impressions from living nature. He had a home, and joys and sorrows; he held his hunting-feasts, and knew how to procure a kind of enjoyment with the aid of the arts of imitation and ornamentation. He recognized rank and a hierarchy, for he possessed emblems of honor and insignia of command. But this was all. He had no agriculture, no domestic life; and, if those men had any particular way of disposing of their dead, it was by exposure in the open air; and this is probably the reason that so few of their remains are found.

Is there any way in which we can determine the physical traits and osteological structure of this Magdalenean race? The numerous remains found at Cro Magnon in connection with articles of the Magdalenean age were thought to belong to the artistic race of Périgord; but M. de Mortillet discredits this opinion by showing that the places where these remains occur were disturbed in the succeeding period, the Robenhausian, and that the burials, unknown to the Magdaleneans, were practiced by those who came after them.

To M. de Mortillet, the European Magdalenean race was only a modified prolongation of that of Chelles and Moustier. Mixtures by migration and the co-existence of several races having differently shaped skulls were posterior to the recent quaternary and to the extinction of the mammoth and the retreat of the reindeer to the north. Then came an age in which, the climate having undergone amelioration, the glaciers having retired to the foot of the mountains, and the sea having withdrawn from Northern Europe to within its present limits, a new era was inaugurated. This was the era of continuous development and activity, the progress of which at last leads us step by step to the invention of metals and to history proper. The last period, however, includes many sub-periods. The metals were still unknown for a long time, and stone continued to be the only material used in making working-tools. A few arts, the necessary point of departure for all society, had, however, begun to be exercised: among them were the domestication of useful animals, beginning with the dog; agriculture, and consequently the adoption of some of the food-plants; the use of pottery; and, finally, the grouping of men and their habitations in view of common defense, and also of the observance of religious rites. To an age of this kind, which has left a host of points in Europe, from Scandinavia to Switzerland, and from the heart of France to Southern Italy, M. de Mortillet has given the name Robenhausian. To follow it on this new ground through its progress to the age of bronze, would require the consideration of details that would carry us too far. It was the age of the dolmens and of the lake-villages; in it man was beginning to grow out of his infancy. Although, at least in Europe, he was not acquainted with the use of metals, and possessed only a rudimentary agriculture and industry, and although his food was still scanty and his existence precarious, he had already begun to sow wheat and barley; he wove coarse linen cloths; he made vessels of pottery and hardened them in the fire; and he built real monuments to his dead, artificial representations of caves made by piling rough stones together. Religious rites and invocations, a kind of luxury in furniture, and medical and surgical processes, came in vogue. We feel that we are on the verge of great inventions and of gigantic efforts, tending to enlarge the formerly extremely narrow circle of knowledge and of processes.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE REMEDIES OF NATURE.

By FELIX L. OSWALD, M. D.

THE ALCOHOL-HABIT.

I.

IN the tragedy of errors, called the history of the human race, ignorance has often done as much mischief as sin; and the erroneous theories of the cause—and, consequently, the proper cure—of the *Poison-Vice* have caused nearly as much misery as that vice itself. They have made intemperance an all but incurable evil; they have helped to originate the dogma of natural depravity, the confidence in the efficacy of anti-natural remedies, and that baneful mistrust in the competence of our natural instincts that still vitiates our whole system of physical education.

Physiology is a true thaumaturgic science—a description of wonders. The veriest savage must dimly recognize the fact that man can not measure his cunning against the wisdom of the Creator, and, if the development of science should continue at the present rate of progress for a thousand generations, the accumulated knowledge of all those ages would convince its inheritors that a blade of grass is a greater marvel than all the products of human skill. No human artificer can imitate the mechanism of a motor-nerve; the structural devices which the microscope reveals in the tissue of the meanest moss are perfect hyperboles of wisdom and plastic skill. But the greatest miracles of that wisdom manifest themselves in the self-protecting contrivances of a living organism. Our nervous system performs its functions by a combination of alarm-signals that apprise us of an infinite variety of external dangers and internal needs, in a language that has a distinct expression for every want of our alimentary and respiratory organs, for every distress of our tissues, sinews, and muscles, for every needed reaction against the influence of abnormal circumstances; our skin protests against every injurious degree of heat and cold, our lungs against atmospheric impurities, our eyes against the intrusion of the smallest insect; the human body is a house that cleanses its own chambers and heats its own stoves, opens and shuts its windows at proper intervals, expels mischievous intruders, and promptly informs its tenant of every external peril and internal disorder.

How, then, can it be explained that the wonderful architect of that living house has provided no better safeguard against such a dreadful danger as the alcohol-habit? Millions of our fellow-men complain that they owe their temporal and eternal ruin to the promptings of an irresistible appetite—as if Nature herself had lured them to their destruction. Temperance-preachers descant on the "danger of worldly temptations" and "selfish indulgence," on the "lusts of unregenerate hearts." Drunkards plead their willingness to reform, but "the flesh is stronger than the spirit," the clamors of instinct silence the voice of every other monitor. Does the power of such appetites not suggest the occasional incompetence of our natural intuitions? Does it not seem to confirm the dogma of natural depravity, and prove an essential defect in the constitution of our physical conscience? Nay, in the light of Nature, for reason too often fails to supply the shortcomings of instinct; the teachers whom the ignorant must follow seem themselves to be in need of a guide; the stimulant-vice has found learned and plausible defenders; zealous priests of Moloch have worshiped the man-devouring fire as a sacred flame; for thousands of honest truth-seekers the disagreement of doctors makes it doubtful if alcohol is a friend or a foe, a health-giving tonic or a death-dealing poison.

Does all this not prove that, in one most important respect, Nature has failed to insure the welfare of her creatures?

What it really proves is this: That habitual sin has blunted our physical conscience till we have not only ceased to *heed*, but ceased to *understand*, the protests of our inner monitor; it proves that the victims of vice have so utterly forgotten the language of their instincts that they are no longer able to distinguish a natural appetite from a morbid appetency.

For the Creator has not intrusted our physical welfare to accident or the tardy aid of science, and, in spite of the far-gone degeneration of our race, our children still share nearly all the protective instincts of the Nature-guided animals. Children abhor the vitiated air of our city tenements; they need no lecturer on practical physiology to impress the necessity of out-door exercise; their instinct revolts against the absurdities of fashion and the unnatural restraints of our sedentary modes of life. And the same inner monitor warns them against dietetic abuses. Long before Bichat proved that our digestive organs are those of a frugivorous animal, children preferred apples to sausages and sweetmeats to greasy made-dishes; they detest rancid cheese, caustic spices, and similar whets of our jaded appetites. No human being ever relished the first taste of a "stimulant." To the palate of a healthy child, tea is insipid; the taste of coffee (unless disguised by milk or sugar) offensively bitter, laudanum acrid-caustic; alcohol as repulsive as corrosive sublimate. No tobacco-smoker ever forgets his horror at the first attempt, the seasick-like misery and headache—Nature's protest against the incipience of a health-destroying habit. Of lager-beer—"the grateful and nutritive beverage which our brewers are now prepared to furnish at the rate of 480,000 gallons a day"—the first glass is shockingly nauseous—so much so, indeed, as to be a fluid substitute for tartar emetic. Nor do our instincts yield after the first protest: nausea, gripes, nervous headaches, and gastric spasms, warn us again and again. But we repeat the dose, and Nature, true to her highest law of preserving existence at any price, and feeling the hopelessness of the life-endangering struggle, finally chooses the alternative of palliating an evil for which she has no remedy, and adapts herself to the abnormal condition. The human body becomes a poison-engine, an alcohol-machine, performing its vital functions only under the spur of a specific stimulus.

And only *then* the unnatural habit begets that craving which the toper mistakes for the prompting of a healthy appetite—a craving which every gratification makes more exorbitant. For by-and-by the jaded system fails to respond to the spur; the poison-slave has to resort to stronger stimulants; rum and medicated brandy now mock him with the hope of revived strength; the gathering night still gives way to an occasional flickering-up of the vital flame, till the nervous exhaustion at last defies every remedy: the worshiper of alcohol must consummate his self-sacrifice, the shadow of his doom has settled on his soul, and all the strongest stimulants can now do for him is to recall a momentary glimmering of that light which filled the unclouded heaven of his childhood.

In order to distinguish a poison-stimulant from a harmless and nutritive substance, Nature has thus furnished us three infallible tests:

1. *The first taste of every poison is either insipid or repulsive.*

2. *The persistent obtrusion of the noxious substance changes that aversion into a specific craving.*

3. *The more or less pleasurable excitement produced by a gratification of that craving is always followed by a depressing reaction.*

The first drop of a wholesome beverage (milk, cold water, cider fresh from the press, etc.) is quite as pleasant as the last; the indulgence in such pleasures is not followed by repentance, and never begets a *specific craving*. Pancakes and honey we may eat with great relish whenever we can get them, but, if we can't, we won't miss them as long as we can satisfy our hunger with bread and butter. In midwinter, when apples advance to six dollars a barrel, it needs no lectures and midnight prayers to substitute rice-pudding for apple-pie. A Turk may breakfast for thirty years on figs and roasted chestnuts, and yet be quite as comfortable in Switzerland, where they treat him to milk and bread. Not so the dram-drinker: his "thirst" can not be assuaged with water or milk, his enslaved appetite craves the wonted tipple—or else a stronger stimulant. Natural food has no effect on the poison-hunger; Nature has nothing to do with such appetites.

The first choice of any particular stimulant seems to depend on such altogether accidental circumstances as the accessibility or cheapness of this or that special medium of intoxication. Orchard countries use distilled or vinous tipples; grain-lands waste their products on malt-liquors. The pastoral Turkomans fuddle with *koumiss*, or fermented mare's-milk, the Ashantees with sorgho-beer, the Mexicans with pulque (aloe-sap), the Chinese and Persians with opium and hasheesh (*Cannabis Indica*), the Peruvians with the acrid leaves of the coca-tree. Even mineral poisons have their votaries. There are thousands of arsenic-eaters in the southern Alps. Arsenious acid, antimony, cinnabar, and acetate of copper, are mistaken for digestive tonics by Spanish and South American miners. By the process of fermentation, rice, sago, honey, sugar, durrha (*Sorghum vulgaris*), dates, plums, currants, and innumerable other berries and fruits, have been converted into stimulants. The pastor of a Swiss colony on the Llanos Ventosos in the Mexican State of Oaxaca told me that the Indians of that neighborhood stupefy themselves with macerated *cicuta*, a kind of water-hemlock, and remarked that the delirium and the subsequent reaction of a cicuta-debauch correspond exactly to the successive phases of a whisky-spree, the only difference being in the price of the tipple. If intoxication were a physiological necessity, it would, indeed, be folly to buy the stimulant at the dram-shops, since cheaper poisons would serve the same purpose. A dime's worth of arsenic would protract the stimulant-fever for a week, with all the alternate excitements and dejections of an alcohol-revel. A man might get used to phosphorus and inflame his liver with the same lucifer-matches he uses to light his lamp; we might gather jimson-weed or aconite, or fuddle with mushrooms, like the natives of Kamchatka, who prepare a highly-intoxicating liquor from a decoction of the common fly-toadstool (*Agaricus maculatus*).

These facts teach us two other valuable lessons, viz., that *every poison can become a stimulant*, and that *the alcohol-habit is characterized by all the symptoms which distinguish the poison-hunger from a natural appetite.* One radical fallacy identifies the stimulant-habit in all its disguises: its victims mistake a process of *irritation* for a process of *invigoration.* The self-deception of the dyspeptic philosopher, who hopes to exorcise his blue-devils with the fumes of the weed that has caused his sick-headaches is absolutely analogous to that of the pot-house sot who tries to drown his care in the source of all his sorrows; and there is no reason to doubt that it is precisely the same fallacy which formerly ascribed remedial virtues to the vilest stimulants of the drug-store, and that, with few exceptions, the poisons administered for "medicinal" purposes have considerably increased, instead of decreasing, the sum of human misery.

The milder stimulants (light beer, cider, and narcotic infusions) would be comparatively harmless, if their votaries could confine themselves to a moderate *dosis.* For sooner or later the tonic is sure to pall, while the morbid craving remains, and forces its victim either to increase the quantity of the wonted stimulant, or else resort to a stronger poison. A boy begins with ginger-beer and ends with ginger-rum; the medical "tonic" delusion progresses from malt-extract to

Munford's Elixir; the coffee-cup leads to the pipe, and the pipe to the pot-house. Wherever the nicotine-habit has been introduced, the alcohol-habit soon follows. The Spanish Saracens abstained from all poisons, and for seven centuries remained the teachers of Europe in war as well as in science and the arts of peace—freemen in the fullest sense of the word, men whom a powerful foe could at last expel and exterminate, but never subdue. The Turks, having learned to smoke tobacco, soon learned to eat opium, and have since been taught to eat dust at the feet of the Muscovite. When the first Spaniards came to South America they found in the Patagonian highlands a tribe of warlike natives who were entirely ignorant of any stimulating substance, and who have ever since defied the sutlers and soldiers of their neighbors, while the tobacco-smoking red-skins of the North succumbed to fire-water. In the South-Sea Islands, too, European poisons have done more mischief than gunpowder: wherever the natives had been fond of fermented cocoa-milk, their children became still fonder of rum; while the Papuans, whose forefathers had never practiced stimulation, have always shown an aversion to drunkenness, and in spite of their ethnological inferiority have managed to survive their aboriginal neighbors. International statistics have revealed the remarkable fact that the alcohol-vice is most prevalent—not in the most ignorant or most despotic countries (Russia, Austria, and Turkey), nor where alcoholic drinks of the most seductive kind are cheapest (Greece, Spain, and Asia Minor), but in the *commercial countries that use the greatest variety of milder stimulants*—Great Britain, Western France, and Eastern North America. Hence the apparent paradox that drunkenness is most frequent among the most civilized nations. The tendency of every stimulant-habit is toward a stronger tonic. Claude Bernard, the famous French physiologist, noticed that the opium-vice recruits its female victims chiefly from the ranks of the veteran coffee-drinkers; in Savoy and the adjoining Swiss cantons kirsch-wasser prepares the way for arsenic; in London and St. Petersburg many ether-drinkers have relinquished high wines for a more concentrated poison; and in Constantinople the Persian opium-shops have eclipsed the popularity of the Arabian coffee-houses.

We see, then, that *every poison-habit is progressive*, and thus realize the truth that there is no such thing as a harmless stimulant, because the incipience of every unnatural appetite is the first stage of a progressive disease.

The facts from which we draw these conclusions have long been familiar to scientific specialists, and have separately been commented upon; but in science, as in morals, the progress from special to general inferences is often amazingly slow. The ancient Athenians would have shuddered at the idea of selling and buying a burgher of their own city, but had no hesitation to enslave the Greeks of the neighboring states. The Romans enfranchised the citizens of Latium, and at last all the natives of the Italian Peninsula, but kidnapped all the "barbarians" they could lay their hands upon! The French and Spaniards of the last century were deeply shocked at the indiscriminate manhunts of the Algerian corsairs, and even refused to retaliate on the men of Argel, because, in spite of their black turpitude, many of those misbelievers had something like a Caucasian skin on their faces, but those same moralists thought it perfectly proper to kidnap and cowhide the black sons of Ham; but, since the children of a negress were as salable as their mothers, and miscegenation and mistakes could not always be avoided, it sometimes happened that the auctioneer got hold of a white slave, till William Wilberforce at last arrived at the grand conclusion that all human slavery is wrong. More than a hundred years ago, Dr. Boerhaave entered an emphatic protest against rum, French high-wines, and "other adulterated spirits," but confessed a predilection for a drop of good *Schiedam*. Dr. Zimmermann objected to all distilled liquors, but recommended a glass of good wine, and a plate of beer-soup—the latter a Prussian invention, and one of those outrages on human nature that embittered the childhood of Frederick the Great. The hygienic reformers of our own country denounce intoxicating drinks of all kinds, but connive at mild ale, cider, opiates, narcotics, and patent "bitters." The plan has been thoroughly tried, and has thoroughly failed. We have found that the road to the rum-shop is paved with "mild stimulants," and that every bottle of medical bitters is apt to get the vender a permanent customer. We have found that cider and mild ale lead to strong ale, to lager-beer, and finally to rum, and the truth at last dawns upon us that the only safe, consistent, and effective plan is Total Abstinence from all Poisons.

We have seen that the poison-habit is a upas-tree that reproduces its germs from the smallest seeds; but where did the first seed come from? How did the life-blighting delusion happen to take root in the human mind? "Man is the only suicidal animal," says Dr. Haller, "and the first opium-eater was probably some life-weary wretch who tried to end his misery by a lethal dose, and found that his poison could be used as a temporary nepenthe." The physiologist Camper ascribes the introduction of alcoholic liquors to the experiments of unprincipled physicians; but the most plausible theory is the conjecture of Fabio Colonna, an Italian scientist of the seventeenth century. "Before people used wine," says he, "they probably drank sweet must, and preserved it, like oil, in jars or skins. But in a warm climate a saccharine fluid is apt to ferment, and some avaricious housekeeper may have drunk that *spoiled* stuff till she became fond of it, and thus learned to prefer wine to must." Not a compliment to human nature, but quite probable enough to be true. An animal would have preferred water to spoiled grape-juice, but even at a very early period of his development the Nature-despising *homo sapiens* may have learned to disregard the warnings of his instinct. The economical housekeeper probably thought it a shame that his (giving poor Eve the benefit of the doubt) servants should grumble about a slight difference in the taste of the must, and the servants had to submit, had to drink the "spoiled stuff" again and again, till habit more than neutralized their disgust, for they found that the sickness induced by the effects of the putrefaction-poison (alcohol) could be cured by a repetition of the dose. They began to hanker after fermented must, and, by drinking it in larger quantities, induced a delirium which they described as anything but unpleasant; and their master, after repeated experiments, probably arrived at the same conclusion, namely, that must could be improved by fermentation. The next year they gathered grapes for the deliberate purpose of manufacturing an intoxicating drink, and the fatal precedent was established. Nature exacted the just penalties: the votaries of the poison-god were stricken with physical and mental nausea—weariness, headaches, fits of spleen and hypochondria—but still they found that all these symptoms could be temporarily relieved by a draught of fermented must; and the neighbors were astonished to learn that the servants of Goodman Noah had discovered a panacea for all earthly afflictions. They, too, then tried the receipt—with indifferent success at first, but the experience of the *habitués* encouraged them to persist, till the manufacture of *wine* became an extensive business.

The first traffickers in stimulants (like our lager-beer philanthropists) had a personal interest in disseminating the habit, but, whatever may have been the birth-land of the alcohol-vice, its first growth was probably slow, compared with the rate of increase after its exportation across the frontier. The history of tobacco, tea, coffee (and opium, I fear), has repeatedly illustrated the influence of *imitativeness* in promoting the introduction of foreign vices. The rarity and novelty of outlandish articles generally disposes the vulgar to value them as luxuries, especially while a high price precludes their general use. Foreign merchants and a few wealthy natives set the fashion, and soon the lower classes vie in emulating their betters, the young in aping their elders. In England, James I tried his utmost to suppress the use of smoking-tobacco, but, after his young cavaliers had become addicted to the habit, no penalties could prevent the London apprentices from imitating them. "In large cities," says Dr. Schrodt, "one may see *gamins* under ten years grubbing in rubbish-heaps for cigar-stumps, soon after leaning against a board-fence, groaning and shuddering as they pay the repeated penalty of Nature, but, all the same, resuming the experiment with the resignation of a martyr. The rich, the fashionable, do it; those whom they envy smoke: smoking, they conclude, must be something enviable."

Similar arguments, doubtless, aided the introduction of the alcohol-habit, and, after the vice had once taken root, its epidemic development followed as a matter of course. Every poison-vice is progressive, and, soon after the introduction of a new stimulant, the majority of individual consumers will find that the habit "grows upon them," as our language aptly expresses it. The direct effect of the poison, hereditary influences, etc., induce a growing depression of vital energy, which, in turn, leads to an increased demand for the means of stimulation. This want is met in a twofold way: 1. By a direct increase of the quantity or strength of any special stimulant; 2. By the progress from a milder to a more virulent poison of a different kind.

In Prussia, Scotland, Denmark (as well as in some of our Eastern States), actual drunkenness (i. e., intoxication followed by riotous conduct) has apparently decreased, while the revenue register shows an undoubted increase in the *per capita* consumption of alcoholic liquors. This does not prove that our topers are growing less vicious, but that they are growing more practical; intermittent rioters have become "steady hard-drinkers." In the Calmuck *steppes*, whose barrenness has forced the inhabitants to preserve the primitive habits of their ancestors, a little grain is cultivated here and there in the river-valleys, and during the winter migration the herders carry bags full of rye from camp to camp, and bake bread whenever they are short of meat or milk. But at the return of the harvest-season they have both meat and bread, and utilize the surplus of last year's grain by brewing it into a sort of beer, and indulging in a grand carousal—i. e., they get beastly drunk, but only once a year. The Bacchanalia and Symposia of the ancient Greeks were monthly revels in honor of some favorite deity; and even during the middle ages many of the poor Scotch lairds brewed ale only when they expected a guest. To get "as drunk as a lord" was the highest ambition of poor Hodge, but an ambition which he could not often gratify, though he sometimes stinted himself in bread in order to drink his fill—

"At ember-eves and holy ales."

By-and-by, however, wages improved, and *ales* became more frequent and more decidedly unholy, though perhaps less obstreperous, since continual practice enables our topers to "carry their liquor" as discreetly as the Baron of Bradwardine. The most respectable hotel in Geneva, Switzerland, allows its male employés a daily *pour boire* of six quarts of wine; Dr. Buchanan, of Manchester, speaks of English mechanics of the "better class" who take a glass of gin with every meal; and I am sure of understating the truth if I say that in the larger cities of Germany and North America every popular beer-shop has among its customers dozens of "regulars" who drink the year round a daily *minimum* of two gallons of lager-beer. The poison-mania which attacked our ancestors in the form of an intermittent passion has grown into an insatiable hunger; the tempting serpent has become a strangling hydra.

And the heads of that hydra have multiplied. The ancient Greeks knew only one stimulant—wine; the Northmen beer, the American Indians tobacco. We have adopted all three, besides tea from China, opium from India, coffee from Arabia, and fire-water from the laboratory of the German chemists. To this list the modern French have added chloral and *absinthe*. Yet this multiformity of the poison-habit is nothing but a normal symptom of its growth; whenever the quantitative increase of a stimulant-dose has reached its physical limits, the exhausted system craves a new tonic; the beer-drinker rallies his nerves with strong coffee, tobacco, or hot spices (pepper-sauce, "herring-salad," etc.), the brandy-drinker with chloral or opium, the opium-eater with arsenic. "It is alcohol that has led me to opium," says Charles Nisard; "at first I used laudanum only as an antidote."

Antidote means counter-poison. Supplementary poison would have been the right word; foreign poison-habits have supplemented rather than superseded our old stimulant-vices. The brewers' argument, that the use of lager-beer would prevent the introduction of opium, is therefore a bottomless sophism: no stimulant-vice has ever prevented the dissemination of other and stronger poisons. The alcohol-habit has sometimes been supplanted by a passion for opium, chloral, or arsenic, but it can not be exorcised with a weaker stimulant. Beelzebub does not yield to a hobgoblin. Yet nothing is more common in temperance-hospitals than to comfort a converted drunkard with strong black coffee or stimulating drugs, in the hope that the milder tonic might operate as a sort of antidote and neutralize the after-effects of the stronger poison. That idea is an unfortunate delusion. The *succedaneum* may bring a temporary relief, but it can not assuage the thirst for the stronger tonic, and only serves to *perpetuate the stimulant-diathesis*—it prepares the way for the return of Beelzebub with a legion of accomplices. On the total-abstinence plan the struggle with the fiend is sharper, but decisive. If, by the help of a strong physical (or moral) constitution, the drunkard can suppress his appetite for a year, he may manage to keep it afterward in a dormant condition; but only with extreme precaution, for a mere spark is apt to rekindle the flame.

"It should ever be borne in mind," says Dr. Sewall, "that such is the sensibility of the stomach of the reformed drunkard, that a repetition of the use of alcohol, in the slightest degree and in any form, under any circumstances, revives the appetite; the blood-vessels of the stomach again become dilated, and the morbid sensibility of the organ is reproduced."

A young priest from one of the West India Islands once consulted Dr. Rush for an affection of the lungs, and was advised to try the use of garlics. "I am satisfied that your prescription is doing me good," said he at the next interview, "but I wish you would let me steep it in some good old Geneva." "No, indeed, sir!" said the doctor, with emphasis; "no man shall look me in the face, on the day of judgment, and tell the Almighty that Dr. Rush made him a drunkard!"

I do not intend to deny that the use of mild alcoholic tonics, as a substitute for the frightful remedies of the mediæval Sangrados, is a decided improvement, but, still, it is only a lesser evil, a first step of a progressive reform. Alcohol lingers in our hospitals as slavery lingers in the West Indies, as the witchcraft delusion lingers in Southern Europe. Has alcohol any remedial value whatever? Let us consider the matter from a purely empirical stand-point. Does alcohol protect from malarial fevers? It is a well-known fact that the human organism can not support two diseases at the same time. Rheumatism can be temporarily relieved by producing an artificial inflammation; a headache yields to a severe toothache. For the same reason the *alcohol-fever* affords a temporary protection from other febrile symptoms—i. e., a man might fortify his system against chills and ague by keeping himself constantly under the stimulating influence of alcohol. But sooner or later stimulation is followed by depression, and during that reaction the other fever gets a chance, and rarely misses it. The history of epidemics proves that pyretic diseases are from *eight* to *twelve* times more destructive among dram-drinkers than among the temperate classes; rich or poor, young or old, abstainers are only *centesimated* by diseases that decimate drunkards. On no other point is the testimony of physicians of all schools, all times, and all countries, more consistent and unanimous.

Is alcohol a peptic stimulant? No more than Glauber's-salt or castor-oil. The system hastens to rid itself of the noxious substance, the bowels are thrown into a state of morbid activity only to relapse into a morbid inactivity. The effect of every laxative is followed by a stringent reaction, and the habitual use of peptic stimulants leads to a chronic constipation which yields only to purgatives of the most virulent kind.

Does alcohol impart strength? Does it benefit the exhausted system? If a worn-out horse drops on the highway, we can rouse it by sticking a knife into its ribs, but, after staggering ahead for a couple of minutes, it will drop again, and the second *deliquium* will be worse than the first by just as much as the brutal stimulus has still further exhausted the little remaining strength. In the same way precisely alcohol rallies the exhausted energies of the human body. The prostrate vitality rises against the foe, and labors with restless energy till the poison is expelled. Then comes the reaction, and, before the patient can recover, his organism has to do double work. Nature has to overcome both the original cause of the disease and the effect of the stimulant.

Alcohol has no remedial value. But that would be a trifle, if it were not for the positive mischief which the wretched poison is liable, and very liable, to cause. Four repetitions of the stimulant-dose may inoculate a child with the germs of the alcohol-diathesis and initiate a habit which years of anguish and despair will fail to cure. By a single glass of medicated brandy thousands of convalescing topers have lost their hard-earned chance of recovery; poor, struggling wretches, swimming for their lives, and, at last approaching a saving shore, have been pushed back into the surging whirlpool, and perished almost in sight of the harbor! The only chance of curing the poison-habit consists in the hope of guarding its victims against all stimulants; and I would as soon snatch bread from a starving man as that last hope from a drunkard.

Abstinence is easier, as well as safer, than temperance. "In freeing themselves from the bonds of an unworthy attachment," says Madame de Sévigné, "men have one great advantage—they can travel." If young Lochinvar's suit had been hopeless, the furtive interview with his lost love might have soothed his sorrow for a moment, but for his ultimate peace of mind it would have been better to stay in the west. The anchorites of old knew well why they preferred the wilderness to the humblest village: they found it easier to avoid *all* temptations. Vices, as well as virtues, are co-operative.

In the cure of the alcohol-habit, the total renunciation of all stimulants is, therefore, the first and most essential measure. A change of diet, a change of climate, of employment, and general habits, will help to shorten the distressing reaction that must precede the re-establishment of perfect health. The force of example may partly supply a deficiency in moral principles, ambition may strengthen their influence. But the effect of any secondary stimulant is more than enough to counteract such tendencies. With the following precautions the total-abstinence plan will prove to have the further advantage of progressive effectiveness; for, after the removal of the irritating cause has in some degree allayed the morbid sensitiveness of the digestive organs, the abnormal appetite will gradually disappear, like the secondary symptoms of the disease, and thus lessen the influence of the subjective temptation.*

THE AIM OF THERMO-CHEMICAL INVESTIGATIONS.

By JULIUS THOMSEN.†

THEORETICAL chemistry is based upon the molecular theory, according to which all matter is made up of molecules, and these molecules of atoms. The physical state of bodies depends upon the arrangement and motions of the molecules; the other physical and chemical properties depend upon the kind and number of the atoms in the molecule, upon their arrangement and relative motions.

* The treatise on "The Alcohol-Habit" will be concluded in our next issue.

† Translated from the introduction to Thomsen's "Thermochemische Untersuchungen," Leipsic, 1882, by W. R. Nichols.

Every action which causes a change in the internal structure of the molecules is a chemical action. These changes may be of various sorts: either there takes place simply a change of position among the atoms of the molecule and there is then formed a body which is isomeric or metameric with the original substance; or the molecule is broken up into several molecules, and the process is then one of dissociation, or of simple decomposition; or, further, several molecules unite together to form a single molecule, in which case the process is spoken of as one of condensation or addition; or, finally, molecules act upon each other with interchange of atoms and formation of new molecules, which is the phenomenon of mutual decomposition, the most common sort of chemical action.

From the doctrine of the conservation of matter, it follows that the mass of the bodies which take part in any chemical reaction does not change, and is fully accounted for in the products of the reaction: this principle forms the foundation for quantitative chemical investigations into the composition of substances.

From the principle of the conservation of energy, it follows, in like manner, that no energy is lost or created, and that, consequently, the whole of the energy originally present in the bodies, which act upon each other, appears again in the products of the chemical reaction, although often in a different manner than before. This principle forms the foundation of all quantitative thermo-chemical investigations.

The energy of a molecule is always the same at the same temperature; any increase or diminution of the energy of the molecules, without change of their internal structure, manifests itself as an elevation or a lowering of the temperature of the substance in question.

By chemical action, the structure of the molecule is changed, the atoms become grouped together in a different way, new relations manifest themselves among them, and the energy of the new molecule becomes different from that of the original one. The simplest case is that where the only change is in the grouping and the motions of the atoms of the same molecule, that is where an isomeric compound is formed; in such a case the atoms of the molecule pass from one condition of equilibrium to another, and, according as the new condition of equilibrium answers to a greater or less stability than the original, there occurs either an evolution or an absorption of energy, and the temperature of a corresponding body changes; in the first case it rises, in the second case it falls.

The chemical action, the passage from one isomeric condition to the other, is therefore accompanied by an evolution, or by a disappearance of heat, according as the attractions of the atoms are more fully or less fully satisfied in the body in its new condition.

The case is similar in other chemical actions; if the molecules of the substances produced by the reaction contain at the same temperature a smaller total energy than the molecules of the bodies acting upon each other, then the chemical action is accompanied by an evolution of heat; in the opposite case, an absorption of heat takes place. The greater the difference, the greater also will be the change of temperature accompanying the process, so that, if the action takes place rapidly, the temperature may reach that of a red heat, as a result of which the chemical action assumes the character of combustion in the more limited sense of the word.

The aim of quantitative thermo-chemical investigation is now, in the first place, to measure those quantities of heat which are evolved or absorbed in chemical actions. It is true that these values furnish no direct information as to the magnitude of the forces which are concerned in the chemical action, partly because they are merely an expression for the difference between the energy of the molecules decomposed and that of the molecules formed, partly because they are often affected by other actions which accompany the chemical process; they furnish, however, the material for theoretical investigations—for *the higher aim of thermo-chemistry is to establish the dynamical laws of chemical action and to afford an insight into the mysterious region of the constitution of chemical compounds—that is, of the molecules.*

Up to the present time, an almost impenetrable veil has enveloped the internal structure of the molecules and the true nature of the atoms: we know, at the most, the relative number of the different atoms in the molecule, the relative mass of the molecules, and of the individual atoms, and the presence of certain groups of atoms (radicals) in the molecules; but we know almost nothing about the nature of the forces which dominate in the molecule, and which cause the formation and decomposition of compounds.

Experience teaches that the different atoms exert an influence upon each other, which seems to be independent of their mass and which appears now as attraction, now as repulsion, and that the combining capacity of the atoms does not extend beyond a certain limit; still, up to the present time, no satisfactory explanation has been offered for these, the chief phenomena of chemistry. Chemical processes consequently do not as yet admit of a mathematical discussion in their entire extent, as is the case, for example, with the phenomena of physics and astronomy; for the general mathematical discussion of chemical phenomena we lack that which is most important as a basis, namely, a knowledge of the fundamental laws which govern the actions of the atoms. With each decade, however, chemistry approaches nearer and nearer the exact sciences, and already many laws of wider or narrower application are being established on the basis of experiment. The extremely rich and varied material of chemistry now arranges itself in large groups, the members of which follow certain common rules or laws, with reference to their formation and decomposition, and whose properties may be, to a certain extent, deduced from the composition of their molecules.

There is, however, probably no doubt that the mutual action of the atoms, their attractions, and their unequal combining capacity—in short, that "affinity" follows the general dynamic and static laws of mechanical phenomena, and that, in chemistry, as in mechanics, the right of the stronger prevails; with this assumption, general dynamic and static laws may be developed for the phenomena of chemistry, although the real nature of "affinity" is still entirely unknown.

THE HISTORICAL DEVELOPMENT OF MODERN NURSING.*

By ABRAHAM JACOBI, M. D.

NURSING is as old as the human species. Even among animals, such as they are at present, we find occasional sympathy with fellow-suffering, and meet with efforts for the purpose of relief. We can not imagine that human beings, in ever so remote prehistoric times, should have lived together, or near each other, without mutual attempts at relief, when suffering or sick. But this is presumption only, not history. No book, no tradition refers to facts in regard to the subject until the times of ancient Hellas and its successor in civilization, ancient Rome. Antiquity yields but few proofs of systematic nursing. It is true, hospitality was the pre-eminent virtue of the Greek. The stranger was always welcome. If he was sick, he was doubly so. In all Hellas poor sick citizens found ready admission to and nursing in the houses of the rich. It may be that the facility of finding private relief on the part of the sick was one of the causes why no systematic and collective efforts for the purpose of attending and nursing the sick were ever made to any extent. That such was the case, there can be little doubt; for the temples of Æsculapius and the adjoining residences of the physicians were probably not hospitals, but temporary domiciles for those who congregated in large numbers around the homes of the gods. Of the same nature was the edifice erected by Antoninus Pius near the temple of the Epidaurian Æsculapius. In Italy, also, the temple of Æsculapius, on the island in the Tiber, between Rome and the outlet of the river, was never of much importance as a hospital or sanitarium. The only real hospitals at all comparable with institutions such as we have, existed in favor of human property, and for the benefit of soldiers. According to the testimony of Columella, Seneca, and Celsus, the Romans had hospitals for slaves, warriors, and gladiators. In Greece, also, as early as the period of

* Address delivered at the first commencement of the Mount Sinai Training-School for Nurses, May 12, 1883.

Solon, those injured on the battle-field were attended and nursed at the expense of the community. Of the great Cæsar it is well known that he had a regular medical service in his armies.

There is a word in the ancient Greek which has given rise to the belief that Hellas may have had hospitals. But, as no facts and reports sustain that supposition, it is probable that *ἰατρεῖον* meant a medical office, a policlinic, perhaps, but not a hospital. Real hospitals were not built by either Greek, Roman, or Hebrew. The commonwealth of the latter was hierarchic and intolerant. The stranger—though he who was permitted to live in Judea was to be treated like a member of the community—was to be exterminated, and must not be spared. Thus, while there are no proofs of the existence of hospitals for the friend, a painstaking care in favor of the stranger was out of the question.

Antiquity, however, is not without its humane culture. The reconciling feature in that immense picture of indifference and thoughtlessness is found in Buddhism. We have the reliable report of a genuine hospital founded by a king in Ceylon, in the fifth century B. C. One of his successors in the second century B. C. is credited with eighteen hospitals under regular medical superintendence. In the East Indies hospitals are mentioned in the third century. Nor have other civilizations been slow in outgrowing the humane exertions of Hellas, Rome, and Palestine, for Prescott tells us that there were hospitals in Mexico before the Christian Spaniards introduced the blessings of torture, inquisition, and extermination. And when finally the Christians, in the second century after Christ, bethought themselves of the poor and sick and established hospitals, the largest and most effective ones were founded in Asia Minor and Persia, where Buddhism had prepared both means and public opinion—Buddhism, under whose beneficent rules aiding the poor and nursing the sick were two of the religious duties of kings and princes. Nor has Christianity the claim of having the first *large* hospitals. The Arabs had many good and large hospitals about 1200. Cordova, in Spain, sustained fifty within its own walls.

The first information in regard to Christian hospitals dates back to the second century; other reports go back as far as the fourth, and a few others to the sixth century. In most cases the establishments were not exactly hospitals, but stopping-places and dormitories for pilgrims on their way to Rome. To what extent such institutions were necessities is best proved by the order of the so-called "Bridge-makers" (*Hospitaliers Pontifes*), whose original vocation it was to protect pilgrims from the robberies and rapacity of the ferry-men on the large rivers. They existed a long time, became rich and degenerated, and were finally dissolved in 1672 by Louis XIV.

The hierarchic character of the institutions calculated to benefit the poor remained intact until the period of the Crusade wars. At that time Italian and German merchants initiated the great combinations of the several orders of Hospital Brothers.

Their efforts were not isolated or altogether premature. For there existed a humanistic movement among the better classes of the Occident, on a Christian basis it is true, but spontaneous. Particularly in the cities, societies were formed for the purpose of nursing the sick and aiding the forlorn. Guy, of Montpellier, France, established a hospital in that city, *of larger size*, while up to that time all the institutions of a similar character were small and unavailing, and located outside the walls. The new hospital in Montpellier, and seven more French houses, and two under the same direction in Rome, are first mentioned in a bull of Pope Innocent III, in the year 1198. The secular character of the institutions was at that time fully recognized. In connecting four clergymen with them he commanded that they were to attend to spiritual duties only ("*sine contradictione et murmuratione*"), and not to interfere with the office of the superiors. In 1204 the same pope recognized the newly established Hospital of the Holy Ghost, on the old Tiber bridge, in Rome. With the peculiar mixture of ferocity and mildness so common to the mediæval age, the same man who humiliated emperors, dethroned kings, and persecuted the French heretics with fire and sword to extermination, looked for the helpless and sick in the streets and saved illegitimate babies from their watery graves. Guy de Montpellier's creation, the Order of the Holy Ghost, did not remain long in its original condition. Pope Gregory X (1271–'76) subjected all the houses belonging to the order to the one located in Rome, the first step in the attempt at depriving the order and its hospitals of their secular supervision. It was finally disposed of by the bull of Pope Sixtus IV, of the 21st of March, 1477. Meanwhile and afterward the order spread over all Europe. With its increasing wealth and power it degenerated in the seventeenth century. Though clerical by name, it was the most secular of all the institutions of dissipation. Grand-master and officers lived on the fat of the land and their immense income. In vain Louis XIV attempted to abolish it. The only change French royalty could work was its transmutation into a royal order. In some of the provinces laymen had succeeded, however, in controlling the management. Thus it was in many parts of Germany, where, between 1400 and 1600, several of the institutions belonging to the order were secularized. In Italy, however, the Order of the Holy Ghost remained exclusively clerical. As late as in the beginning of the eighteenth century it had great possessions in Europe and the West Indies.

The Order of St. Elizabeth was founded in 1225 by Elizabeth, daughter of Andrew II of Hungary, and wife of Landgrave Ludwig of Thuringia. Women need not complain that domestic virtues do not warm more than their own home, and do not immortally challenge the admiration of posterity. Her name will never die, when many a great warrior's memory will be buried out of sight. She founded two hospitals in Eisenach, and another in Marburg, into which the twenty-two-years-old widow retired. The rule was to nurse the female sick only. But when Francis-Joseph and Windischgrätz (*par nobile fratrum*) let loose their Croats over unhappy Vienna, in our own times in 1848, the Sisters of St. Elizabeth were in the front ranks bringing aid and comfort.

In 1171 the orders of St. Protais and St. Gervais were founded in France. About the same time, the houses in Roncesvalles and Burgos. In 1409 José Gilaberto established an order in Valencia for the special purpose of nursing the lunatic.

Those I have mentioned, with several others, were orders founded by the Church, or whose supervision soon became clerical. Those which, though all of them were anxious to submit to the Church, for spiritual reasons, succeeded in retaining their autonomy, must be credited with more real success in accomplishing their ends. Among the first we have any information of is the order of St. Catherine. Its members nursed poor and strange women and girls three days, and buried those who died in prisons or in the streets. In those good old times to which many dissatisfied hearts of to-day look back with longing eyes, those good olden times with their innocence, simplicity, and piety, this dying in the street was of common occurrence, and the Sisters of St. Catherine had plenty of work. We have not only accumulated seven more centuries, but gained more safety, more comfort, and more confidence in the future of mankind.

In the Hôtel-Dieu, the immense Paris hospital, thirty-eight men and thirty-eight women served as nurses. The places were, in later centuries, filled by Sisters of Mercy.

The Brothers of Mercy were founded in 1534 by Juan di Dios (John of God) in Granada. They were laymen, entered the order at between eighteen and thirty-one years of age, and nursed the sick of every faith and creed. Within a hundred years they possessed 18 hospitals, and there was a time when in Spain and the West Indies they had 138 hospitals, with 4,140 beds, and 47,000 sick annually, and in the rest of Europe 155 hospitals, 7,210 beds, and 150,000 sick. Twenty-five years ago they had in Austria alone 29 hospitals, with 20,000 patients.

Of similar character were the Obregons, founded about 1600, with their complicated duties of nursing the sick, praying, and repenting. This multitude of duties must have crippled their efficiency; they can not compare with the Brothers of Mercy.

The "Bons Fils" (Good Boys) were founded in Flanders in 1615. They were tradesmen, with the duties of nursing the sick, mainly the alienated in their homes, and giving elementary instruction.

The Confraternita della Perseveranza was established in Rome, in 1663, for the purpose of caring for the strangers in the taverns.

The Order of the Sisters of Mercy was founded in 1617 by Vincent de Paul, a preacher. In a sermon he placed before his congregation the case of a poor and sick family, urging their co-operation and sympathy. Enthusiasm and much zeal were roused, and a noble and gifted woman, Louise de Marillac, the wife of Legras, the secretary of Mary of Medicis, enlisted herself at once in the service of that family and of many equally indigent. She and her friends worked both in private residences and in hospitals, and were soon recognized as an order. As early as 1636 a house was founded for the care and education of children and women, a foundling hospital was established, and a home for the alienated in 1645. Her order owned, after a single century, 290 stations, and had 1,500 members, who entered between the ages of eighteen and twenty-four, bound themselves for life to the order and the Church, and worked in hospitals and private residences, in the interest of both women and men, in rescuing fallen girls and educating the young. In Rome, mainly in this century, they assisted those taken with infectious and acute diseases who could not be admitted to the public hospitals, and everywhere they attended the chronic cases of sickness of all denominations. Their foothold in Germany dates from this century only. Their greatest adversity was the all-purifying thunder-storm, the French Revolution. Many emigrated to England, but during the Napoleonic wars their services were so much appreciated as to procure for Sister Martha the cross of the Legion of Honor.

All of the orders mentioned were composed of Catholics. Not one of them but was intimately associated with the Church. In this connection it ought not to be forgotten that all the culture and knowledge of the mediæval period was confined within the limits of the Church. Within its fold the whole progress of mankind, slow though it was, toward humanistic evolution, was developed. Thus the efforts of the Catholic Church in favor of the poor and sick must be duly appreciated, the more so, as the so-called "Reformation" party exhibits nothing but blank leaves in the history of ethical and humane development. The revolutionary movement prepared by powerful minds for centuries, and finally carried out by Luther, did not result in any good to the sick and poor for a long time. Indeed, the success of the Reformation was in part due to the greed of German princes, who gained a rich harvest by appropriating monasteries, hospitals, and all other possessions of the Catholic Church. Thus the Lutheran Church, or churches, were left so poor that if they *had* the will they had not the *power* to make any pecuniary sacrifices in the interest of the poor and sick. But *even that will* they had not, could not have. For the first axiom in Luther's doctrine was this, that *not work performed, but faith only*, made the Christian. That doctrine was a long stride backward; it fired the imagination of some bigots, chilled the hearts of most men, sustained the egotist, and created dissensions. Never was there a greater failure. The poetry of the Church gone, its efficiency gone, that was the "reformation." Not until some decades ago did we know of Protestant unions established on the plan of their Catholic predecessors. But the *male* orders never tried to imitate the useful example of the Catholics. *They* did not care for the sick or the poor. *Their aim* was and is "home-mission." *They* are replete with faith, distribute Bibles, and glory in the conversion of that Jew who was baptized, once or often, half a dozen years ago, for ready cash. The women, as always, have done better. Their hospital orders, mainly the Deaconesses, have done good work this half-century, both in public institutions and in private. During the war-times in Germany they and other associations established on similar plans did good work, and deserve all the praise bestowed upon them. Their recognition was complete. Princesses joined hands with them—the Archduchess of Baden, Princess Alice of Darmstadt, the Empress Augusta. And not only in military hospitals did they earn deserved praise. Some general hospitals, such as the Augusta Hospital in Berlin, derive great benefit from their incessant and intelligent labors. I do not mean to stint praise, and therefore make this statement of their work, which has been performed under apparently great difficulties. These difficulties are the very rules, for instance, of the Deaconesses of Kaiserwerth, from which I quote for your edification the following introductory paragraph:

"The Christian women who wish to undertake the office of a nursing sister, as deaconess for the sick and poor, must possess a somewhat advanced Christian knowledge. Mere church-membership, mere attendance on Christian assemblies, and reading of Christian works of edification, are not enough. The love of reading the word of God, and a diligent use of the same for a long time past, must exist, as well as a knowledge of the more important histories of the Old and New Testaments. There must also be a knowledge of the sinful heart from their own personal experience, as well as experience of the grace of Christ, in order that they may have learned to despair of themselves, and in their weakness to trust only to the strength of Christ. A Christian walk of life must for a long time have adorned such Christian women," and so on, and so on. You will admit that in the face of so much hyper-religious sentiment an active, unselfish, modern woman must feel bewildered.

After all I have said, it is evident that the cause of humanity was originally not hampered by the efforts of the Catholic Church. On the contrary, many centuries ago it was the only safe deposit, inasmuch as the Arabs lost their importance in humanistic evolution from the fourteenth century, for the gradual development of human feeling. But that human feeling was not fostered and protected because it was human; the Church had but one purpose, the aggrandizement of the Church. The latter has a meaning in the case of the Catholic Church, which is at least a union, and has a uniform standard, which

Protestantism never had and never can have. The latter has, in its imitation of the ways and words of the mediæval rules of Catholic orders, proved one truth, and I emphasize that because here is the great difference between church nursing and modern nursing. "Clerical care of the sick is destined, under the rules, to serve the Church, whatever that may mean, while serving the sick; the main duties and aims in view are ecclesiastical, and not humane, and, instead of a nurse solely given to the performance of her duties, you deal with ecclesiastical officers" (Virchow). And the necessity is clear, that whatever organization is deemed advisable in the interest of the sick, that organization ought to be in our times *un*ecclesiastical and unsectarian. I have alluded to the fact that whatever medical knowledge existed in the masses centuries ago did so through the medium of the clergy. That knowledge was but trifling, for the ancient medicine of the Greeks and the more recent labors of the Arabs were sealed books at that time. But, then, the clergyman was the doctor. Instead of being so at present, we are daily met with the fact that the exact tendency of modern medicine is an unknown territory to the clergy, and that among them the upholders of all sorts of doubtful practices find their most sincere supporters. Medicine is to them a matter of faith, not science. It is not necessary to refer to that Brooklyn impostor whose criminal career has been detailed but lately in the secular press. For no church and no denomination must be held responsible for his methods of fleecing the ignorant and credulous. But the instances where actual clergymen assume responsibilities beyond their clerical powers and duties are also very numerous, and the protection by the Church of a regular monk in a Jersey monastery, who, in the church of his own institution, plies his nefarious trade of laying on hands, and exorcising the devils of disease for cash, these ten years, proves to what extent faith can be abused and the essence of religion distorted. We still live in a time when mediæval ignorance and modern enlightenment appear to find resting-places side by side. That the latter is getting the upper hand, after all, this sketch will prove, I hope, for even the mediæval organizations in the interest of the poor and sick, which I was anxious to estimate at their full value, have finally failed ignominiously. Almost every large society of the kind would degenerate in the end. The uniform report concerning most of them, mainly the male orders, is this, that with increasing power and wealth the original unselfishness of the founder disappeared, the actual work was left to low servants, the wealth of the community was accumulated in the Church. Thus it was that every great calamity sweeping over the lands was a source of riches to the Church. Never was divine blessing more visible in the Church than when half the population of Europe succumbed under the destruction of the "black-death." Never was more business shrewdness developed by "fathers" and "brothers" than when a patient, sick with leprosy—much less contagious than was made out by those who had an interest in exaggerating its dangers—had to give up half his property before being permitted to bury himself for life in the out-of-town places provided by the Church. The omnivorous taste and good digestion of the Church have become proverbial.

The majority of the clerical associations having failed, the seventeenth and still more the eighteenth centuries were far behind former periods in regard to systematic nursing. It has taken a long time between the church institutions, which no longer came up to the intentions of their founders, and the spontaneous efforts of free men and women who felt the necessity of appropriate efforts on a different basis. The history of this slow evolution is very interesting; it is the co-ordinate of the history of a healthy and wholesome individualism in general, after long indifference and chaos.

Schools for training nurses were established in Germany fifty years ago; in Berlin by Dieffenbach, Kluge, and Gedike, and in Göttingen by Ruhstaat. Books to serve the purpose of instructing nurses and the public in general have been written by numerous men and women, some of them, particularly in our days, by celebrities. Gedike himself published a work, fifty years ago, which is a very readable one even now. Passing by Nightingale, who has proved how to become immortal without enjoying high office, or playing on cannon, or tyrannizing nations, or being borne on a throne, let me allude to but a few illustrious names: Nothnagel, who wrote on the nursing of those sick with nerve-diseases; Billroth, who published a book on nursing in general; Esmarch, who taught the first aid in emergencies; and the greatest of the many great men of the century, Virchow, with his many contributions to the literature of the subject, and mainly, in 1869, with a lecture "On the Instruction of Women in caring for the Sick outside the existing Ecclesiastical Organizations."

This instruction of women in caring for the sick, and the relation of women to nursing as a profession, can be considered from two distinct points of view: first, in its influence upon them; second, in its effects upon the public.

The first consideration is a very important one. The opposition to women stepping out of their sphere, which was meant to be cooking and washing, knitting and darning, begging alms and taking a daily whipping, also getting married and raising a family, has been overcome by common sense and habit. Common sense ceased to understand why or how every woman could or should cook and wash, knit and darn, beg alms, or get whipped or married. And habits are formed and reformed with such rapidity that opposition becomes changed into favor in a few years. It is but little more than a dozen years since women physicians were recognized by the profession; not over half a dozen years since you heard of women lawyers. The female part, and, for that matter, the male part of my audience also, are sorry they heard so much of a woman lawyer in a Western town. At all events, the opposition to the attempt at widening woman's sphere, or spheres, has ceased, and the recognition of the principles of equal rights, no matter for what color or sex, or previous servitude, is all but universal.

You will not care to go into the question now, whether law or medicine will ever be resorted to by women to any great extent. The entire liberty given them has proved already, will prove more in future, that neither law nor medicine is an appropriate vocation for any but an exceptional class of women, and that the opposition to women practitioners of law and medicine will come less from the professions than from the public. For the public will never admit that a person in the practice of a profession should not give his or her entire attention and strength to it, and the women of the country will never admit that the superintendence of a home and the proper raising of a family are not sufficient employments of all the time and all the powers of the most gifted woman. The amateurs are losing ground. Thus it is that the professions will never be overrun, and the fear of undue competition has long died out, even among the most chicken-hearted braves of the professions. But the question is not how many women will avail themselves of the opportunities granted, but whether they shall have those opportunities, and whether these shall be given the women of all walks of life, of all standards of intellect. And the question has generally been answered affirmatively, to such an extent that it is considered self-understood that, while the mediæval ages attempted to help them as much as possible, modern times prefer to give them the power to help themselves. In regard to nursing, attention was called early to the unmarried and poor among the women. The statistics of Berlin, of the year 1872, proved that every third woman had to provide for herself. It was remarked with surprise that, of 407 such helpless and breadless creatures, but a single one went into nursing as a business. In other Continental cities it was still worse. In Vienna the shiftlessness of women was still greater; misery and poverty reigned supreme, as must be expected when you learn that a woman who took the making of her own clothing, even *with the aid* of a professional seamstress, into her own hands was punishable under the law.

The proportion of but one nurse to 407 women, who had to work for a living, is remarkable, it is true. For are not nursing, and caring, and attending implanted in woman's nature? What is the reason that so few went into nursing as a business, if not a vocation? Probably, because the women felt, or the public made them feel, that without careful preparation no nurse, or *soi-disant* nurse, can be efficient. We have still the remnants, I fear numerous ones, of that self-made class of nurses among us. In my own recollection of far-away years I remember a great many, and a great many, I was told but lately, remember me also, perhaps too well. Some of you may have seen them—in other people's houses—wrinkled prematurely, thinned out by temper, contrary by nature, or for the most part fattened in the course of their (to them) useful career, complacent, and drowsy while everything was going well, incompetent and snappish when danger required work and sufficiency, always ready to have their regular meals served up-stairs by the help of the house, who breathed freely when they finally left, and always willing to spend their time between rocking a baby, speaking of their long experience, sleeping ten hours, talking gossip all day long, and drinking eleven cups of coffee in the twenty-four hours. This is hardly an exaggeration, for the number of women who took up nursing as a business, driven to it by some natural disposition, gifted with some intellect, modest and willing to profit by superior knowledge and experience, interested in the welfare of their patients, and never stunted in their human feelings by the force of habit, was rather small. But I am glad to say I knew such, too. I gladly shook their hands when I happened to meet them on a common errand, gladly recognizing the diploma they carried in their brains and hearts. But these exceptions proved the rule, and the rule conveyed no blessing. It was, it is, a sad fact that nursing all over the world grew worse in just the same time when medical science grew more exact and medical practice more effective.

Relief in this city came none too soon. The president has detailed to you the history of the training-schools of New York. Since their time the practice in hospitals and in private dwellings has changed wonderfully. After thirty years' work in the city, after twenty-five years' constant labor in public institutions, I ought to know the difference. And I do know and publicly proclaim that the results of the best of physicians have vastly improved since their cases have been in the hands of trained nurses. This is so in private dwellings; it is the same in hospitals. In the hospitals the difference can be measured on a large scale. In them the trained nurse has worked a vast improvement.

Every large hospital ought to perform a double duty. It must give the poor patient, and many rich also, the best possible chance of recovery from sickness. It can afford to accomplish that, because of its pecuniary and intellectual means. Though a hospital be poor, there ought to be, there generally are, means enough to fill all the necessities required. And the intellectual means are expected, are supposed to be, above the average of the general practitioner. There are a great many reasons why that should be so, why hospital places should be open for the competition of the best material among the medical profession, recognized to *be* the best by the medical profession *itself*, and why family and personal influence should not fill places which are better not filled at all than with indifferent or bad material. A hospital must also grant the best possible nursing—attached, wakeful, careful. All this is due to the single patients.

A good deal more, however, is due to the public at large. A hospital looking for the interest of the single patient only might just as well be a private institution, a *maison de santé* for the benefit of a landlord. The benefit derived from hospital treatment by a sick person is not all the satisfaction due to a public who pay four hundred dollars a year for every bed. Nor are the public paid sufficiently for their sacrifices by the accumulated experiences of a few physicians, who enjoy the large field of observation and the opportunity of utilizing it for the benefit of private patients. Every hospital which neglects to increase the stock of medical knowledge, and to give an opportunity of learning the theory and practice of nursing and caring for the sick, performs its duties but half, and serves the public but incompletely. Every large hospital must be, and will be, a clinical school, and a school for nurses. It will be acknowledged that as the presence of a nurse in a sick-ward, who is sent there to learn, is considered unobjectionable, the presence of a few physicians observing a case, which can not be injured by their so doing, is not only not injurious, but ought to be demanded by the public, who have a right to expect a physician in their own families who has seen and knows and understands what he is called in to treat. I do not see why hospital patients only should have the best money and service can afford, and why the public at large should have to fall back in many cases on untried skill. Thus the people have a right to demand that every large hospital should have a clinical school, and a training-school for nurses. The public, who are willing to pay for it, may also demand that the expenses of the same, particularly the nurses' school, should be borne by the hospital. This demand, if considered theoretical only, must stand as long as a hospital is, or claims to be, a public institution. When the board of directors of any institution will recognize that they are not the administrators of the dollars of a small concern, but the benefactors of the public at large, they will also appreciate not only that a few disinterested ladies will open their pocket-books, and collect voluntary contributions, but that a generous public will pay more willingly and more largely.

The demand that a large hospital should be a clinical school and a school for nurses, and that the expense should or might be borne by the institution, is not valid in the case of city or commonwealth hospitals only. Most of the hospitals of the country are originally private institutions. They obtain the character of being public affairs when an always increasing number of men and women become interested in and contributors to them. An institution with one or two thousand paying members represents ten or twenty thousand families —in fact, represents a city. And what it represents, of that it assumes the rights and duties. And the main duty the public at large will soon know how to enforce from the directors of every large hospital is, to administer the public domain to the greatest possible advantage for the greatest possible number. The selfishness of an individual adversary, the animosity of evil-spirited persons will never weigh, ought never to weigh, against the public good; the latter only is the object of those who are placed in trust of money, institutions, and the public welfare, because of their actual or supposed public spiritedness and superior intellect.

Is it necessary to detail the advantages of the services of a trained nurse over those of an untrained one? The latter class, as a rule, brings to their work no previous education, no theoretical schooling, no technical experience. They come mostly from inferior walks of life, with less intellectual power, and less moral force. Only those who come from better stock, and raise themselves to higher ambitions, will spend money, and two years of their lives, for the purpose of learning both theoretically and practically the art of relieving the sick, aiding their comfort, taking responsibilities which sometimes are as difficult as they are life-saving, and obeying orders with intelligence and understanding. That such persons are valuable additions to our hygienic requirements and sanitary progress everybody can conceive. That without them many a case would not recover, in spite of the most competent medical skill, all of you may have experienced. I, for one, know from personal experience that many a case can be, has been saved, first by the medical orders; secondly, and often mostly, by the execution of orders, such an execution as is rendered possible by combined knowledge and skill only. If I say that we practitioners have commenced to feel safe in regard to many of our cases only since we could rely on the co-operation of a trained nurse, I express but a common observation. I trust that there are households within hearing which know how to appreciate the services rendered them by a trained nurse.

So much only in regard to individual cases. But the service to the public at large hitherto rendered, and constantly increasing, is of a different and still more important nature. Who is nowadays the teacher of the public at large in sanitary matters, in hygienic rules? The knowledge of the Church, when *it* nursed, was faith, and, let us add, in its best times, love. The knowledge of uneducated women was, and is, ignorance driven to actual or alleged work by starvation. The knowledge of a trained nurse is the result of a two years' study under competent teachers, and a constant practice. Who in the community is her superior in the knowledge of the facts mostly necessary for the health and life of your children, and dear ones in general? The clergyman is no longer the teacher of the mysteries of life and common sense. The schoolmaster or schoolmistress knows about the classics, geography, and arithmetic, but no normal school ever taught them the elements of applied physiology. The educated member of any profession except the medical has not the slightest idea of the necessities of the body, the action of food, the effect of clothing, and the hundred facts required by different ages, conditions, and states of health. With the exception of the physician, whose advice is frequently sought only to repair the effects of ignorance, the only teacher the public have, and will have, is *the trained nurse*. Ten or twenty families may enjoy her presence annually, ten or twenty mothers will learn simple and important truths, knowledge will increase, and prevention of disease will become a possibility. Enjoyable and useful as the service of a trained nurse is in an individual case of sickness, her services to the community are very much greater, by virtue of her theoretical and practical teaching. May I tell you what a good trained nurse may teach, and can teach? How to recognize a fever, how to compare the local temperatures of the several parts of the body, and how to equalize them; she knows that ever so many feeble children might have been saved, if but the feet and legs had not been allowed to get cold; how to bathe, when, and when to stop; how to regulate the position of the head—I remember quite well the case of inflammatory delirium which would always be relieved by propping up the head—how to treat intelligently an attack of fainting; how to render cow's milk digestible by repeated boiling, or lime-water, or table-salt, or farinaceous admixtures; how to feed in case of diarrhœa; how to refuse food in case of vomiting; how to apply and when to remove cold to the head; how to ventilate a room without draught; and a thousand other things. She will also use her knowledge and influence in weaning the public of nostrums, concerning which hardly anything is known except what you have to pay for the promises of the label. She will break the public of the indiscriminate use of quinia, with its dangers possibly for life; cure you of the tendency of making the diagnosis of malaria the scapegoat of every unfinished or impossible diagnosis; she will teach you that the frequent and reckless domestic use of chlorate of potassium leads to many a case of ailment, to chronic poisoning, possibly in the shape of Bright's disease or to acute poisoning with unavoidable death. These are but very few of the things she can do, and but a little of the knowledge she can not but distribute. With the aid of the class of women who frequent our training-schools, the public at large must and will gain, in a short time. Let the number of the schools increase, and increase the number of pupils, and every one of them will be a teacher and an apostle of sound information on sanitary and hygienic subjects. And let nobody leave this place to-night without intending to aid an institution as helpful as this.

Will the pupils come? Certainly they will. There is an increasing demand for their services. Many times had I to wait a day or two before any of the schools could accommodate me. There is no fear that there ever will be too many good nurses. There is fear, either, that many persons of inferior intelligence and morals will present themselves for or obtain admission to a school. By attending the suffering, it is true, many a crude or brutal nature is ennobled; but I should not advise to run the risk of admitting that class at the expense of the sick, or of a rising and beneficent profession. The occasional specimens of cold-hearted and arrogant persons one is apt to meet, even among trained nurses, must discourage the admission of any but the very best. These *will* apply. The calling is an honorable one, it promises a competence, it corresponds with the innermost nature of woman. It is not true that the Church alone could raise the enthusiasm for hard work, the performance of arduous duties, and self-sacrifice. One of the first nurses I had in my division in Bellevue Hospital, many years ago, was an accomplished girl, the daughter of a rich man in the far West. After a year and a half it took all the influence and begging of her family to take her away from us and her hard work among the poorest of the poor. The large number of ladies, wealthy and accomplished, who work assiduously and regularly under Felix Adler, and in other places, under our very eyes, prove that the very best class of society can be prevailed upon to do the hardest and most beneficent kind of work. And the fact that the *élite* of the women of the city are willing and anxious to undertake the arduous task of founding and supporting training-schools, in the face of all sorts of difficulties, proves also that the work is in accordance with the requirements of both woman's nature and humanity. There will be many trained nurses who will work for humanity's sake, as centuries ago they claimed to serve for God's sake. Many a woman who would have buried herself in a monastery centuries ago, driven from the face of the living earth by misunderstood and unsatisfied longing, I believe, would nowadays become a nurse, knowing and enthusiastic.

Ladies of the graduating class: The remarks I was expected to make have extended into a lecture. You have been used to lectures, however; if you had not enjoyed them, and profited by them, you would not be here to-night, the most honored and most conspicuous of this assembly. Thus I thought I might be permitted to speak, instead of to you, of you, and your chosen calling and its history. From nothing can any profession derive so much advantage as from the history of its development. It is certainly an interesting spectacle to see how your profession depended intimately on the changing conditions of thought and feeling among mankind. You are happy enough to live and work in a time when, while following individual tastes and having individual motives, your labors are given to the suffering for no outside reason, no church command, but from the free choice of free women in the interest of humanity. I had also to allude to several subjects which may to some appear a little outside the legitimate domain of your ambition and duties. You know better. An intelligent woman will not spend two of her young years in acquiring a certain knowledge without enlarging her horizon in general. You have chosen a profession as noble and as deserving as any there is in existence. You will be the interpreters and right hands of the physician, and the connecting link between the physician and not only the single patient, but also the public at large. My opinion of the services you can render is high, but I trust not exaggerated. When your numbers shall increase, and the character of those who are admitted remain of the same standard, your importance will grow. In your hands will, to a great extent, lie the opportunity for removing prejudices, spreading knowledge, healing and preventing disease. Even those of you who will not always consent to serve in *other* people's homes, will, by example and by teaching, remain in close alliance and co-operation with such as intend to remain in the ranks forever. As you now mean to leave us, endowed with the certificate of the required accomplishments, I can only add, while offering my best wishes for your future, that I trust you will never forget the place which gave you so ample opportunities for perfecting yourselves. You will never forget the gentlemen who taught you, nor that accomplished young woman who impressed all of you with the fact that the charms of womanhood will not suffer from hard work, from a classical education, and thorough medical or other knowledge. Do not forget, also, at the beginning of your independent career, the ladies to whose care and sacrifices and labors you owe the existence of the school which sends you forth as its first graduates, nor the great charitable institution which, after having given you your practical training, honors you to-night by the presence of many of its officers, and designates its president to deliver to you your diplomas.

CLOTHING AND THE ATMOSPHERE.

By M. R. RADAU.

CLOTHING is a kind of armor to help us in the battle against the elements, the importance of which increases with the rigor of the climate which man inhabits. The house may be regarded as an amplified clothing, to be used less constantly, but as more enduring than other clothing, and capable besides of furnishing a full shelter. Both clothing and the house have been invented to protect us; but a very common error, which has given rise to many mistakes, has been to regard the house and the clothing as designed essentially to isolate us from the external air. The truth is, that they are simply regulators of our indispensable and constant relations with the ambient atmosphere. These relations can not well be comprehended unless we take account of the complex phenomena by which the temperature of the body is kept up in the midst of the most diverse influences. We know that animal heat is produced by chemical changes that are accomplished in the tissues, and principally, but not exclusively, by the combustion of the food which is assimilated and brought into the circulation, where the inspired oxygen transforms it into alcohol and carbonic acid. This combustion raises the temperature of the blood, and the warm liquid, which penetrates everywhere, warms the organism almost in the same way that a house is heated by hot-water pipes. The activity of respiration and the consumption of oxygen are diminished during sleep, but increased in taking exercise, when a part of the heat produced is transformed into mechanical work; but, from birth to death, man continues, without ever wholly resting, to draw the breath that keeps up the fire of life.

Notwithstanding this incessant production of heat, which may be increased or diminished, according to circumstances, by as much as fifty per cent, the temperature of the body continues almost invariable. In health it is always about 98°, and seldom varies as much as 2°; and yet we know that in some regions of the globe the monthly means of external temperature present variations rising to more than 115°, with much wider divergences in extreme cases. In parts of Siberia the extremes range from 70° or 80° below zero to 80° or 90° above; temperatures of from 120° to 130° have been remarked in hot regions in Australia and Asia; and men have been able to support much higher temperatures than these for a short time — Blagden 259° for seven minutes, and a certain Martinez, by wrapping his head in cloth, 338° for a quarter of an hour. Under such excessive heats, the temperature of the blood may rise a few degrees higher than its ordinary extreme; but such cases are abnormal.

Constancy of bodily temperature is an indispensable condition of health to warm-blooded animals. By what means does Nature supply deficiencies of internal heat and eliminate an injurious excess, and, in either case, restore the organs to the temperature which is most agreeable to the regular performance of the functions of life? The means are various. When food becomes insufficient, calorification is effected at the expense of the tissues of the animal, and it grows lean. When heat is produced in excess, the organism rids itself of it speedily by several outlets. The body may be cooled by radiation, by evaporation, or by conduction or convection. It is estimated that radiation generally carries off half, and the other two ways a quarter each, of the surplus heat. These ratios are, however, far from being constant; they vary with external circumstances. Evaporation is the valve that regulates the loss of heat, by completing, at a given point, the action of conduction and radiation.

The intensity of radiation, by which heat is dissipated from the body around, is proportional to the difference between the normal temperature of the body and that of the surrounding medium, and increases in the neighborhood of a very cold body. We may in this way explain the chilly sensation we feel and which persists in a room that has not been used for a long time, after the fire has been kindled, and even after the air in the room has become quite warm; while, after the room has been well warmed up, we may feel quite comfortable in it, even with the air at a lower temperature than that in which we were previously chilly. In the former case the walls and the furniture were still cold and abstracted so much caloric as to provoke radiation from the body. The loss of heat becomes less and the sensation of cold disappears as soon as the objects around have become tolerably warm. This also explains why it is dangerous in winter to stay long near a wall or a window where one side of the body is exposed to be cooled by excessive radiation.

For a similar reason we feel too hot in a room full of people, even when the air is only moderately warm. The presence of a considerable number of persons prevents radiation, and the excess of heat can be carried off only by currents of air, or by a more abundant transpiration. We fan ourselves to expedite the cooling by convection and evaporation, by bringing more air in contact with the skin ; and if we leave the room when we are nearly smothered, to go out "to take a breath" in an empty room, we shall be astonished to find by the thermometer that the temperature of the two rooms is nearly the same ; only that radiation is free in the empty one. The agreeable refreshment the shadow of the woods gives us is due to the relatively low temperature produced in the trees by their faculty of evaporation, and the facility it affords for promoting radiation from the skin. The body is also cooled by convection, or by giving off its heat to the air that bathes it, and this loss is more sensible in proportion as the air is cooler and more frequently renewed. The atmosphere is always in motion, even when apparently most calm ; and thousands of its movements escape our senses, because they are not strong enough to impress our organs. These ceaseless motions, it must be clear, contribute greatly to the cooling of our bodies ; but the effect is most marked in the open air, when we are exposed to the action of the winds. In our climate, the average velocity of the atmospheric currents is about ten feet a second, or seven miles an hour. Supposing that the extent of the surface of the body exposed to the currents is one square metre, there pass over a man walking out for an hour about eleven thousand cubic metres of fresh air. In hot climates we seek the shade, not only because the air under it is fresher, but also because it has more motion, in consequence of the differences in density arising from the unequal heating. Notwithstanding all the devices that have been contrived for the reduction of temperatures, it is evident that civilization is possessed of more varied and efficacious means of contending against the cold than of mitigating the effects of the heat. It is for this reason that the European finds it so difficult to acclimate himself under the tropics. The Hindoo reduces his internal calorification by eating little ; but he is at the same time defective in energy, and has extremely little capacity to work. Assiduous labor exacts a large quantity of food, while an excess of surplus heat simultaneously results from it ; for the organism can convert into mechanical labor only about twenty-five per cent of the increase of heat which it produces under a sustained effort. The problem we have to solve is not to seek for a way of producing less heat, but to find a means of getting rid of that which we do produce.

Water is a much more effective refrigerant than air, because of its much greater conductibility; at the same temperature, a bath of water will refresh one more than a bath of air; but baths are necessarily of limited use. The important matter should be to diminish the temperature of the air that comes in contact with the body.

We have next to consider the effect of evaporation through the lungs and the skin. When the thermometer indicates more than 98° in the shade, the body can no longer be cooled by contact or by radiation, and only a single way is left by which the surplus heat can be dissipated. It can only expend itself in vaporizing the water which transpiration carries to the skin and to the mucous membrane of the respiratory apparatus. The lungs, as a rule, exhale about half as much water as is excreted by the skin. Both together remove about a kilogramme of water every twenty-four hours, disposing of as much heat as would boil five quarts of water; but the quantity of water and of heat removed in this way may be doubled and even tripled when all the channels of transpiration are fully opened under the pressure of an excess of internal heat. The vapor disengaged by these operations is absorbed by the surrounding air with a facility proportioned to the dryness of the atmosphere, or to the degree in which it is removed from the point of saturation. There is a limit at every degree of temperature to the proportion of vapor which the air can contain; and the interval between the points of dryness and of saturation increases with the temperature. An atmosphere at the same time very moist and very hot seems heavy to us because it hinders the evaporation of the water that transpiration brings to the surface of the body. This is why hot and moist climates are so much more unhealthy than hot and dry ones.

When the internal calorification is increased in consequence of violent exercise, the excess of sensible heat is eliminated by a more intense radiation, by ascending air-currents, and by a more abundant transpiration; it thus happens that after several hours of sustained effort we sometimes observe a slight cooling of the body, an effect which is the result of a too rapid using up of disposable materials. Hence, to cite the illustrations given of this fact by M. Bouchardat, dogs, which have run long at the hunt, and the overworked and exhausted children in the Belgian coal-mines, returning to the lodge or to their home, first of all things, before even satisfying their hunger, stretch themselves before the bright fire for warmth.

Thus the means of refrigeration at the disposal of Nature are quite varied; they complement and replace each other according to circumstances. But it is necessary to avoid the too abrupt changes which would surprise the system while it is in the process of accommodation. "The organization," says Dr. Pettenkofer, "is a prudent and faithful servant, which will deliver itself and its master from trouble if it is given time to set itself right and is protected against rude treatment." The body, even when exposed stark naked to the air, is not wholly without defense against heat and cold. It can, up to a certain point, itself regulate the expenditure of caloric by the intervention of the vaso-motor nerves that go to the capillaries of the skin. Cold provokes a shrinking of the little vessels, and, restraining the peripheric circulation, diminishes the radiation and the transpiration to such a degree as to protect the internal organs for a considerable time. Heat, on the other hand, dilates the vessels so that the blood flows to the surface and the caloric is in a certain way driven out. Unfortunately, this automatic regulator, the play of which is commanded by the nerves, is too easily disordered and its springs are too easily relaxed. We can doubtless fortify it by exercise, harden ourselves, and habituate the body to support inclement conditions ; and there are peoples and persons who have done wonders in this direction ; but the hardening process works under limitations, and its results are not within everybody's reach. The real regulators of the heat of the body are clothes.

The thinnest veil is a vestment in the sense that it moderates the loss of heat which radiation causes the naked body to experience. In the same way a cloudy sky protects the earth against too great cooling in spring nights. In covering ourselves with multiple envelopes of which we augment the protecting thickness according to the rigor of the seasons, we retard the radiation from the body by causing it to pass through a series of stages, or by providing relays. The linen, the ordinary dress, and the cloak constitute for us so many artificial epidermises. The heat that leaves the skin goes to warm these superposed envelopes ; it passes through them the more slowly in proportion as they are poorer conductors ; reaching the surface, it escapes, but without making us feel the chills which direct contact with the atmosphere occasions, for our clothes catch the cold for us. The hairs and the feathers of animals perform the same function as toward their skin, serving to remove the seat of calorific exchange away from the body. The protection we owe to our clothes is made more effectual by their always being wadded with a stratum of warm air. Each one of us thus has his own atmosphere, which goes with him everywhere, and is renewed without being cooled. The animal also finds under its fur an additional protection in the bed of air that fills the spaces between the hairs ; and it is on account of the air they inclose that porous substances, furs, and feathers keep warm.

Experiments to determine the degree of facility with which different substances used for clothing allow heat to escape were made by Count Rumford, Senebier, Boeckmann, James Starck, and M. Coulier.

The results were not in all cases consistent with each other, but they indicate that the property is dependent on the texture of the substance rather than on the kind of material, or—as concerns non-luminous heat—its color.

The most recent experiments are those of Dr. Krieger, some results of which are cited by Dr. Pettenkofer. He observed the rate of cooling of a sheet-iron cylinder filled with hot water and covered by turns with different cloths. Wrapping it with successive envelopes of wool, buckskin, silk, cotton, and linen, and observing regularly the diminution of temperature in a given time, he found the differences insignificant, not exceeding one or two per cent. The color of the materials did not cause the results to vary any more. It appears, then, that in a dark heat the emissive power and the absorbing power, which is correlative with it, vary but little between one kind of cloth and another. The case is different when we have to do with luminous heat, or the solar rays. With envelopes of linen, cotton, flannel, and silk, M. Krieger observed that the absorption of solar heat increased in the proportions indicated by the numbers 90, 100, 102, and 108. The influence of color was much greater: with cotton goods of different hues he found the numbers to be—white, 100; straw-color, 102; yellow, 140; bright green, 155; dark green, 168; Turkey red, 165; bright blue, 198; black, 208. These facts explain why in the hot sun a black coat is warmer than a white one, while the difference disappears in the shade. The influence of colors on the absorbing powers of surfaces had already been made clear by the researches of Leslie and Melloni.

To form an estimate of the part which the conductibility proper of the different materials plays in these phenomena, M. Krieger inquired how much the loss of caloric was diminished when the cylinder was covered with double layers of the same cloths. The doubling of the satin, cotton cloth, and fine linen diminished the loss only by from three to six per cent, while doubling the envelopes of buckskin, flannel, and woolen cloth diminished it by ten, twenty, and even thirty per cent. It is clear from these experiments that the resistance offered by cloths to the passage of heat depends much less on the conductibility of the fibers that form their substance than on the thickness, the volume, and the texture of the tissues. This can also be shown in observing the cooling of a cylinder covered with wadding, which is forty per cent more rapid when the wadding is strongly compresesd. So a dressing-gown lined with wadding and a flannel waistcoat are warmer when we first put them on than after they have been worn for some time. The packing which the filaments undergo with use renders the cloth more permeable to heat. Although doubling the envelope has little influence when both layers are stretched tight over the cylinder, it is not the same when a slight space is left between them; then the cooling is retarded thirty or thirty-five per cent by the interposed stratum of air. Hence, we should expect in many cases to find a loose garment warmer than a tight one; and we know that close-fitting gloves or shoes afford but a poor protection against the cold. This reasoning, however, supposes that the protecting layer of air is motionless; but more frequently an ample and flowing garment favors the circulation of air, and therefore seems to us to be cooler, and is for that reason preferred in summer and in hot climates.

We are now brought to the important fact that the most serious obstacle to the propagation of heat in any body is the discontinuity of its elements. This is because heat is a mode of motion, and every derangement of molecular continuity impedes the transmission of vibrations. This principle is more or less unwittingly put to profitable use in the manufacture of clothing. We obtain very warm clothes from light, loose, and porous tissues, having a capacity to retain in the spaces between their fibers a large volume of air. I said, retain; I might more properly have said, let pass; for the air which our clothes inclose is not motionless, but circulates and undergoes constant renewal in filtering through the envelopes which we mistakenly believe are intended to isolate us from the surrounding medium. It is, in fact, an essential condition of a good garment that it shall not interpose an obstacle to ventilation. The warmest clothes let the air pass more readily than those which are considered cool. Dr. Pettenkofer demonstrated this fact by measuring the volumes of air which under the same pressure and in the same time passed through a series of tubes stopped by pieces of different kinds of cloth. The numbers representing the volumes were for the different goods: flannel, 100; linen, 58; silk, 40; strong cloth, 58; buckskin, 51; glazed skin, 1. Flannel is, then, a hundred times more permeable to the air than a glazed glove, and we know at the same time that it is infinitely warmer. The volumes of air transmitted are but little changed by doubling the goods. Our clothes are thus continually aërated by an exchange, the activity of which depends on the external temperature, the degree to which the atmosphere is agitated, and the porosity of the tissues; the essential point is that the change shall be so slow that the nerves of touch shall not be affected by it. The warmest coat is one of fur, and its warmth lies not in the skin only, but chiefly in the hairs, although their mass is relatively insignificant, and is almost wholly due to the air interposed between them. Furs are warmer in proportion as the hairs are finer, because, doubtless, the air that circulates through them is more thoroughly warmed. There are formed around the bodies of furred animals superimposed strata of air, the temperature of which diminishes from the skin to the ends of the hairs; and in winter the animals seem cold to the touch, while the zone of exchanges retires toward the skin as the cold becomes more intense. The body of the animal is, then, cooled principally by convection and by the ventilation which incessantly removes the heated air. When the atmosphere is much agitated the cold penetrates more readily through the furs, and also through our overcoats, as all know who have been much exposed to cold winds. According to M. Krieger's experiments, the loss of heat through the skin is doubled when the fur is shaved off, and tripled when the skin is varnished. These facts bring us to the conclusion that the goods called impermeable are generally anti-hygienic, because they impede the aëration of the garments beneath them. They are good for protection against rain, but they excite perspiration and prevent its evaporation, and are very uncomfortable in pleasant weather.

Another very important property in cloths is their hygroscopicity; they condense moisture from the atmosphere and become impregnated with it the more speedily as the air is more nearly saturated with vapor, and consequently less capable of favoring evaporation. The condensation, which is equivalent to a kind of dew, is increased when the temperature is diminishing. According to M. Coulier's researches, the water absorbed by a cloth may be divided into two parts: one part which is not perceptible to the touch and can not be pressed out—the hygrometric water proper; and the other part, that which fills the pores and can be wrung out, and which M. Coulier calls interposed water. According to his experiments, wool is more hygroscopic than hempen cloth, and linen than cotton. Dr. Pettenkofer compared the hygroscopic qualities of a piece of linen and a piece of flannel having equal surfaces and nearly equal weights. Having been previously dried at the boiling-point of water, the two pieces of goods were exposed together in places more or less moist, and the variations in weight they went through after several hours of exposure were measured. It was found that wool was nearly twice as hygroscopic as linen. Similar differences between different materials may be observed when they are wet by immersion. Linen gets wet much more speedily than wool, but the wool really absorbs the most water.

The quantity of water that cloths are capable of absorbing is evidently more considerable than is commonly supposed. A woolen coat weighing five or six kilogrammes may take up nearly a litre of water, and this will add a kilogramme to its weight. We see also that cloths absorb more moisture when the temperature is low than at ordinary summer heat. Wet garments conduct heat better than dry ones, and consequently give much less protection against chills; hence the danger of cold combined with dampness. But wool, although it is more hygroscopic than linen, protects better against the effects of humidity because of the slowness with which it absorbs and gives off water, and because of its indestructible porosity.

As we fill up the meshes and pores of a tissue, it becomes less permeable to air, and goods with close meshes, like linen, cottons, and silks, feel this effect much more quickly than woolen goods. As Dr. Pettenkofer remarks, the elasticity of the fibers counts for much in the persistence of porosity. The fibers of wool, even when moistened, lose but little of their elasticity and do not allow the pores to close, while the filaments of linen, cotton, and silk become quite soft under the influence of moisture, and do not resist the invasion of the water. For this reason damp wool cools us much less than damp linen. A linen or silken shirt is cooler than a woolen one, because it more completely sponges off the sweat and exposes it to evaporation. These facts illustrate clearly the capital influence which space between the fibers exercises on the physical properties of cloths. A cloth must evidently be considered as a tissue formed of textile matter and air. The properties of the fibers themselves can give us only the most incomplete ideas of the physical effects which their assemblage would bring about. The arrangement of the fibers and the manner in which they are prepared are most frequently the important points. There is reason to believe that by looking along this road, still so little explored, we shall reach results that will permit us to make a better use of some of the innumerable textile materials which Nature has put at the disposition of our industry.

Hygienists, in speaking of different cloths, are generally contented with classifying them vaguely in the order of conductibility, and of designating by that word the greater or less facility they offer to the passage of heat. It is agreed that conductibility decreases in the following order: linen or hemp cloth, cotton, silk, and wool. Cloths made of linen, hemp, and cotton, are considered the coolest. They are readily moistened and cool the skin by both conductibility and evaporation. Linen, whether made of hemp or flax, is, says M. Bouchardat, of all substances destined for clothing, the one that most favors the affections resulting from the impression of moisture on the skin. But with many persons the coolness and pleasant feeling of linen are very highly appreciated as advantages.

Cotton cloth lets less heat escape, absorbs and retains a part of the perspiration, and cools less rapidly by evaporation; its use is generally more advantageous than that of linen. An opinion or prejudice prevails widely that cotton is less healthful than linen, based on the fact that, being a less perfect conductor and rougher, cotton irritates the skin more than linen does. Examined with the microscope, the fibers of cotton appear angular and stiff, while those of linen are round and supple. Cotton is not agreeable in cutaneous affections, but wool, in such cases being more hairy and warmer, would be still more disagreeable. This is the only condition, says M. Bouchardat, in which any other substance than very fine, well-washed, and well-worn linen can be worse than it. Aside from this, cotton cloth has the advantage over linen of being warmer in winter, and, in summer, of not exposing the body to the dangers of too rapid cooling. It should be used in preference to linen by inhabitants of cold and moist countries. Wool is still more irritating than cotton, on account of the stiffness of the hairs with which it bristles; but the excitation it produces becomes a therapeutic means whenever the skin needs a stimulant. Unfortunately, its use next to the skin may become the source of the infirmities for the cure of which it is indicated when too effeminate an education has caused us to contract the habit of wearing it too early and without sufficient reason. It may cause a grievous predisposition to colds, rheumatisms, and neuralgias, while, the habit once acquired, it can not be given up without danger. But the use of wool is precious in some countries and under some conditions of life.

Professor Brocchi, a writer well known for his investigations in malaria, attributes the good health and vigor of the ancient Romans to their habit of wearing coarse woolen clothes; when they began to disuse them, and to wear lighter goods and silks, they became less vigorous and less able to resist the morbid influence of bad air. It was first at about the time the women began to dress in notably fine tissues that the insalubrity of the Roman air began to be complained of. Dr. Balestra, in his book on the "Hygiene of the City of Rome and of the Campagna," admits that there may be some little truth in these views, although the increasing unhealthfulness of the Roman climate was chiefly explainable by the abandonment of cultivation and the physical degeneracy of the people in consequence of the general change in the manner of living. At any rate, woolen clothing has a right to be considered an excellent prophylactic in countries infected with malaria. "In the English army and navy," says Dr. Balestra, "the soldiers of garrisons in unhealthy places are obliged constantly to wear wool next to the skin, and to cover themselves with sufficient clothing, for protection against paludine fevers, dysentery, cholera, and other diseases." According to Pâtissier, similar measures have been found efficacious to guard the health of workmen employed on dikes, canals, and ditches, in marshy lands; while, previous to the employment of these precautions, mortality from fevers was considerable among them.

The hygienic properties of wool are due, first, to a slight roughness of the surface that excites the functions of the skin; and, secondly, to its porosity, which, as we have already explained, moderates the expenditure of caloric and prevents a too sudden cooling of the body. Dr. Balestra believes that flannel contributes to the elimination from the body of the paludine miasms, which have been absorbed by the pores, and also to rid it of the deposits that cause rheumatic affections. The hypothesis is confirmed by the singular connection that seems to exist in miasmatic regions between rheumatic and intermittent fevers. Furthermore, woolen goods arrest in their down a portion of the germs borne in by the air which thus reaches the skin filtered and purified; Dr. Balestra has proved by direct experiments in marshy regions that thick and hairy woolen garments have the filtering power that is here attributed to them. It is hardly necessary to add that such clothing, to afford real protection, should be frequently washed. Cotton is next to wool in value, and is preferable to linen, because it gives a gentle excitation to the skin. Silk also has a warm feeling, and might be substituted for flannel in the winter; but it could hardly be worn next to the skin in summer, on account of the excessive heat it provokes. Dr. Balestra insists that it is best for inhabitants of unhealthy countries never to go out without being provided with a woolen cloak or blanket, to be used in case the weather should change. The ancient Romans wore ample over-garments over their tunics, and never put them away. It is no less important to be well covered during the night; and precautions of this kind should be recommended to all who live in a swampy country. We are sometimes astonished when we see the natives of particularly warm countries enveloped in woolen, as the Arab in his burnoose, or the Spanish peasant in his tobacco-colored cloak. Such materials protect both against the rays of the sun and against the coolness of the night, and are excellent regulators of heat. It is dangerously imprudent to travel in southern countries without provision of warm clothing.

The hat completes the dress, as the roof crowns the house. It preserves the head from insolation and cold, and protects it against accidents. Without going so far as M. Bouchardat, who says that the best head-dress is none, we content ourselves with remarking that the hat should be light and well aired. According to M. Troupeau's experiments, conical and rounded head-coverings are cooler than flat ones, and preferable in hot countries.

The bed is not only a piece of furniture indispensable to secure repose; it is also, in fact, a dress for the night. Like other articles of clothing, it should be both warm and permeable to the air. The heat which the body gives off to the mattress and the coverings is continually taken away by the air that traverses them. "Beds designed to regulate the flow of heat," says Dr. Pettenkofer, "are with us thicker than the garments which clothe us during the day, for two reasons: first, because, the circulation being less active during rest and sleep, less heat is evolved; and, secondly, because the ascending currents cool us more rapidly in the horizontal than in the vertical position, where they rise from the feet to the head, passing over the whole body." The heat of the bed thus favors the peripheric circulation and assists the internal organs that have to keep up the calorification. To do without a bed for several days in succession is a great privation, not only because it deprives the limbs of rest, but also because of the troubles to the economy it induces. A too hot and too soft bed is also objectionable because it keeps the body in a condition of moisture that enfeebles the muscular system and reduces all the functions. Feather-beds are generally more noxious than useful. They are warm on account of the air they hold; but an air-mattress should be as warm. Birds also clothe themselves in heat when they sleep, by ruffling up their feathers, putting themselves in the shape of a ball, and surrounding themselves with the thick strata of air included within the filaments of their plumage. We purpose in another article to consider the relations of our habitations to the atmosphere.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE SAVINGS OF SCIENCE.*

By P. L. SIMMONDS.

IN the last quarter of a century, very important progress has been made in our home industries and foreign commerce; but certainly the success that has been effected in the utilizing of waste products, and developing neglected ones, is not the least remarkable of recent scientific advances.

It is evident that, when considered from the point of view of industrial science, the phrase, "utilization of waste," may be fairly applied not only to the unused residual products of manufactures, but to the boundless, undeveloped wealth of nature. The beautiful aniline dye, produced from the tar of the gas-works, is not more an example of the utilization of waste than beet-root sugar, obtained from what, a century ago, was a weed growing by the sea-side. Nature produces, abundantly and spontaneously, in many countries, vegetable substances (such, for instance, as the esparto-grass), which were long allowed to run to waste. Important industrial uses have been found for many of them, and fortunes realized by numbers who have turned their attention toward rendering them articles of commerce.

The flesh of domestic animals fit for food is almost a waste substance in many countries, since it can not be locally consumed nor profitably preserved. In the River Plate republics alone there are 80,000,000 sheep and 25,000,000 cattle to a population of 2,500,000. For years sheep were only valued there for their wool, and, when flayed, carcasses were left to rot, or, when dried in the sun, piled up in stacks for fuel, while later on they were boiled down for their tallow. Sheep get very fat in the province of Buenos Ayres, and those of three and four years will give frequently from eighteen to twenty-five pounds of tallow. Countless numbers of sheep are boiled down every year in the so-called *graserías* only for the tallow, which forms one of the staple articles of export. The mutton is thrown away, or used in a dry state as fuel.

In the five years ending with 1850, more than 1,500,000 sheep and 200,000 horned cattle were boiled down simply for their tallow, in the colonies of New South Wales and Victoria.

* From a paper read before the London Society of Arts.

We English are great meat-eaters, and, as our home supply is quite insufficient, we have to import more than 600,000 tons every year. With the growth of our population, and the decreasing number of live-stock at home, the imports of meat from abroad have prodigiously increased in the last quarter of a century.

In a paper read before the Royal Colonial Institute, Sir Francis Bell, the Agent-General for New Zealand, stated that frozen meat in any quantity can be placed upon this market from the other side of the world at 6*d.* to 6½*d.* a pound, leaving a good profit to the grower. "This," he added, "ought ultimately to make meat cheaper here, or at least prevent the further rise now threatened. Australia and New Zealand can, in fact, export 700,000 tons of meat a year, or 2,000 tons a day, which is not much more than you want in England even now, without reducing even the present capital number of their sheep and cattle, and we are able to send on sheep to Smithfield with greater ease to-day than the Tweed farmers could one hundred years ago, when meat was selling at a penny a pound in Scotland against ten-pence in London."

Horses, although numerous in some countries, as in Russia and the River Plate states, have not been, commercially, very useful when dead. In South America mares are never broken to the saddle, and the carcasses are generally boiled down for their fat, the exports of mares' grease being considerable, while the hide is also useful. But, within the period now under our notice, horse-flesh has come largely into use on the Continent for human food. Its sale has become a legalized and recognized trade in many of the Continental states, especially in France and Germany. The published statistics of the Society for Promoting the Use of Horse-flesh show that, since its foundation in July, 1866, 160,080 horses, 6,690 donkeys, and 395 mules had been sold in Paris alone for food, up to the end of 1881, furnishing 67,809,460 pounds of meat. Horse-flesh is sold at half the price of beef. The innovation has gained ground rapidly in most of the principal towns of France, and the public sale of horse-flesh for human food is now general in Austria, Prussia, Bohemia, Saxony, Hanover, Switzerland, Belgium, and Sweden. In England, the hundreds of horses which die in the metropolis are sent, with other carcasses, to special firms, which utilize every part commercially. The skin is removed, and the bones are taken out with great expedition; the flesh is then placed in caldrons, of a capacity of 600 gallons. Upon boiling the flesh, the oil is separated, and used by soap-makers and leather-dressers. The bones are also boiled, yielding further oil and fat, and are afterward utilized for manure.

In the United States there was formerly a plethora of waste. The time was when, in Cincinnati, Chicago, and other slaughtering centers, the food of millions was cast out and allowed to be entirely lost by being thrown into the river, or burned in large pits. Now, such is not the case, for the poor but industrious German and Irish populations have saved much of this extravagant waste, and, by their cheaper labor, almost the whole of these substances has been converted to profitable use. Even now a great deal of the ox is disused, which in Europe is esteemed most nutritious food.

There is an important industry which has sprung up out of animal waste, in the utilization of purified tallow and other fats for food and domestic purposes. It was originated in France in 1869 by M. Mége, and was intended for the manufacture of artificial butter from fat, by extracting the oil at a low temperature, and converting this, by churning, into butter. It was first known as oleomargarine, then as margarine, and latterly as butterine. The manufacture of this product has spread extensively, and it is carried on in the United States on a very large scale. As a London trade journal observed, a few weeks ago, "It is to be regretted that shopkeepers do not see their way to offer it to the public under its proper name, a proceeding which would be not only more honest, but which would ultimately tend to the more general adoption of butterine as an article of daily consumption."

From statistics prepared by Mr. Nimmo, of the United States Department of Agriculture, it appears that more than one third of the American exports of butter are sworn to be oleomargarine. Now, as we receive over 8,700 tons of so-called butter from North America, it is not pleasant to know that one third of this is the artificial butterine. Not only is margarine thus used, but, under the name of sueine, much lard is now introduced into the butter.

In the utilizing of inferior or waste materials, and in the separating of tallow from the substances with which it is found in combination, machines are employed which are both ingenious and effective, and by their use much material that would otherwise be worse than useless is turned to good account.

In Europe, rabbits are not a waste substance, but are eagerly sought for as food, and even bred in large numbers; but their introduction into Australia and New Zealand has proved an unmitigated evil to the colonists. About twenty years ago there was not a single rabbit in Australia, save, perhaps, a few domesticated pets. Since their introduction they have become a perfect pest, and the difficulty is to exterminate and keep them down by poison, dogs, etc.

From New Zealand alone 8,500,000 rabbit-skins were exported in 1880, but this does not probably represent one tenth part of the animals actually destroyed. In that climate the rabbit breeds nearly every month in the year. But even supposing that a pair of rabbits do not breed oftener than in England, which is seven times a year, and that they only bring eight young at a time, they would multiply in the course of four years to 1,250,000. Besides the skins shipped to England and America, the colonists are trying to send us rabbits' flesh in tins. Rabbit-skins are in demand by the furrier. About 30,000,000 indigenous rabbit-skins and 2,000,000 or 3,000,000 hare-skins are used up in this country. The skins of those which are not used or dyed as furs are, after the hair has been pulled for the hat-maker and for stuffing beds, employed for glove-making. The hair is also now used for making yarn and cloth.

The wool manufacture, in almost all countries, now uses up cuttings of cloth and shreds of all kinds which were formerly thrown away. These, and the strippings and waste in carding, are now classed immediately after pure wool, and command relatively high prices. There are many who may be disposed to regard the shoddy manufacture as a business to be despised, but the political economist discovers in it a most important source of wealth—wealth resulting from the application of skilled labor to the utilization of material once worthless, but now contributing no mean sums annually to the wealth of nations.

There are now 137 shoddy-factories, principally situated in the Yorkshire district, which employ over 5,000 persons, 3,000 of whom are females. About 40,000 tons of woolen rags are annually torn into shoddy in England alone, and the quantity made in the United States must be almost equal. No accurate data can be found of the European use of these articles, but an immense quantity of both shoddy and mungo is now made and exported from the Continent, principally to England, and it is probable that the whole of the world's annual consumption is over £7,000,000 in value. At the recent International Wool Exhibition, held at the Crystal Palace under my charge, there were shoddies sent from most of the states of Europe. Italy first began to work woolen rags into yarn in 1858, and most of the other European countries followed the example.

Raw silk having become scarce and dear of late years, much more attention has been given to the employment of the different sorts of silk waste, for which, at one time, scarcely any use could be found.

The variety of these is very large, and most of them are now profitably and extensively employed. The outside and inside husks of the cocoons used to be mere refuse. These pass under various trade names in different countries; in England, as "knubs and husks" and "floss silk"; on the Continent, as *bourre de soie*, *frisonets*, and *floret*. What is termed "yarn waste" is the waste made by the silk throwster. The pierced cocoons, that have been eaten through by the moths, are now largely employed in the preparation of *chappe*, or *schappe*. Then there are the noils and thread waste from the silk-factories.

In 1857 the imports of these waste silks were only 18,000 hundred-weight, valued at £302,286. In 1881 the imports reached 540,119 hundred-weight, valued at £757,796. France, Switzerland, Germany, Great Britain, and the United States have now entered extensively into the utilization of silk waste for manufactures, which was formerly a drug in the market. In the Swiss report on the Paris Exhibition of 1867, it was stated that the annual production of floss-silk yarns then ranged in value from £400,000 to £600,000. In 1872 about 7,750,000 pounds of thread were made from waste silk in Europe. In the United States, 2,000 to 3,000 bales of waste silk are used up annually, valued at £200,000. Italy exports annually about 5,000,000 pounds of silk waste.

There are fifteen establishments in France, with 479,353 spindles, working up waste-silk; that is, the waste from the cocoon not reelable, the short pieces, etc. What remains over from this working is again used up by seven other factories, which, by means of further combing and carding, employ waste formerly only partially utilized or altogether lost to consumption.

In connection with this subject I may draw attention to the stimulus given to the collection of the cocoons of the wild silk-worm of India, known under the name of *Tusser*. These, which were formerly only used in the East for making a kind of drab or coffee-colored silk, have now been made to take dyes, and are profitably employed in the silk manufacture in England. The waste of the wild cocoons in China and Japan is made into felt for hats, and enters into the manufacture of paper.

The improvements in machinery for the preparation and spinning of silk-waste have made great strides of late, and whereas a few years ago one never heard of anything but "spun-silk" hosiery, handkerchiefs, or some other little article of similar make, the whole world now knows the *schappe* velvets of Crefeld, the "spun" ribbons of Basle, and the laces of Nottingham, while the king of silk-spinners—Lister, of Manningham—has even produced machine-twist of excellent quality from this unlikely material.

The refuse from the tanneries, now so profitably utilized, is of considerable importance; it consists of untanned dried pelt, or glue-pieces, fleshings, hair, lime deposit, and spent-tan. Glue-pieces or "scrolls," as they are termed, are sold to the paper-maker, and scores of tons for the manufacture of gelatine and portable soups. Ordinary size is made from the flesh refuse of the hide, and is extensively used by paper-hangers, cotton-spinners (to give firmness to the thread), and carpet manufacturers. The so-called cheap seal-skins are manufactured in the north of England from common plasterers' hair, or that obtained from the tan-pits. There has been made for many years, in Germany, printing-paper and cardboard of the waste bark from tanneries. The common papers receive about ten or fifteen per cent of this pulp; the boards for roofing from twenty to forty per cent. Artificial leather is also now extensively made from leather cuttings, pressed and rolled into sheets with some glutinous composition.

Latterly it has been found that leather-waste cuttings, etc., when steamed with certain waste liquors, produce a valuable material in the shape of a new black, which is destined to have a variety of important uses, such as in the manufacture of printing-inks, dark pigments, covering substances, and notably for the manufacture of blacking. Bone-black, from which the latter is chiefly made, costs £9 per ton, and the supply is limited, while this new tannic black can be sold at one third of the price.

The blood from the slaughter-houses, which used to be wasted, is now collected in Europe, and utilized for manufacturing into blood-albumen, which sells at about 1*s.* a pound. The drainings and the clot go for manure.

Among the miscellaneous animal substances now utilized, we find many species of fish-skin tanned, such as the so-called porpoise-skin, (*Beluga catodon*). Alligators and crocodiles, and even snakes, are hunted for their skins, which are tanned, and provide a valuable article for making slippers, purses, pocket-books, cigar-cases, etc.

Let us now pass to vegetable substances, and I will first consider the paper manufacture. A recent estimate was published, which set down the paper-mills of the world at 4,000, producing 1,000,000 tons of paper, of which one half was used for printing.

It is now evident that the future of the paper industry will, in a large degree, depend upon the use of wood, which is already extensively employed. For the ordinary varieties of paper, ground wood is used; but, for the finer sorts, chemically prepared wood-fiber, or cellulose, is employed. The practical process for the preparation of cellulose was discovered in 1852, and numerous other processes or improvements have since been invented. It comes into commerce in two forms—wood-pulp in sheets or blocks, and ligneous meal or wood flour. In Central Russia, aspen-wood is most extensively employed; in Sweden and Finland, spruce and fir, which afford the longest fibers; in Germany, France, and Belgium, mixed woods. The pulp from beech and birch woods has too short a fiber.

About twenty years ago, some of the American paper manufacturers used the bamboo largely for making paper. This is no new application, for the Chinese have long employed it for a common description of paper. Good paper is now also made from esparto-grass.

A good deal of the jute sent from India to the United States consists of the dark root, or butt-ends of the fiber, which are cut off when the jute is pressed into bales. These are called "cuttings" in Calcutta, and with us, "rejections"; they now form a regularly quoted article of export to America, where they are employed in the fabrication of various shoddy-stuffs. In former years these cuttings were thrown away. Megass, the refuse stalk of the sugar-cane, makes excellent paper. The husks of oats, barley, rye, and rice, are also used alone, or combined with other materials. Straw-board, of late years, has been found to be a cheaper material than the old-fashioned "pasteboard," and it has come extensively into use in America for paper-boxes.

Straw has long been employed as a paper material, but it is often scarce and dear. It is even found profitable to buy up the bedding-litter from the metropolitan stables, and, after washing and disinfecting it, to sell it to the paper-mills.

Until a very recent period, the waste-paper of the Government offices of London was the perquisite of the messengers. But when it was found that the aggregate sales of this waste-paper reached the sum of £10,000 to £15,000 a year, it was thought time to look into this, and it was then handed over to the Stationery-office, and, in the last financial year, the sale of waste-paper reached £11,771. The United States Treasury sells yearly more than 600 tons of paper-pulp, resulting from the destruction by maceration of Government securities, bank-notes, etc.

In one large printing and publishing establishment in London, the waste-paper, in shavings and imperfect impressions, exceeds seventy-five tons a year. Even the newspaper-offices now economize and use up their spoiled impressions, or overplus papers, for printing their posters on.

It is only since 1860 that the extraction of the oil from cotton-seed has been carried on on a commercial scale; before that date vast quantities of the seed were allowed to accumulate and to rot on the cotton-plantations. It is an industrial fact of considerable interest and significance, that at the present time the seed is often more valuable to the planters for its oil and oil-cake than the cotton-fiber, for of the latter it contains only about one quarter of its weight.

In the process of refining, the residue of the crude oil is distilled, and, with care, produces a hard grease or stearine, which commands, when of good color, within 3*s.* or 4*s.* per hundred-weight the price of Petersburg tallow. The by-product is used for making artificial butter. Even the foots, or tarry residue, is useful as a paint ingredient.

It would be difficult to define the limits to which the indirect consumption of Indian corn extends. Every pound of American pork eaten, the laundry and food starches used, the large production of alcohol (that of whisky in the States is 67,000,000 gallons), the varnishes used by the cabinet-maker, the perfumery of the toilet-table, the different kinds of illuminating fluids, all indicate the universality of the employment of maize.

It was in 1867 that a new use was found for maize, by converting it into glucose. The report of the New York Chamber of Commerce states that the production of this sugar is now not less than 1,000 tons a day for the whole United States.

In America, they are also endeavoring to utilize the immense quantities of pulp remaining from the corn after the extraction of the starch. This pulp, which is at present a waste product, consists wholly of cellulose or woody fiber, and would, it is considered, be an excellent material for making the commoner grades of paper, suitable for wrapping and newspaper purposes.

The present sources of the supply of potash are rapidly failing; every year the area of the supply becomes smaller, and the product, in consequence of this and the increased demand, becomes more and more expensive. The cobs of Indian corn, which are now considered of little or no value, may yet share the same fate as many substances which, though formerly considered worthless, have become new mines of wealth, through the aid of chemistry.

The average yield of 1,000 parts of cobs is 7·62 parts of carbonate of potash, or nearly twice as much as the best specimens of wood, and it is a material which can fill its full measure of usefulness for other purposes, before it comes into the hands of the manufacturer of potash. At the shipping ports, large shelling-mills are established, capable of running through 500 bushels of corn an hour. Here, then, are the places where a supply of cobs may be procured.

The corn-crop of North America varies; but, taking the yield of 1871—1,100,000,000 bushels, at fourteen pounds of cobs to the bushel—this would yield 7,700,000 tons of cobs, containing an average of three quarters per cent of pure carbonate of potash. The enormous quantity of 115,500,000 pounds of that useful article might thus be thrown into commerce. In some districts, these corn-cobs are extensively used as fire-lighters, being dipped into a composition of resin and tar, and then dried.

It is only some twenty years now since glycerine, a by-product in the manufacture of soap and candles, has been produced on a commercial scale, but the quantity now made represents an annual value of nearly a quarter of a million sterling. Glycerine has thus attained to a position of considerable technical importance. The introduction of the stearine-candle industry and the efforts to utilize the heretofore waste products of the soap manufacture demonstrated its existence in considerable quantity. The important uses to which this substance is now applied are so numerous that it would be difficult to enumerate them.

There is a large consumption of cork-bark, in this and other countries (the quantity we import exceeds in value half a million sterling), and even in this direction the economizing of the waste is found profitable and useful. The suberine powder is made into cork carpets for floor-cloth, and it is even used by chemists in place of lycopodium, powdered rice, starch, etc. Old corks are collected, and cleaned with hydrochloric acid and hot water, so as to be used again. The Paris sewers are provided with gratings, and the corks thus collected are re-cut, and used again. All cork cuttings are useful for filling life-buoys, belts, jackets, and even beds.

In Europe, as much use has not been made of sea-weed as in China and Japan, where it forms a very large article of consumption for food. In China, it is imported both from Japan and Asiatic Russia, to the extent of more than 25,000 tons a year. It is received in two forms: first quality, cut, and some known as *agar-agar;* and second quality, long. This sea-weed is principally consumed by the lower classes of Chinese as a condiment or flavoring, with their rice or other food.

Another product into which sea-weed is converted is gelose—a sort of vegetable isinglass. Viewed from whatever direction, the more general utilization of sea-weed is a most important matter. In some of the northern countries of Europe, cattle are fed on it. Formerly, iodine was only obtained in any quantity from the kelp of sea-weed, but it now appears likely that it can be produced in Peru at a comparatively small cost, as a by-product extracted during the process of manufacturing nitrate of soda; while the necessary arrangements for the manufacture of iodine from kelp are very costly, and the works and machinery used require a large sum of money. It is possible that 5,000 or 6,000 hundred-weight of iodine might be manufactured in Peru at a low cost, but the war with Chili interfered materially with the production. With the exception of the manufacture of kelp, the principal use of sea-weed is for manuring land. Under the name of carrageen, or Irish moss, some is used for food. In France, a gelatine or gum is prepared from sea-weed, which is variously useful in the arts, as in finishing cotton fabrics, making artificial leather, etc. When chemically prepared and pressed, it was, at one time, used extensively for the manufacture of a substitute for horn, called laminite, but this has been dropped. It has occasionally been made into paper.

There is an application of waste substances of vegetable origin that is largely carried on, which certainly does not merit approval, being, for the most part, prosecuted for the purposes of deception and fraudulent gain, and this is in substitutes for, or additions to, coffee. Figs, date-stones, lupines, malt, chiccory, etc., are largely sold, besides the seeds of a stinking weed (*Cassia occidentalis*) which, when roasted, according to French authorities, is equal to coffee. While the production of coffee is fully equal to the demand, and the price is moderate, I can not see the necessity for these various substitutes. The more legitimate use of date-stones is that to which they are put by the Arabs. They are soaked in water for two or three days, and, when somewhat softened, used to feed their camels, cows, and sheep. There are shops in Medina where they sell only date-stones, and the poor often occupy themselves in collecting the date-stones thrown about the streets by those who eat dates.

Cocoa is not so largely consumed in this country as on the Continent. But the cocoa shells or husks which are separated from the nibs after sifting are imported here to the extent often of 500 tons annually, paying a duty of 2*s.* a hundred-weight, against 9*s.* 4*d.* a hundred-weight charged on cocoa and chocolate. These shells or husks form about twelve per cent of the weight of the beans. In the manufacture of the finer chocolates they are always separated, and hence accumulate in large quantities in France and Spain. In the cheaper kinds of chocolate and cocoa, these husks are ground with the nibs, and some other cheap farinaceous substance is added. The black appearance of such chocolate is unmistakable; it will always be found gritty and rough, and, of course, difficult of digestion. The husks are no better than sawdust, and may cause irritation by the minute spiculæ left after grinding.

I must now touch upon the utilization of mineral waste.

The utilizing of tin-plate cuttings and the recovery of the tin have become important and profitable industries. In the manufacture of tin-ware, it is said six per cent of the whole of the plates employed disappears in the form of scrap. Birmingham produces thirty tons per week. Mr. Beck, of that town, is said to have made a profit for many years of £100 a week by taking off the tin from the scrap by solution and precipitation. A very fair trade is done by parties who go about the tin-works buying up the tin-dust. They even go to France and other countries, and ship it to England to be reduced. This so-called tin-dust is really the scum of the tin-pot, and, as it is mixed with grease, it is black. It contains a considerable quantity of metal, which is reduced by ignition and flux. An engineering paper states that the waste of tinned iron, used for all kinds of purposes, but especially for saucepans, kettles, button-making, etc., was formerly large, but a method is now employed by which the tin can be recovered from the waste, simply by the action of dilute sulphuric acid. Tin, to the extent of from five to fifteen per cent, and worth about £97 per ton, with a vast amount of sulphate of iron, is thus procured, giving a large profit on the operation.

Within the last quarter of a century, that formerly neglected mineral—pyrites—has been turned to useful purposes, to supply our manufacturers with the important material, sulphur.

In wire-making factories, the dilute sulphuric acid, formerly used to clean the wire, was allowed to run into the sewer, when it had become so charged with the iron scale as to cease to "bite," and large quantities of refuse wire were employed only to fill up hollows in grading, or thrown into a heap. All this waste material is now, however, converted into articles of commercial value. The processes are simple and comparatively inexpensive.

Not only in the inferior metals is waste now prevented, but increased attention is given to the collection of gold formerly lost. Immense heaps of refuse, or "tailings," as they are technically termed, accumulate where mining operations are carried on. The sludge which is emptied from the puddling-mills in Australia contains a considerable quantity of fine gold. Much of this is now recovered, and the yield of gold from it exceeds three pennyweights per ton. The right to wash the tailings is often sold to the Chinese, who are always well satisfied with the result of their labors.

The quantity of gold used in the arts, in interior and exterior decorations, in photography, electro-gilding, water-gilding, the ornamentation of china, etc., is very large, and the greater part is practically lost. Jewelers' sweepings from the floors of the workshops are carefully collected, and even the clothes of the workmen are generally saved and sent to the refiner. After a large gold coinage at the Royal Mint, there is always a great deficiency in waste and sweep. The sweep is composed of cinders or dust from the forge, the sweepings of the workshops, broken crucibles, the dross which adheres to the ingots of metal after fusion, and of every waste which can possibly contain minute particles of the metal. This is generally sold. The silver and gold from photographers' waste is also now carefully collected, and forms a considerable item of economy. A method of utilizing the waste of gold-leaf, used in printing and the arts, is by converting it into what is called fleece-gold. The composition is used like the ordinary bronze, except that rather more copal is mixed with it. It is used for all fancy papers for which gold-leaf and bronze have hitherto been used.

The waste of the glass-furnaces—such as pieces of broken glass, flaw-glass, the hearth-droppings, and the glass remaining adherent to the blower's pipe—is utilized again, serving a purpose in the manufacture of glass, similar to rags in paper-making. Agate glass is made by melting waste pieces of colored glass. One to two thousand tons of cullet, or broken glass, are collected in the metropolis alone, and sold to the few city glass-works to be remelted. Broken bottles are now collected and utilized. Thousands of tons of these are broken every year in London alone. Broken "wines" and broken "sodas" are converted to many useful purposes, the latter especially. The broken bottles are utilized for the manufacture of cheap jewelry, chimney-ornaments, and inferior household glass for the manufacturing districts. They are also used for the manufacture of emery-powder, glass paper, etc. Some idea of the number of "sodas" broken in the process of filling, corking, cleaning, and distributing may be gathered from the circumstance that one great mineral-water manufacturer in London sold last year one hundred tons. The value of the "metal," as it is styled, is somewhere about ten shillings per ton, but it varies according to the demand. When the market for "fancy goods" is active, broken bottles command a better price. A revival of trade sets this particular industry in motion along with others, and broken bottles are enhanced in value. In fact, broken glass and broken pottery serve many purposes, though it is only lately that economic science has learned how to turn them to account.

The utilization of blast-furnace slag is not new, but has made great progress. Scattered throughout the iron-making districts of Great Britain are many million tons of scoria or refuse from the blast-furnaces, which is technically known as "slag." This slag goes on accumulating at the rate of nearly 8,000,000 tons per annum, its bulk being some three times that of the iron from which it has been separated. It forms a heavy incumbrance to iron-masters, demanding the purchase of large tracts of land whereupon to deposit it, while the investment is, of course, wholly unremunerative. There are one or two exceptions to this rule, where the slag is tipped into the sea, and serves to form land for the works, and where some of the iron-works supply slag for the construction of breakwater and training walls. The quantity thus utilized, however, on the Tees is but about 600,000 tons per annum, forming only a small proportion of the whole yield of the district.

In early times, slag was broken up by hand, and used for road-making, and it so continues to be used, where it can be had without a heavy cost for transport; but there is only a limited demand for this purpose. On the Continent, where stone is scarce, slag plays a prominent part in road-making, as in Silesia and other similarly situated districts. Another direction in which many attempts have been made to utilize slag, both at home and abroad, is to adapt it for constructive purposes, and various schemes have been devised for transforming the highly refractory slag into bricks, sand, and other materials for building.

It is also applied to the manufacture of artificial stone, and molded into chimney-pieces, window-heads, balustrading, and outside ornamental builders' work generally. The stone is composed of two and a half parts of finely pulverized slag, and two and a half parts of ground brick, to one part of Portland cement. The mixture is run into molds, and sets quickly, the articles being ready for the market in four or five days. Besides bricks and stone articles, the slag is used for making mortar, cement, and concrete. The mortar is a mixture of slag and common lime, the cement being composed of the same materials, with the addition of iron oxides.

Another useful purpose for which it has been successfully utilized is that of glass manufacture. The vitreous character of slag indicates a resemblance to glass in its composition. It does, in fact, contain the principal components of glass, but not in proper proportions, and those in which it is deficient have therefore to be added, with others which are not present. Bottles made of this slag by the Britten Patent Glass Company were shown at the Paris Exhibition in 1878, and received honorable mention.

Another application is to the manufacture of slag-wool. By the action of strong jets of steam, the slag is transformed into a fibrous whitish silicate cotton, which, being metallic, is incombustible, like asbestos. In the construction of new houses with Mansard-roofs, the space between the interior lath, or paneling, and the exterior covering of zinc, slate, or tin, is filled with this slag-wool, which protects from the rigor of frost in winter and the intense heat in summer. If in winter the taps and spouts and water-pipes are covered with this slag-wool, it prevents the freezing of the water and the bursting of the pipes and joints. This slag-wool is also used now by gardeners to cover plants and protect them from the effects of sudden changes of temperature.

In view of the general usefulness of slag, when converted into the various articles described, it is to be hoped, in the interests of commerce and progress, that the practice of its utilization may become more and more extended. Doubtless, human progress will show that what is now the veriest waste will, in the course of time, assume a condition of value. Thus will art be made to approximate to nature, in that it will know no waste.

There are one or two other mineral substances, formerly neglected, which have of late years been applied to very extensive important uses. One of these is asbestos. This was long considered a mere curiosity for making small fire-proof articles. It is the only flexible fibrous mineral substance that is perfectly indestructible by fire or acids, notwithstanding it consists of fibers as fine as the finest linen. Now it is scarcely possible to enumerate all the uses to which it is applied. Among others are, as a roofing material, cement, paint, fire-proof coating for inside of factories, theatres, etc., in danger of ignition, felting for steam-pipes, boilers, lining for floors, roofs, etc.

A prominent and peculiar feature in the landscape of the coal-mining regions is the enormous heaps of black and apparently useless material collected near the outlet of each mine. As the quantity of small waste coal in the United Kingdom has been estimated at 28,000,000 tons per annum, the utilization of this refuse is a matter of national importance in more senses than one. It is now, in many districts, consolidated into blocks, and, besides what is used at home, 412,310 tons of this patent manufactured fuel were exported last year.

In several foreign countries, the pitch from coal-tar is combined with coal-dust, and pressed into the form of bricks, and an excellent fuel is thus produced, which, it is said, will generate a greater amount of heat than can be obtained from the same quantity of any other combustible material employed for utility or comfort, while, at the same time, it can be stored more compactly and in better shape than either wood or coal. Some 40,000,000 tons of valueless coal-dust, lying in the vicinity of the coal-mines and depots of Pennsylvania, have been thus gradually utilized. In some American factories they have found it cheaper and more advantageous to burn only coal-dust or pea-coal. A furnace or grate bar has been specially devised for the purpose of burning this kind of fuel, and there is no doubt, with its increasing uses, but that other convenient devices will be supplied for making it of more practical benefit. The utilization of this waste in the coal-regions of the United States is now a decided success. The American Fuel Company, Pennsylvania, works up large quantities of culm (as the coal-dust is technically called) with pitch into blocks, brick-shaped, weighing but fourteen pounds each. Anything tending to the utilization of what is now waste is of value, when we consider that the amount of anthracite coal sent to market represents but about four fifths of the quantity that is actually raised from the earth, the balance being piled up in unsightly heaps.

Many of the subjects which I have incidentally touched upon have been so elaborately dealt with by specialists in papers before the members of this society, that the ground has been taken from under me, and I am but a gatherer and gleaner, summarizing, as it were, the results of their descriptions. Although, in the period under review, many of the waste products of manufactures, formerly thrown away, have been made to serve a useful purpose, there is yet room for fresh efforts in this direction, and the reward is certain. The manufacturer who discovers a heretofore unknown use for the waste product of his work necessarily cheapens the cost of the principal article of his production, and thus secures an advantage over competitors. Much, as we have seen, has already been done in this way, but there are many other products which could be made under the direction of that mighty converter, chemistry, to yield substances of use and profit.

Science has taught us how to transmute the waste and refuse materials—elements of pollution—into sources of economy and wealth. The utilization of the sewage of great cities for agricultural ends has virtually been a demonstrated success in Paris and many of our own towns. The same success, by patient experiment, is obtainable in many other waste products, which, in ignorance of their value, we suffer to defile our streets, pollute our rivers, and taint the air we breathe. The purification of the outflow of paper-mills and the utilization of the sludge and other waste products are now carried out.

It would have been impossible, in the limits of this paper, to refer in detail to more than a few of the principal examples of the successful use of refuse. But those enumerated will serve to show to how great an extent civilization is daily adding to the useful products of the world, both by economizing its resources and by calling forth new ones with the aid of chemistry.

SYMBIOSIS AND "VEGETATING ANIMALS."

A REVIEW.

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SINCE the publication of the interesting observations and speculations of Dr. Karl Brandt concerning the occurrence of chlorophyl in animals, of which a summary account was given in a recent number of this periodical, under the heading "A Partnership of Plant and Animal Life," at least two important contributions to the same subject have made their appearance. One of these, written by Mr. P. Geddes, of Edinburgh, may be found in "Nature" of January 26, 1882. The other, from the pen of Professor E. Ray Lankester, was published in the April number of the "Quarterly Journal of Microscopical Science."

The spectroscopic examination of animal pigments, a line of investigation in which Professor Lankester was one of the earliest observers, has shed much light on these previously little known compounds, and has opened a wide field for further research. Especially fruitful in this direction was the announcement, perhaps a dozen years ago, that various animal greens yield a spectrum identical or nearly so with that furnished by chlorophyl, the common green coloring-matter of plants. At once a host of interesting questions sprang up as to the occurrence, structure, and properties of "animal chlorophyl"—all of which, however, culminated in this: Is the color "accidental" and unimportant in animals, or has it rather some profound significance, such as attaches to it when it is found in vegetable protoplasm?

It may well be considered as one of the fundamental truths of biology that chlorophyl in vegetable substance is no insignificant intruder. Though the exact method of its working is just now a matter of much dispute, the broad fact of its usefulness is freely admitted; in one way or in another, chlorophyl aids in the economy of the vegetable cell so that it feeds greedily upon the carbonic acid of the surrounding air or water, and tears to pieces, for building up afresh its own substance, compounds which, without chlorophyl, it would be powerless to utilize, or which if utilized would be speedily sacrificed. A long series of experiments, reaching from the time of Priestley to the present day, uphold and strengthen this fundamental fact; but, among them all, the simplest is the most unique and the most pronounced. If a piece of a green plant be immersed in water and exposed to sunlight, bubbles of oxygen are given off, and analysis will prove that carbonic acid has simultaneously disappeared from the water. With plants not green, or with animals, the facts are reversed—oxygen disappears and is replaced by carbonic acid.

The green plants, then, exhibit a peculiar power, viz., that of splitting up carbonic acid, and of availing themselves for the manufacture of starch, etc., of the carbon thus gained; at the same time procuring such a large supply of oxygen that they are able to reject a vast amount over and above their own needs. In this respect they differ from colorless plants and animals, and for this power they depend exclusively upon the agency of chlorophyl. We have no evidence whatever that the chlorophyl of plants has ordinarily any other function.

Very considerable interest has consequently been felt in the solution of the question, What significance (if any) has chlorophyl when found in animals? And since the only known use to which it could in general be put (inferring from plants) is in decomposing carbonic acid, and thus aiding alimentation, it has become an important question to discover if this same physiological habit belongs to animal chlorophyl. If it can be proved that animal substance endowed with chlorophyl can, just as well as plant protoplasm similarly colored, break down carbonic acid and utilize its elements, then we remove the last formidable barrier between plant and animal protoplasm. If it should be shown, on the other hand, that when found in animals it is always functionally incapable of splitting up carbonic acid, it is true that we preserve a point of difference between plants and animals, but a result so negative would land us in a new difficulty, viz., that of explaining its presence by attributing to it some other function, and one unknown to plant chlorophyl. No sufficient explanation of this kind has hitherto been offered. In some cases a "protective resemblance" to vegetation would explain its occurrence; but in most cases this is out of the question.

Now, up to 1878 no evidence of value had ever been advanced to show that animal chlorophyl does enable its host to split up carbonic acid and give off the excess of oxygen resulting. In that year, however, Mr. Geddes, whose later work is referred to above, visited Roscoff and found there quantities of "the grass-green planarian (worm) *Convoluta Schultzii*, of which multitudes are to be found in certain localities on the coast, lying on the sand covered only by an inch or two of water, and apparently basking in the sun. It was only necessary to expose a quantity of these animals to direct sunlight to observe the rapid evolution of bubbles of gas, which, when collected and analyzed, yielded from forty-five to fifty-five per cent of oxygen."

Having obtained so much of valuable evidence, Mr. Geddes followed up his discovery by examining these green worms to see whether or not the animal protoplasm derives the same kind of benefit from its work as does plant protoplasm which is known, as a result of the co-operation of chlorophyl, to build up starch or starchy compounds.

This, indeed, proved to be the case, for he adds: "Both chemical and histological observations showed the abundant presence of starch in the green cells; and thus these planarians, and presumably also *Hydra*, *Spongilla*, etc., were proved to be truly 'vegetating animals.'"

The only link here needed is the full proof that the "grass-green planarian" owed his color to veritable chlorophyl. There is little or no reason to doubt it; yet, when we are told by Professor Lankester that in *Spongilla* alone among animals has spectroscopic investigation really *proved* the presence of that pigment, we can not help wishing that this confirmatory evidence had been obtained by Mr. Geddes.

Meantime slow progress had been making in a kindred subject. Before speaking of this, however, it must be said that chlorophyl is now known to be by no means a simple substance, but is rather made up of several simpler compounds not well understood. Nor is it always green, though in that form it occurs most familiarly. Sometimes the true chlorophyl is obscured by some other color, and is nevertheless perfectly functional, physiologically speaking; for instance, a yellow color is particularly common in the lower forms of plants—as in the algæ.

In 1871 Cienkowski boldly announced his conviction that certain yellow cells, which, first pointed out by Huxley, had for some time attracted attention in the substance of radiolarians, were really no part of the animals themselves, but rather veritable algæ living in the animals. Haeckel had previously called them "liver-cells," and when starch was found in them he believed his view confirmed, as it is in the liver of the higher animals that glycogen—a form of starch—is constantly present. The views of Cienkowski made little progress, however, till 1879, when a distinguished morphologist, R. Hertwig, of Jena, who had previously taken sides with Haeckel, adduced reasons which inclined him to the belief that the yellow cells were "parasitic," as Cienkowski had considered them to be.

In the same year (1879) the brothers Hertwig concluded that the so-called pigment-bodies in the tentacles of certain sea-anemones are true algæ—plants, multiplying by tranverse division. Then followed quickly the paper by Dr. Brandt, referred to at the beginning of this review. His work was extensive, and resulted in a complete confirmation of the observations of Cienkowski and the Hertwigs. He fully believes that the yellow cells are true algæ, and was able to prove his points to his own satisfaction. He went, however, a step further, and announced his conviction that all animal chlorophyl is to be considered as located in associated vegetable organisms, which, together with the animal, make up "a partnership of plant and animal life." He unhesitatingly puts *Hydra viridis* and *Spongilla* (green variety) in this position, and thus disposes of all "vegetating animals," or animals living like plants endowed with chlorophyl.

In October, 1881, Mr. Geddes visited Naples for the sake of making further studies upon this subject, and in the paper in "Nature," referred to above (and which has been freely drawn upon in preparing this review), he gives a summary account of his work.

He devoted his attention at first to the yellow cells of *Radiolaria*, and was completely successful in demonstrating in them not only a cell-wall of cellulose and contents made up of protoplasm and nucleus, but he was also able to watch their growth both before and after the death of the animal; and, what was of special interest, he obtained a fair amount of evidence that certain tiny bubbles which in sunlight studded the radiolarians were really made up, in part at any rate, of oxygen. Besides this, he pronounces starch to be invariably present, and completely confirms the observations of Cienkowski and Brandt as to the survival and growth of the yellow cells long after the animal has perished. The yellow pigment, he says, is identical with that of diatoms, and gives the same chemical reactions.

Turning his attention next to the sea-anemones, medusæ, etc., he was equally successful. He is convinced that the pigment-bodies are true algæ; and he records this remarkable experiment: "The exposure of a shoal of the beautiful blue pelagic Siphonophore, *Velella*, for a few hours, enabled me to collect a large quantity of gas which yielded from twenty-four to twenty-five per cent of oxygen. . . . But the most startling result was obtained by the exposure of the common *Anthea cereus* [sea-anemone], which yielded great quantities of gas, containing on an average from thirty-two to thirty-eight per cent of oxygen." He was able also to prove that this gas came from the associated algæ—specimens destitute of algæ giving off no oxygen whatever.

It is, therefore, now very certain that the yellow cells of radiolarians and the pigment-bodies of cœlenterates are in many cases true algæ living in the animal substance. Geddes's work, when added to that of Cienkowski, the Hertwigs, and Brandt, makes this so clear that we are justified in fully accepting their theory, and in hereafter considering the association of certain chlorophyl-bearing plants with certain animals as an established fact. It has been proposed to apply to this association the term *symbiosis*, and to designate animals which are thus supplied with algoid messmates as "symbiotic." So much for the "yellow cells" and pigment-bodies of radiolarians and cœlenterates. Dr. Brandt, it will be remembered, has expressed his belief that the green-colored *Hydra* and *Spongilla* are also symbiotic. In Mr. Geddes's paper nothing is said upon this subject, although, from a remark let fall near the close, it is plain that when the paper was written he did not accept Dr. Brandt's view, but would reserve *Hydra*, *Spongilla*, and *Convoluta*, for a special group of "vegetating animals" distinctly unlike those which are symbiotic.

Professor Lankester, however, while inclined to accept all that has been shown for symbiosis in the other cases, refuses most emphatically to apply that doctrine to *Hydra* and *Spongilla*. His dissent is all the more important, because he has paid much attention to the study of animal and plant pigments (especially with the spectroscope); and, because he was the first to establish the presence of chlorophyl in *Hydra* and *Spongilla*, he has a special right to be heard in this case. In the paper quoted above he attacks the subject with great vigor, and describes several important experiments tending to show that the green color of *Hydra* and *Spongilla* is due to chlorophyl bodies analogous rather to those structures in plants than to any algoid messmates. He fails to confirm Dr. Brandt's observations, and questions the virtue of his inferences so generally, that the two authorities are practically in diametrical opposition. It is obvious that still further studies must be made upon these so-called "vegetating animals," and that at present it would be highly unsafe to consider them as symbiotic.

Professor Lankester's paper is full of entertaining facts of his own discovery, but a number of experiments made by Mr. Blomfield, of Oxford, and University College, London, and quoted by Professor Lankester, are of special interest to us in this connection, as they furnish some evidence that the green *Hydra* does, like *Convoluta*, evolve oxygen in the sunlight. The observations are incomplete, but nevertheless of much value as they go to establish a second case in which animals destitute of yellow cells and pigment-bodies, but endowed presumably with true chlorophyl, do actually give off oxygen.

Meantime the reader can not have failed to perceive that the question as to the evolution of oxygen has become of secondary importance. It is nothing strange if algæ living in animals give off oxygen by virtue of their chlorophyl. In any special case we must now first inquire—Are the colored parts mere plants dwelling within the animal, or are they not? If not, then we must, if possible, apply the spectroscope for the study of the pigment (the chlorophyl group giving rather characteristic spectra), and then, if chlorophyl is present, test, if we can, for oxygen elimination. It is tolerably clear that the occurrence of native chlorophyl in animal protoplasm is not so wide-spread as was suspected before symbiosis was detected; yet the cases of *Hydra*, *Spongilla*, and *Convoluta* are still unsettled, and others may be added to their number: it must be granted, however, that the indications seem to be that in some cases animals may possess veritable chlorophyl arranged as in plants, giving the same spectrum and having the same power over carbonic acid.

At present it will be far more profitable to consider the significance of symbiosis than to speculate upon the result of observations belonging to the future. Professor Semper, in his work entitled "Animal Life," reminds us that, if it should come to pass [as it has] that we must consider much of the chlorophyl found in animals to be borne by vegetable messmates, we need not be surprised; since lichens—formerly supposed to be simple vegetables—have now been shown to be associated organisms—a fungus parasitic upon algæ. There is, indeed, much superficial resemblance between the two phenomena, and it is said to have been from the literature of lichens that the expressive word, *symbiosis*, was borrowed. In truth, there is really less analogy than at first appears; and, as there is no reason for considering the lichens as other than interesting and complicated cases of parasitism, we may hereafter, I think, reserve the word *symbiosis* for the description of that very different association of algæ with animals which it has been the purpose of the writer to elucidate. The word *zoöphyte* might, indeed, be used here with an accurate meaning had it not already a very definite (though utterly senseless) use in pseudo-scientific books and minds.

Mr. Geddes pictures at considerable length the probable physiological relationship between the organisms associated in symbiosis;

and in what comes hereafter we must to a great extent follow his lead. The algæ which are found in animal substance have been referred to above as "parasitic," but it is chiefly to avoid the use of this term that the more accurate one (symbiosis) has been employed. A closer analogy than that offered by the lichens would be, it seems to me, afforded by any perfect plant—an oak, for example. Here the colorless cells—of the root, let us say—are bound to live at the expense of the green cells in the stem and leaves. Yet we do not think of this as a parasitic event. The root-cell is rather a unit in a vast colony of units (cells) associated for mutual benefit. The green cell gets quite as much good from the root-cell as the latter gets from the green cell; water and salts are exchanged by the root-cells for sugary matters and other things readily made use of by any cell, and no harm (as would be the case in parasitism), but rather much good, is done by the exchange. Evidently the oxygen thrown off by the alga is precisely what the plant needs, and the carbonic acid and nitrogenous waste eliminated by the animal is most useful to the alga. Moreover, the algæ gain the advantage of ready locomotion with their host, and the animal can go further into unfavorable media when stocked with algæ ready to build up starches and sugary matters from carbonic acid and water. If either dies, the other is the gainer; since the algæ can thrive on the products of animal decomposition, and algæ—digestible, i. e., dead algæ—are much esteemed by most animals.

The whole burden of the physiological history of symbiosis is forcibly summed up by Mr. Geddes as follows: "Thus, then, for a vegetable cell no more ideal existence can be imagined than that within the body of an animal cell of sufficient vital activity to manure it with carbonic acid and nitrogen waste, yet of sufficient transparency to allow the free entrance of the necessary light. And, conversely, for an animal cell there can be no more ideal existence than to contain a vegetable cell, constantly removing its waste products, supplying it with oxygen and starch, and being digestible after death. . . . In short, we have here the relation of the animal and the vegetable world reduced to the simplest and closest conceivable form.

"It must be by this time sufficiently obvious that this remarkable association of plant and animal is by no means to be termed a case of parasitism. If so, the animals so infested would be weakened, whereas their exceptional success in the struggle for existence is evident. *Anthea cereus*, which contains most algæ, probably far outnumbers all the other species of sea-anemones put together, and the radiolarians, which contain yellow cells, are far more abundant than those which are destitute of them. . . . Such an association is far more complex than that of the fungus and alga in the lichen, and indeed stands unique in physiology as the highest development, not of parasitism, but of the reciprocity between the animal and vegetable kingdoms."

The foregoing paper was written several months ago, and since that time important contributions to the subject have been made by Geddes, Hamann, Jickeli, Entz, and especially by Brandt. The latter has published a summary of the whole matter, enriching it by observations of his own made at the zoölogical station at Naples. Brandt attaches less physiological significance to symbiosis than does Geddes, from whom he still differs in considering even *Hydra* and *Spongilla* as symbiotic and not "vegetating" animals. At present the views of Brandt, as laid down in his last paper (see "Mitt. aus zool. Stat. Neapel," iv, ii, 1883), seem likely to prevail; and in that article the student will find a complete literature and a full discussion of the whole subject.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

XIII.

THE process of frying follows next in natural order to those of roasting and grilling. A little reflection will show that in frying the heat is not communicated to the food by radiation from a heated surface at some distance, but by direct contact with the heating medium, which is the hot fat commonly, but erroneously, described as "boiling fat."

As these papers are intended for intelligent readers who desire to understand the philosophy of the common processes of cookery, so far as they are understandable, this fallacy concerning boiling fat should be pushed aside at once.

Generally speaking, ordinary animal fats are not boilable under the pressure of our atmosphere (one of the constituent fatty acids of butter, butyric acid, is an exception; it boils at 314° Fahr.). Before their boiling-point, i. e., the temperature at which they pass completely into the state of vapor, is reached, their constituents are more or less dissociated or separated by the repulsive agency of the heat, new compounds being in many cases formed by recombinations of their elements.

When water is heated to 212° it is converted completely into a gas, which gas returns to the fluid state without any loss on cooling below 212°. In like manner if we raise an essential-oil, such as turpentine, to 320°, or oil of peppermint to 340°, or orange-peel oil to 345°, or patchouli to 489°, and other such oils to various other temperatures, they pass into a state of vapor, and these vapors, when cooled, recondense into their original form of liquid oil without alteration. Hence they are called "volatile oils," while the greasy oils which can not thus be distilled (in which animal fats are included) are called "fixed oils."

A very simple practical means of distinguishing these is the following: Make a spot of the oil to be tested on clean blotting-paper. Heat this by holding it above a spirit-lamp flame, or by toasting before a fire. If the oil is volatile, the spot disappears; if fixed, it remains as a spot of grease until the heat is raised high enough to char the paper, of which charring (a result of the dissociation above-named) the oil partakes.

But the practical cook may say, "This is wrong, for the fat in my frying-pan does boil, I see it boil, and I hear it boil." The reply to this is, that the lard, or dripping, or butter that you put into your frying-pan is oil mixed with water, and that it is not the oil but the water that you see boiling. To prove this, take some fresh lard, as usually supplied, and heat it in any convenient vessel, raising the temperature gradually. Presently, it will begin to splutter. If you try it with a thermometer you will find that this spluttering-point agrees with the boiling-point of water, and if you use a retort you may condense and collect the splutter-matter, and prove it to be water. So long as the spluttering continues, the temperature of the melted fat, i. e., the oil, remains about the same, the water-vapor carrying away the heat. When all the water is driven off, the liquid becomes quiescent, in spite of its temperature, rising from 212° to near 400°, then a smoky vapor comes off and the oil becomes darker; this vapor is not vapor of lard, but vapor of separated and recombined constituents of the lard, which is now suffering dissociation, the volatile products passing off while the non-volatile carbon (i. e., lard-charcoal) remains behind, coloring the liquid. If the heating be continued, a residuum of this carbon, in the form of soft coke or charcoal, will be all that remains in the heated vessel.

We may now understand what happens when something humid—say a sole—is put into a frying-pan which contains fat heated above 212°. Water, when suddenly heated above its boiling-point, is a powerful explosive, and may be very dangerous, simply because it expands to 1,728 times its original bulk when converted into steam. Steam-engine boilers and the boilers of kitchen-stoves sometimes explode simply by becoming red-hot while dry, and then receiving a little water which suddenly expands to steam.

The noise and spluttering that are started immediately the sole is immersed in the hot fat, are due to the explosions of a multitude of small bubbles formed by the confinement of the suddenly expanding steam in the viscous fat, from which it releases itself with a certain degree of violence. It is evident that, to effect this amount of eruptive violence, the temperature must be considerably above the boiling-point of the exploding water. If it were only just at the boiling-point, the water would boil quietly.

As we all know, the flavor and appearance of a boiled sole or mackerel are decidedly different from those of a fried sole or mackerel, and it is easy to understand that the different results of these cooking processes are to some extent due to the difference of temperature to which the fish is subjected.

The surface of the fried fish, like that of the roasted or grilled meat, is "browned." What is the nature, the chemistry of this browning?

I have endeavored to find some answer to this question, that I might quote with authority, but no technological or purely chemical work within my reach supplies such answer. Rumford refers to it as essential to roasting, and provides for it in the manner already described, but he goes no further into the philosophy of it than admitting its flavoring effect.

I must therefore struggle with the problem in my own way as I best can. Has the gentle reader ever attempted the manufacture of "hard-bake," or "toffy," or "butter-scotch," by mixing sugar with butter, fusing the mixture, and heating further until the well-known hard, brown confection is produced? I venture to call this fried sugar. If heated simply without the butter it may be called baked sugar. The scientific name for this baked sugar is *caramel.*

The chemical changes that take place in the browning of sugar have been more systematically studied than those which occur in the constituents of flesh when browned in the course of ordinary cookery. Believing them to be nearly analogous, I will state, as briefly as possible, the leading facts concerning the sugar.

Ordinary sugar is crystalline, i. e., when it passes from the liquid to the solid state it assumes regular geometrical forms. If the solidification takes place undisturbed and slowly, the geometric crystals are large, as in sugar-candy; if the water is rapidly evaporated with agitation, the crystals are small, and the whole mass is a granular aggregation of crystals, such as we see in loaf-sugar. If this crystalline sugar be heated to about 320° it fuses, and without any change of chemical composition undergoes some sort of internal physical alteration that makes it cohere in a different fashion. (The learned name for this is *allotropism*, and the substance is said to be *allotropic*, other conditioned; or *dimorphic*, two-shaped.) Instead of being crystalline the sugar now becomes vitreous, it solidifies as a transparent amber-colored glass-like substance, the well-known barley-sugar, which differs from crystalline sugar, not only in this respect, but has a much lower melting-point; it liquefies between 190° and 212°, while loaf-sugar does not fuse below 320°. Left to itself, vitreous sugar returns gradually to its original condition, loses transparency, and breaks up into small crystals. In doing this, it gives out the heat which during its vitreous condition had been doing the work of breaking up its crystalline structure, and therefore was not manifested as temperature.

This return to the crystalline condition is retarded by adding vinegar or mucilaginous matter to the heated sugar, hence the confectioners' name of "barley-sugar," which, in one of its old-fashioned forms, was prepared by boiling down ordinary sugar in a decoction of pearl barley.

The French cooks and confectioners carry on the heating of sugar through various stages bearing different technical names, one of the most remarkable of which is a splendid crimson variety, largely used in fancy sweetmeats, and containing no foreign coloring-matter, as commonly supposed. Though nothing is added, something is taken away, and this is some of the chemically-combined water of the original sugar, in the parting with which not only a change of color occurs, but also a modification of flavor, as anybody may prove by experiment.

When the temperature is gradually raised to 420°, the sugar loses two equivalents of water, and becomes *caramel*—a dark-brown substance, no longer sweet, but having a new flavor of its own. It further differs from sugar by being incapable of fermentation. Its analogies to the crust of bread and the "brown" of cooked animal food will be further discussed in my next.

XIV.

In my last I described the dissociation of sugar by heat and the formation of caramel, to illustrate by simple example the "browning" of other kinds of food. I might have added, in connection with this cookery of sugar, an historical connection with one of the lost arts of the kitchen—viz., the "spinning" of sugar. Within the reach of my own recollection no evening party could pretend to be stylish unless the supper-table was decorated with a specimen of this art—a temple, a pagoda, or something of the sort done in barley-sugar. These were made by raising the sugar to 320°, when it fused and became amorphous, or vitreous, as already described. The cook then dipped a skewer into it, the melted vitreous sugar adhered to this and was drawn out as a thread, which speedily solidified by cooling. While in the act of solidification it was woven into the desired form, and the skillful artist did this with wonderful rapidity. I once witnessed with childish delight the spinning of a great work of art by a French cook in St. James's Palace. It was a ship in full sail, the sails of edible wafer, the hull a basket-work of spun sugar, the masts of massive sugar-sticks, and the rigging of delicate threads of the same. As nearly as I can remember, the whole was completed in about an hour.

But to return from high art to chemical science. The conversion of sugar into caramel is, as already stated, attended with a change of flavor: a kind of bitterness replaces the sweetness. This peculiar flavor, judiciously used, is a powerful adjunct to cookery, and one which is shamefully neglected in our ordinary English domestic kitchens. To test this, go to one of those Swiss restaurants originally instituted in this country by that enterprising Ticinese, the late Carlo Gatti, and which are now so numerous in London and our other large towns; call for *macaroni al sugo;* notice the rich, brown gravy, the "sugo." Many an English cook would use half a pound of gravy-beef to produce the like, but the basis of this is half an ounce of sugar, or even less; the sugar is browned by heating, not quite up to the caramel state. Burnt onion may contribute, but this is only another form of caramel with more savory properties.

While engaged upon your macaroni, look around at the other dishes served to other customers. Instead of the pale slices of meat spread out in a little puddle of pale, watery liquid, that are served in English restaurants of corresponding class, you will see dainty morsels, covered with rich, brown gravy, or surrounded by vegetables immersed in the same. This sugo is greatly varied according to the requirements, by additions of stock-broth, tarragon-vinegar, ketchup, etc., etc., but burnt sugar, or burnt onions, or burnt something is the basis of it all, sugar being the cheapest.

To further test the flavoring properties of browning, take some eels cut up as usual for stewing; divide into two portions; stew one brutally—by this I mean simply in a little water—serving them with this water as a pale gravy or juice. Let the second portion be well fried, fully browned, then stewed, and served with brown gravy. Compare the result. Make a corresponding experiment with a beef-steak. Cut it in two portions: stew one brutally in plain water; fry the other, then stew it and serve brown.

Take a highly-baked loaf, better one that is black outside; scrape off the film or crust that is quite black, i. e., completely carbonized, and you will come to a rich brown layer, especially if you operate upon the bottom crust. Slice off a thin shaving of this, and eat it critically. Mark its high flavor as compared with the comparatively insipid crumb of the same loaf, and note especially the resemblance between this flavor and that of the caramel from sugar, and that of the browned eels and browned steak. A delicate way of detecting the flavor due to the browning of bread is to make two bowls of bread and milk in the same manner, one with the crust, the other with the crumb of the same loaf. I am not suggesting these as examples of better or worse flavor, but as evidence of the fact that much flavor of some sort is generated. It may be out of place, as I think it is, in the bread and milk, or it may be added with much advantage to other things, as it is by the cook who manipulates caramel and its analogues skillfully.

The largest constituent of bread is starch. Excluding water, it constitutes about three fourths of the weight of good wheaten flour. Starch differs but little from sugar in composition. It is easily converted into sugar by simply heating it with a little sulphuric acid, and by other means of which I shall have to speak more fully hereafter when I come to the cookery of vegetables. When simply heated, it is converted into dextrin or "British gum," largely used as a substitute for gum-arabic. If the heat is continued a change of color takes place; it grows darker and darker until it blackens just as sugar does, the final result being nearly the same. Water is driven off in both cases, but in carbonizing sugar we start with more water, sugar being starch plus water or the elements of water. Thus the brown material of bread-crust or toast is nearly identical with caramel.

I have often amused myself by watching what occurs when toast-and-water is prepared, and I recommend my readers to repeat the observation. Toast a small piece of bread to blackness, and then float it on water in a glass vessel. Leave the water at rest, and direct your attention to the under side of the floating toast. Little thread-like streams of brown liquid will be seen descending in the water. This is a solution of the substance which, if I mistake not, is a sort of caramel, and which ultimately tinges all the water.

Some years ago I commenced a course of experiments with this substance, but did not complete them. In case I should never do so, I will here communicate the results attained. I found that this starch caramel is a disinfectant, and that sugar caramel also has some disinfecting properties. I am not prepared to say that it is powerful enough to disinfect sewage, though at the time I had a narrow escape from the Great-Seal Office, where I thought of patenting it for this purpose as a non-poisonous disinfectant that may be poured into rivers in any quantity without danger. Though it may not be powerful enough for this, it has an appreciable effect on water slightly tainted with decomposing organic matter.

This is a very curious fact. We do not know who invented toast-and-water, nor, so far as I can learn, has any theory of its use been expounded, yet there is extant a vague, popular impression that the toast has some sort of wholesome effect on the water. I suspect that this must have been originally based on experience, probably on the experience of our forefathers or foremothers living in country places where stagnant water was a common beverage, and various devices were adopted to render it potable.

Gelatine, fibrine, albumen, etc.—i. e., all the materials of animal food—as already shown, are composed, like starch and sugar, of carbon, hydrogen, and oxygen, with, in the case of these animal substances, the addition of nitrogen; but this does not prevent their partial carbonization (or "caramelizing," if I may invent a name to express the action which stops short of blackening). Animal fat is a hydrocarbon which may be similarly browned, and, if I am right in my generalization of all these browning processes, an important practical conclusion follows, viz., that cheap soluble caramel made by skill-fully heating common sugar, is really, as well as apparently, as valuable an element in gravies, etc., as the far more expensive coloring-matter of brown meat-gravies, and that our English cooks should use it far more liberally than they usually do.

Its preparation is easy enough; the sugar should be gradually heated till it assumes a rich brown color and has lost its original sweetness. If carried just far enough, and not too far, the result is easily soluble in hot water, and the solution may be kept for a long time, as it is by cooks who understand its merits. In connection with the idea of its disinfecting action, I may refer to the cookery of tainted meat or "high" game. A hare that is repulsively advanced when raw, may by much roasting and browning become quite wholesome, and such is commonly the case in the ordinary cooking of hares. If it were boiled or merely stewed (without preliminary browning) in this condition, it would be quite disgusting to ordinary palates.

A leg of mutton for roasting should be hung until it begins to become odorous; for boiling it should be as fresh as possible. This should be especially remembered now that we have so much frozen meat imported from the antipodes. When duly thawed it is in splendid condition for roasting, but is not usually so satisfactory when boiled. I may here mention incidentally that such meat is sometimes unjustly condemned on account of its displaying a raw center when cooked. This arises from imperfect thawing. The heat required to thaw a given weight of ice and bring it up to 60°, is about the same as demanded for the cookery of an equal quantity of meat, and therefore, while the thawed portions of the meat is being cooked, the frozen portion is but just thawed, and remains quite raw.

A much longer time is demanded for thawing—i. e., supplying 142° of latent heat—than might be supposed. To ascertain whether the thawing is completed, drive an iron skewer through the thickest part of the joint. If there is a core of ice within, it will be distinctly felt by its resistance.

XV.

Before leaving the subject of caramel, I should say a few words about French coffee, or "coffee as in France," of which we hear so much. There are two secrets upon which depend the excellence of our neighbors in the production of this beverage: First, economy in using the water; second, flavoring with caramel. As regards the first, it appears that English housewives have been demoralized by the habitual use of tea, and apply to the infusion of coffee the popular formula for that of tea, "a spoonful for each person and one for the pot."

The French after-dinner coffee-cup has about one third of the liquid capacity of a full-sized English breakfast-cup, but the quantity of solid coffee supplied to each cupful is more than equal to that ordinarily allowed for the larger English measure of water.

Besides this, the coffee is commonly though not universally flavored with a specially and skillfully prepared caramel, instead of the chiccory so largely used in England. Much of the so-called "French coffee" now sold by our grocers in tins is caramel flavored with coffee, rather than coffee flavored with caramel; and many shrewd English housewives have discovered that, by mixing the cheapest of these French coffees with an equal quantity of pure coffee, they obtain a better result than with the common domestic mixture of three parts coffee and one of chiccory.

A few months ago a sample of "coffee-finings" was sent to me for chemical examination, that I might certify to its composition and wholesomeness. I described it in my report as "a caramel, with a peculiarly rich aroma and flavor, evidently due to the vegetable juices or extractive matter naturally united with the saccharine substance from which it is prepared." I had no definite information of the exact nature of this saccharine substance, but have good reason to assume that it was a by-product of sugar-refining.

Neither the juice of the beet-root nor the sap of the sugar-cane consists entirely of pure sugar dissolved in pure water. They both contain other constituents common to vegetable juices, and some peculiar to themselves. These mucilaginous matters, when roughly separated, carry down with them some sugar, and form a sort of coarse sweet-wort, capable, by skillful treatment, of producing a rich caramel such as I received.

I tested its practical merits by making an infusion of pure coffee of fine quality, dividing this into two parts, adding to one a small quantity of the caramel, and leaving the other half unmixed. I found the infusion greatly improved in flavor by the admixture, and recognized the peculiarity which characterizes the coffee prepared by Gatti and his compatriots, whose numerous establishments are doing so much for the promotion of temperance in this country. The aroma of this particular caramel is peculiarly fine, and the greater part of it is soluble in boiling water; thus I was able to mix it by merely adding to the coffee as we add sugar.

I have used my best eloquence in trying to persuade the manufacturers to sell it separately, but have not yet succeeded. They seem to have had painful experience of the gastronomic bigotry of Englishmen, who refuse to eat or drink anything that is not hallowed by the sanction of their great-grandmothers, unless it is surreptitiously introduced by means of some device approaching as nearly as possible to a commercial swindle.

Returning to the subject of frying, we encounter a good illustration of the practical importance of sound theory. A great deal of fish and other kinds of food are badly and wastefully cooked in consequence of the prevalence of a false theory of frying. It is evident that many domestic cooks (not hotel or restaurant cooks) have a vague idea that the metal plate forming the bottom of the frying-pan should directly convey the heat of the fire to the fried substance, and that the bit of butter or lard or dripping put into the pan is used to prevent the fish from sticking to it, or to add to the richness of the fish by smearing its surface.

The theory which I have suggested (see No. XIII, page 818) is that the melted fat cooks by convection of heat, just as water does in the so-called boiling of meat. If that is correct, it is evident that the fish, etc., should be completely immersed in a bath of melted fat or oil, and that the turning over demanded by the greased-plate theory is unnecessary. Well-educated cooks understand this distinctly, and use a deeper vessel than our common frying-pan, charge this with a quantity of fat sufficient to cover the fish, which is simply laid upon a wire support, or frying-basket, and left in the hot fat until the browning of its surface, or of the flour or bread-crumbs with which it is coated, indicates the sufficiency of the cookery.

At first sight this appears extravagant, as compared with the practice of greasing the bottom of the pan with a little dab of fat; but any housewife who will apply to the frying of sprats, herrings, etc., the method of quantitative inductive research, described and advocated by Lord Bacon in his "Novum Organum Scientarum," may prove the contrary.

"Must I read the 'Novum Organum,' and buy another dictionary, in order to translate all this?" she may exclaim in despair. "No!" is my reply. This Baconian inductive method, to which we are indebted for all the triumphs of modern science, is nothing more nor less than the systematic and orderly application of common sense and definite measurement to practical questions. In this case it may be applied simply by frying a weighed quantity of any particular kind of fish—say sprats—in a weighed quantity of fat used as a bath; then weighing the fat that remains and subtracting the latter weight from the first, to determine the quantity consumed. If the frying be properly performed, and this quantity compared with that which is consumed by the method of merely greasing the pan-bottom, the bath-frying will be proved to be the more economical as well as the more efficient method.

The reason of this is simply that much or all of the fat is burned and wasted when only a thin film is spread on the bottom of the pan, while no such waste occurs when the bath of fat is properly used. The temperature at which the dissociation of fat *commences* is below that required for delicately browning the surface of the fish itself, or of the flour or bread-crumbs, and therefore no fat is burned away from the bath, as it is by the overheated portions of a merely greased frying-pan; and, as regards the quantity adhering to the fish itself, this may be reduced to a minimum by withdrawing it from the bath when *the whole* is uniformly at the maximum cooking temperature, and allowing the fluid fat to drain off at once. When cooked on the greased plate, one side is necessarily cooling, and the fat settling down into the fish, while the other is being heated from below.

SOME UNSOLVED PROBLEMS IN GEOLOGY.*

By Dr. J. W. DAWSON.

I.

MY predecessor in office remarked, in the opening of his address, that two courses are open to the retiring president of this Association in preparing the annual presidential discourse—he may either take up some topic relating to his own specialty, or he may deal with various or general matters relating to science and its progress. A geologist, however, is not necessarily tied up to one or the other alternative. His subject covers the whole history of the earth in time. At the beginning it allies itself with astronomy and physics and celestial chemistry. At the end it runs into human history, and is mixed up with archæology and anthropology. Throughout its whole course it has to deal with questions of meteorology, geography, and biology. In short, there is no department of physical or biological science with which geology is not allied, or at least on which the geologist may not presume to trespass. When, therefore, I announce as my subject on the present occasion some of the unsolved problems of this universal science, you need not be surprised if I should be somewhat discursive.

Perhaps I shall begin at the utmost limits of my subject by remarking that in matters of natural and physical science we are met at the outset with the scarcely solved question as to our own place in the nature which we study, and the bearing of this on the difficulties we encounter. The organism of man is decidedly a part of nature. We place ourselves, in this aspect, in the sub-kingdom vertebrata, and class mammalia, and recognize the fact that man is the terminal link in a chain of being, extending throughout geological time. But the organism is not all of man; and, when we regard man as a scientific animal, we raise a new question. If the human mind is a part of nature, then it is subject to natural law; and nature includes mind as well as matter. On the other hand, without being absolute idealists, we may hold that mind is more potent than matter, and nearer to the real essence of things. Our science is in any case necessarily dualistic, being the product of the reaction of mind on nature, and must be largely subjective and anthropomorphic. Hence, no doubt, arise much of the controversy of science and much of the unsolved difficulty.

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

We recognize this when we divide science into that which is experimental, or depends on apparatus, and that which is observational and classificatory—distinctions, these, which relate not so much to the objects of science as to our methods of pursuing them. This view also opens up to us the thought that the domain of science is practically boundless; for who can set limits to the action of mind on the universe, or of the universe on mind? It follows that science must be limited on all sides by unsolved mysteries; and it will not serve any good purpose to meet these with clever guesses. If we so treat the enigmas of the sphinx Nature, we shall surely be devoured. Nor, on the other hand, must we collapse into absolute despair, and resign ourselves to the confession of inevitable ignorance. It becomes us, rather, boldly to confront the unsolved questions of Nature, and to wrestle with their difficulties till we master such as we can, and cheerfully leave those we can not overcome to be grappled with by our successors.

Fortunately, as a geologist, I do not need to invite your attention to those transcendental questions which relate to the ultimate constitution of matter, the nature of the ethereal medium filling space, the absolute difference or identity of chemical elements, the cause of gravitation, the conservation and dissipation of energy, the nature of life, or the primary origin of bioplasmic matter. I may take the much more humble *rôle* of an inquirer into the unsolved or partially solved problems which meet us in considering that short and imperfect record which geology studies in the rocky layers of the earth's crust, and which leads no further back than to the time when a solid rind had already formed on the earth and was already covered with an ocean. This record of geology covers but a small part of the history of the earth and of the system to which it belongs, nor does it enter at all into the more recondite problems involved; still it forms, I believe, some necessary preparation, at least, to the comprehension of these.

What do we know of the oldest and most primitive rocks? At this moment the question may be answered in many and discordant ways; yet the leading elements of the answer may be given very simply. The oldest rock formation known to geologists is the lower Laurentian, the fundamental gneiss, the Lewisian formation of Scotland, the Ottawa gneiss of Canada. This formation of enormous thickness corresponds to what the older geologists called the fundamental granite—a name not to be scouted, for gneiss is only a stratified granite. Perhaps the main fact in relation to this old rock is that it is a gneiss; that is, a rock at once bedded and crystalline, and having for its dominant ingredient the mineral orthoclase—a compound of silica, alumina, and potash—in which are imbedded, as in a paste, grains and crystals of quartz and hornblende. We know very well, from its texture and composition, that it can not be a product of mere heat; and, being a bedded rock, we infer that it was laid down layer by layer, in the manner of aqueous deposits. On the other hand, its chemical composition is quite different from that of the muds, sands, and gravels usually deposited from water. Their special characters are caused by the fact that they have resulted from the slow decay of rocks like these gneisses, under the operation of carbonic acid and water, whereby the alkaline matter and the more soluble part of the silica have been washed away, leaving a residue mainly silicious and aluminous. Such more modern rocks tell of dry land subjected to atmospheric decay and rain-wash. If they have any direct relation to the old gneisses, they are their grandchildren, not their parents. On the contrary, the oldest gneisses show no pebbles, or sand, or limestone—nothing to indicate that there was then any land undergoing atmospheric waste, or shores with sand and gravel. For all that we know to the contrary, these old gneisses may have been deposited in a shoreless sea, holding in solution or suspension merely what it could derive from a submerged crust recently cooled from a state of fusion, still thin, and exuding here and there through its fissures heated waters and volcanic products.

It is scarcely necessary to say that I have no confidence in the supposition of unlike composition of the earth's mass on different sides, on which Dana has partly based his theory of the origin of continents. The most probable conception seems to be that of Lyell; namely, a molten mass, uniform except in so far as denser material might exist toward its center, and a crust at first approximately even and homogeneous, and subsequently thrown into great bendings upward and downward. This question has recently been ably discussed by Mr. Crosby in the London "Geological Magazine." *

In short, the fundamental gneiss of the lower Laurentian may have been the first rock ever formed; and in any case it is a rock formed under conditions which have not since recurred, except locally. It constitutes the first and best example of these chemico-physical, aqueous or aqueo-igneous rocks, so characteristic of the earliest period of the earth's history. Viewed in this way, the lower Laurentian gneiss is probably the oldest kind of rock we shall ever know—the limit to our backward progress, beyond which there remains nothing to the geologist except physical hypotheses respecting a cooling, incandescent globe. For the chemical conditions of these primitive rocks, and what is known as to their probable origin, I must refer you to my friend Dr. Sterry Hunt, to whom we owe so much of what is known of the older crystalline rocks,† as well as of their literature and the questions which they raise. My purpose here is to sketch the remarkable difference which we meet as we ascend into the middle and upper Laurentian.

In the next succeeding formation, the true lower Laurentian of Logan, the Grenville series of Canada, we meet with a great and sig-

* June, 1883.

† Hunt, "Essays on Chemical Geology."

nificant change. It is true we have still a predominance of gneisses which may have been formed in the same manner with those below them; but we find these now associated with great beds of limestone and dolomite, which must have been formed by the separation of calcium and magnesium carbonates from the sea-water, either by chemical precipitation or by the agency of living beings. We have also quartzite, quartzose gneisses, and even pebble-beds, which inform us of sand-banks and shores. Nay, more, we have beds containing graphite which must be the residue of plants, and iron-ores which tell of the deoxidation of iron oxide by organic matters. In short, here we have evidence of new factors in world-building—of land and ocean, of atmospheric decay of rocks, of deoxidizing processes carried on by vegetable life on the land and in the waters, of limestone-building in the sea. To afford material for such rocks, the old Ottawa gneiss must have been lifted up into continents and mountain-masses. Under the slow but sure action of the carbonic dioxide dissolved in rain-water, its feldspar had crumbled down in the course of ages. Its potash, soda, lime, magnesia, and part of its silica, had been washed into the sea, there to enter into new combinations and to form new deposits. The crumbling residue of fine clay and sand had been also washed down into the borders of the ocean, and had been there deposited in beds.* Thus the earth had entered into a new phase, which continues onward through the geological ages; and I place in your hands one key for unlocking the mystery of the world when I affirm that this great change took place, this new era was inaugurated, in the midst of the Laurentian period.

Was not this time a fit period for the first appearance of life? Should we not expect it to appear, independently of the evidence we have of the fact? I do not propose to enter here into that evidence, more especially in the case of the one well-characterized Laurentian fossil, *Eozoön Canadense*. I have already amply illustrated it elsewhere. I would merely say here, that we should bear in mind that in this latter half of the lower Laurentian, or, if we so choose to style it, middle Laurentian period, we have the conditions required for life in the sea and on the land; and, since in other periods we know that life was always present when its conditions were present, it is not unreasonable to look for the first traces of life in this formation, in which we find for the first time the completion of those physical arrangements which make life, in such forms of it as exist on our planet, possible.

This is also a proper place to say something of the doctrine of what is termed "metamorphism." The Laurentian rocks are undoubtedly greatly changed from their original state, more especially in the matters of crystallization and the formation of disseminated minerals by

* Dr. Hunt has now in preparation for the press an important paper on this subject, read before the National Academy of Sciences.

the action of heat and heated water. Sandstones have thus passed into quartzites, clays into slates and schists, limestones into marbles. So far metamorphism is not a doubtful question; but, when theories of metamorphism go so far as to suppose an actual change of one element for another, they go beyond the bounds of chemical credibility: yet such theories of metamorphism are often boldly advanced and made the basis of important conclusions. Dr. Hunt has happily given the name "metasomatosis" to this imaginary and impossible kind of metamorphism, which may be regarded as an extreme kind of evolution, akin to some of those forms of that theory employed with reference to life, but more easily detected and exposed. I would have it to be understood that, in speaking of the metamorphism of the older crystalline rocks, it is not to this metasomatosis that I refer, and that I hold that rocks which have been produced out of the materials decomposed by atmospheric erosion can never, by any process of metamorphism, be restored to the precise condition of the Laurentian rocks. Thus there is in the older formations a genealogy of rocks which, in the absence of fossils, may be used with some confidence, but which does not apply to the more modern deposits. Still, nothing in geology absolutely perishes or is altogether discontinued; and it is probable that, down to the present day, the causes which produced the old Laurentian gneiss may still operate in limited localities. Then, however, they were general, not exceptional. It is further to be observed that the term "gneiss" is sometimes of wide and even loose application. Besides the typical orthoclase and hornblendic gneiss of the Laurentian, there are micaceous, quartzose, garnetiferous, and many other kinds of gneiss; and even gneissose rocks, which hold labradorite or anorthite instead of orthoclase, are sometimes, though not accurately, included in the term.

The Grenville series, or middle Laurentian, is succeeded by what Logan in Canada called the upper Laurentian, and which other geologists have called the Norite or Norian series. Here we still have our old friends the gneisses, but somewhat peculiar in type; and associated with them are great beds rich in lime-feldspar—the so-called labradorite and anorthite rocks. The precise origin of these is uncertain, but this much seems clear, namely, that they originated in circumstances in which the great limestones deposited in the lower or middle Laurentian were beginning to be employed in the manufacture, probably by aqueo-igneous agencies, of lime-feldspars. This proves the Norian rocks to be much younger than the Laurentian, and that, as Logan supposed, considerable earth-movements had occurred between the two, implying lapse of time.

Next we have the Huronian of Logan—a series much less crystalline and more fragmentary, and affording more evidence of land elevation and atmospheric and aqueous erosion, than any of the others. It has great conglomerates, some of them made up of rounded pebbles of Laurentian rocks, and others of quartz-pebbles, which must have been the remains of rocks subjected to very perfect erosion. The pure quartz-rocks tell the same tale, while limestones and slates speak also of chemical separation of the materials of older rocks. The Huronian evidently tells of movements in the previous Laurentian, and changes in its texture so great that the former may be regarded as a comparatively modern rock, though vastly older than any part of the palæozoic series.

Still later than the Huronian is the great micaceous series called by Hunt the Mont Alban or White Mountain group, and the Taconian or lower Taconic of Emmons, which recalls in some measure the conditions of the Huronian. The precise relations of these to the later formations, and to certain doubtful deposits around Lake Superior, can scarcely be said to be settled, though it would seem that they are all older than the fossiliferous Cambrian rocks which practically constitute the base of the palæozoic. I have, I may say, satisfied myself, in regions which I have studied, of the existence and order of these rocks as successive formations, though I would not dogmatize as to the precise relations of those last mentioned, or as to the precise age of some disputed formations which may either be of the age of the older eozoic formations, or may be peculiar kinds of palæozoic rocks modified by metamorphism. Probably neither of the extreme views now agitated is absolutely correct.

After what has been said, you will perhaps not be astonished that a great geological battle rages over the old crystalline rocks. By some geologists they are almost entirely explained away, or referred to igneous action or to the alteration of ordinary sediments. Under the treatment of another school, they grow to great series of pre-Cambrian rocks, constituting vast systems of formations, distinguishable from each other, not by fossils, but by differences of mineral character. I have already indicated the manner in which I believe the dispute will ultimately be settled, and the President of the Geological Section will treat it more fully in his opening address.

After the solitary appearance of Eozoön in the Laurentian, and of a few uncertain forms in the Huronian and Taconian, we find ourselves in the Cambrian, in the presence of a nearly complete invertebrate fauna of protozoa, polyps, echinoderms, mollusks, and crustacea; and this not confined to one locality merely, but apparently extended simultaneously throughout the ocean. This sudden incoming of animal life, along with the subsequent introduction of successive groups of invertebrates, and finally of vertebrate animals, furnishes one of the greatest of the unsolved problems of geology, which geologists were wont to settle by the supposition of successive creations. In an address delived at the Detroit meeting of the Association in 1875, I endeavored to set forth the facts as to this succession, and the general principles involved in it, and to show the insufficiency of the theories of evolution suggested by biologists to give any substantial aid to the geologist in these questions. In looking again at the points there set forth, I find they have not been invalidated by subsequent discoveries, and that we are still nearly in the same position with respect to these great questions that we were in at that time—a singular proof of the impotency of that deductive method of reasoning which has become fashionable among naturalists of late. Yet the discussions of recent years have thrown some additional light on these matters; and none more so than the mild disclaimers with which my friend Dr. Asa Gray and other moderate and scientific evolutionists have met the extreme views of such men as Romanes, Haeckel, Lubbock, and Grant Allen. It may be useful to note some of these as shedding a little light on this dark corner of our unsolved problems.

It has been urged, on the side of rational evolution, that this hypothesis does not profess to give an explanation of the absolute origin of life on our planet, or even of the original organization of a single cell or of a simple mass of protoplasm, living or dead. All experimental attempts to produce by synthesis the complex albuminous substances, or to obtain the living from the non-living, have so far been fruitless; and, indeed, we can not imagine any process by which such changes could be effected. That they have been effected we know; but the process employed by their Maker is still as mysterious to us as it probably was to him who wrote the words, "And God said, Let the waters swarm with swarmers." How vast is the gap in our knowledge and our practical power implied in this admission, which must, however, be made by every mind not absolutely blinded by a superstitious belief in those forms of words which too often pass current as philosophy!

But if we are content to start with a number of organisms ready made—a somewhat humiliating start, however—we still have to ask, How do these vary so as to give new species? It is a singular illusion in this matter, of men who profess to be believers in natural law, that variation may be boundless, aimless, and fortuitous, and that it is by spontaneous selection from varieties thus produced that development arises. But surely the supposition of mere chance and magic is unworthy of science. Varieties must have causes, and their causes and their effects must be regulated by some law or laws. Now, it is easy to see that they can not be caused by a mere innate tendency in the organism itself. Every organism is so nicely equilibrated, that it has no such spontaneous tendency, except within the limits set by its growth and the law of its periodical changes. There may, however, be equilibrium more or less stable. I believe all attempts hitherto made have failed to account for the fixity of certain, nay, of very many, types throughout geological time; but the mere consideration that one may be in a more stable state of equilibrium than another so far explains it. A rocking stone has no more spontaneous tendency to move than an ordinary bowlder, but it may be made to move with a touch. So it probably is with organisms. But, if so, then the causes of variation are external, as in many cases we actually know them to be; and they must depend on instability or change in surroundings, and this so arranged as not to be too extreme in amount, and to operate in some determinate direction. Observe how remarkable the unity of the adjustments involved in such a supposition. How superior they must be to our rude and always more or less unsuccessful attempts to produce and carry forward varieties and races in definite directions! This can not be chance. If it exists, it must depend on plans deeply laid in the nature of things, else it would be most monstrous magic and causeless miracle. Still more certain is this conclusion when we consider the vast and orderly succession made known to us by geology, and which must have been regulated by fixed laws, only a few of which are as yet known to us.

Beyond these general considerations, we have others of a more special character, based on paleontological facts, which show how imperfect are our attempts, as yet, to reach the true causes of the introduction of genera and species.

One is the remarkable fixity of the leading types of living beings in geological time. If, instead of framing, like Haeckel, fanciful phylogenies, we take the trouble, with Barrande and Gaudry, to trace the forms of life through the period of their existence, each along its own line, we shall be greatly struck with this, and especially with the continuous existence of many low types of life through vicissitudes of physical conditions of the most stupendous character, and over a lapse of time scarcely conceivable. What is still more remarkable is, that this holds in groups which, within certain limits, are perhaps the most variable of all. In the present world no creatures are individually more variable than the protozoa; as, for example, the foraminifera and the sponges. Yet these groups are fundamentally the same, from the beginning of the palæozoic until now; and modern species seem scarcely at all to differ from specimens procured from rocks at least half-way back to the beginning of our geological record. If we suppose that the present sponges and foraminifera are the descendants of those of the Silurian period, we can affirm that, in all that vast lapse of time, they have, on the whole, made little greater change than that which may be observed in variable forms at present. The same remark applies to other low animal forms. In forms somewhat higher and less variable, this is equally noteworthy. The pattern of the venation of the wings of cockroaches and the structure and form of land-snails, gally-worms, and decapod crustaceans were all settled in the carboniferous age in a way that still remains. So were the foliage and the fructification of club-mosses and ferns. If at any time members of these groups branched off, so as to lay the foundation of new species, this must have been a very rare and exceptional occurrence, and one demanding even some suspension of the ordinary laws of nature.

Certain recent utterances of eminent scientific men in England and France are most instructive with reference to the difficulties which encompass this subject. Huxley, at present the leader of English evolutionists, in his "Rede Lecture" * delivered at Cambridge, England, holds that there only two "possible alternative hypotheses" as to the origin of species: 1. That of "construction," or the mechanical putting together of the materials and parts of each new species separately; and, 2. That of "evolution," or that one form of life "proceeded from another" by the "establishment of small successive differences." After comparing these modes, much to the disadvantage of the first, he concludes with the statement that "this was his case for evolution, which he rested wholly on arguments of the kind he had adduced"; these arguments being the threadbare false analogy of ordinary reproduction and the transformation of species, and the mere succession of forms more or less similar in geological time, neither of them having any bearing whatever on the origin of any species or on the cause of the observed succession. With reference to the two alternatives, while it is true that no certain evidence has yet been obtained—either by experiment, observation, or sound induction—as to the mode of origin of any species, enough is known to show that there are numerous possible methods, grouped usually under the heads of absolute creation, mediate creation, critical evolution, and gradual evolution. It is also true that almost the only thing we certainly know in the matter is, that the differences characteristic of classes, orders, genera, and species, must have arisen, not in one or two, but in many ways. An instructive commentary on the capacity of our age to deal with these great questions is afforded by the fact that this little piece of clever mental gymnastic should have been practiced in a university lecture and in presence of an educated audience. It is also deserving of notice that, though the lecturer takes the development of the Nautili and their allies as his principal illustration, he evidently attaches no weight to the argument in the opposite sense deduced by Barrande — the man of all others most profoundly acquainted with these animals—from the palæozoic cephalopods.

Another example is afforded by a lecture recently delivered at the Royal Institution in London by Professor Flower.† The subject is, "The Whales, Past and Present, and their Probable Origin." The latter point, as is well known, Gaudry has candidly given up. "We have questioned," he says, "these strange and gigantic sovereigns of the tertiary oceans as to their ancestors—they leave us without reply." Flower is bold enough to face this problem; and he does so in a fair and vigorous way, though limiting himself to the supposition of slow and gradual change. He gives up at once, as every anatomist must,

* Report in "Nature," June 21st, corrected by the author. † Reported in "Nature."

the idea of an origin from fishes or reptiles. He thinks the ancestors of the whales must have been quadrupedal mammals. He is obliged, for good reasons, to reject the seals and the otters, and turns to the ungulates, though here, also, the difficulties are formidable. Finally he has recourse to an imaginary ancestor, supposed to have haunted marshes and rivers of the mesozoic age and to have been intermediate between a hippopotamus and a dolphin, and omnivorous in diet. As this animal is altogether unknown to geology or zoölogy, and not much less difficult to account for than the whales themselves, he very properly adds, "Please to recollect, however, that this is a mere speculation." He trusts, however, that such speculations are "not without their use"; but this will depend upon whether or not they lead men's minds from the path of legitimate science into the quicksands of baseless conjecture.

Gaudry, in his recent work, "Enchainements du Monde Animal,"* though a strong advocate of evolution, is obliged in his final *résumé* to say: "Il ne laisse point percer le mystère qui entoure le developpement primitif des grandes classes du monde animal. Nul homme ne sait comment ont été formés les premiers individus de foraminifères, de polypes, d'étoiles de mer, de crinoides, etc. Les fossiles primaires ne nous ont pas encore fourni de preuves positives du passage des animaux d'une classe à ceux d'une autre classe."

Professor Williamson, of Manchester, in an address delivered in February last before the Royal Institution of Great Britain, after showing that the conifers, ferns, and lycopods of the palæozoic have no known ancestry, uses the significant words, "The time has not yet arrived for the appointment of a botanical king-at-arms and constructor of pedigrees."

Another caution which a paleontologist has occasion to give with regard to theories of life has reference to the tendency of biologists to infer that animals and plants were introduced under embryonic forms, and at first in few and imperfect species. Facts do not substantiate this. The first appearance of leading types of life is rarely embryonic. On the contrary, they often appear in highly perfect and specialized forms; often, however, of composite type, and expressing characters afterward so separated as to belong to higher groups. The trilobites of the Cambrian are some of them of few segments, and, so far, embryonic; but the greater part are many-segmented and very complex. The batrachians of the carboniferous present many characters higher than those of their modern successors, and now appropriated to the true reptiles. The reptiles of the Permian and trias usurped some of the prerogatives of the mammals. The ferns, lycopods, and equisetums of the Devonian and carboniferous were, to say the least, not inferior to their modern representatives. The shell-bearing cephalopods of the palæozoic would seem to have possessed

* Paris, 1883.

structures now special to a higher group, that of the cuttle-fishes. The bald and contemptuous negation of these facts by Haeckel and other biologists does not tend to give geologists much confidence in their dicta.

THE COLORS OF FLOWERS.

By AUGUST VOGEL.

WHEN we contemplate the extraordinary diversity of colors offered to us by the numberless flowers and fruits, ranging through all possible gradations from the purest white to the most intense black, we can do no less than admire so surprising a wealth of color-shades, and are naturally prompted to imagine that chemical processes influence their tone and effect the manifold changes. Although we are able to pursue the chemical processes occasioning changes of color in the mineral kingdom—we know, for instance, those occurring during the conversion of the white color of silver chloride into black—those in the living plant, whereby equally striking changes are effected, are unfortunately hidden from our scrutiny. For instance, we do not know the process which causes the immature fruit of the prune-tree to pass from the brightest of green, through the most varying gradations of color into light red, and finally deep dark blue ; although we know that during the process of maturing the percentage of starch is by the aid of the vegetable acids of the fruit gradually converted into sugar, still, this phenomenon is not sufficient to throw light on so extraordinary an alteration of hues. To the operation of light is ascribed an essential influence in determining the vegetable colors ; but that vegetable pigments can also be produced without light is shown by the yellow turnips, carrots, alkanet-roots and other roots, all of which develop their colors within the soil. Not only the light in general, but also its volume, appear to exert an influence upon the intensity of these pigments and their hues. This fact is confirmed by the intense and lively colors of flowers blossoming upon high mountains, and the increase of the flower pigment of the same species of plants with the augmenting elevation, with otherwise the same properties of soil and location. This increase of the pigments, such as is observed upon the Alps and other high mountains, stands most assuredly in connection with the stronger sun radiation at great height. It has further been proved that, under the influence of the almost uninterrupted duration of light during the short Scandinavian summer, many garden flowers of Central Europe gradually increase in intensity after having been acclimatized in Norway. Imported seeds of winter wheat, corn, peas, and beans, grow darker from year to year, until they have finally assumed the hue of native productions. Not alone do flowers, seeds, fruits, and vegetables, become more aromatic in the northern latitudes, through the long constancy of light in summer, but their color also deepens, while the production of sugar decreases from the insufficient quantity of heat. Thorough experiments will reveal the effects of electric light upon vegetation, and we have no doubt that interesting results will be obtained in time, with regard to the influence of this light upon the pigment of flowers.

Our knowledge of the chemistry of vegetable pigments is not yet sufficiently advanced, for which reason the effect of artificial influence upon the color-tone of flowers has not yet received its merited attention. According to my view, tannin is an important factor in the generation of vegetable colors; it is found in almost every plant, the petals not excepted, and by the action of the most varying reagents—alkalies, earths, metallic salts, etc.—it assumes the most manifold hues from pale rose to deep black. A darker color, therefore, is produced in flowers rich in tannin, when manured with iron-salts, since, as everybody knows, tannin and iron-salts dye black, and produce ink. A practical use has been made of this fact in the raising of hortensias and dahlias. The former, which in ordinary soil blossomed pale-red, became sky-blue when transplanted into soil heavily manured with iron ochre, or when occasionally watered with a dilute alum solution. English gardeners succeeded in growing black dahlias by similar manipulations. It is well known to every florist that a change of location, that is, a change of light, temperature, and soil (replanting), occasionally produces new colors, whence it may be deduced that an interrupted nutrition of the flower may, under circumstances, effect a change of color. We see no valid reason why the well-authenticated fact of the change of color produced by manuring with iron oxide, thereby changing the nutrition of the plant, should not be practically employed by the hothouse gardener. Another very singular and successful experiment, in producing a change of color in a bird, has recently been made. A breeder of canary-birds conceived the idea of feeding a young bird with a mixture of steeped bread and finely pulverized red Cayenne pepper. Without injuring the bird, the pigment of the spice passed into the blood, and dyed its plumage deep red. The celebrated ornithologist Russ believes that the color of the plumage of birds might be altered according to desire, by using appropriate reagents.

Apart from chemical operations, there are also physical ones which, I believe, influence the color of flowers. It is a well-known fact that a most intimate relation exists between color and form. We know very well that the minute division of a pigment exerts a great influence upon its shade of color: a solid piece of vermilion does not possess the pale-red hue of the finely pulverized article; it is dark brown, and only shows a high red when scratched with a hard body, the color increasing with a continued comminution. Mercury oxide, while deep-red in a crystalline condition, becomes light orange-yellow upon continued pulverization. Deep dark-blue smalt can be converted into a perfectly colorless powder by being pulverized and washed, and no one would recognize it as being identical with the coarsely grained original article. Gold-powder, in its most minute division, does not possess the known yellow color of the metal, but a bluish-green shade, and at first glance would not be held to be metallic gold until the blue-green powder, when fused, reassumes its yellow color. When we introduce a film of gold between two transparent pieces of glass, and hold it against the sun, the rays of the latter will shine through with a bluish-green color; this transparency of gold, however, only occurs when the film is $\frac{1}{2000}$ of a line, or less, in thickness. It is indisputable that in the two instances mentioned here the appearance of color depends upon the minute mechanical division of the pigment, and with this is also connected the alteration in the color of solid bodies, when converted into gas or air. In a gaseous (therefore a very minutely divided) condition, black iodine becomes violet, yellow sulphur red, blue indigo purple. All these instances, to which numerous others might easily be added, prove the intimate connection between color and form. According to my opinion, some similar process, as far as regards form and division, possibly occurs in vegetable nature, and exerts its influence upon the multiplicity of color-shades.

Flower pigments, almost without an exception, are so inconstant and transient that they can not be employed in our industries. They, the children of light, separated from a vital union with the plant, no longer resist the effect of light—they wither and bleach in it. This is unhappily true with the most universally found of all—the leaf-green (chlorophyl). If this pigment could by some means be changed into a fast dye, the poisonous Swinefurt, or Paris-green, would have seen its last days. What an incomparable color is contained in the safflower (*Carthamus tinctorius*), which, although used as a beautiful rose in the dyeing of silk, is unhappily of an unstable nature! The same is true of the splendid yellow of the flowers of the wild *Reseda luteola*. This plant, in spite of the instability of its color, is cultivated in France, England, and different parts of Germany. The white color of various flowers—lilies, roses, and others—is generally produced by a white cellular juice, but may also be due to a white pigment, *artholeucine*, suspended in the colorless cell-juice. These white flowers would offer most suitable material for researches, if the experimental conversion of colors were undertaken. When undecomposed light is reflected by a body, its color appears to us as white. White, therefore, is no actual color, but simply a union of all colors, or the collective rays of light in an unseparated combination. By an alteration of the chemical combination in the plant, by means of an appropriate manure, it becomes possible to cause the fibers of the white petals no longer to reflect upon our eye an undivided white, but a divided colored ray. The yellow or orange coloring-matter of flowers, *anthoxan-*

thine, generally arises from the conversion of the chlorophyl. It occurs most frequently in the form of minute grains; sometimes also dissolved in the juice. Two anthoxanthines, therefore, must be distinguished in flowers—*xanthine*, which is not soluble in water, and *xantheine*, which is. The former dissolves with a gold-yellow color in alcohol and ether, is not affected by alkalies or dilute acids, but is colored green or deep indigo-blue by concentrated sulphuric acid. The soluble xantheine is by alkalies changed into brown. In the blue, violet, and red flowers (cornflower, hyacinth, violet, larkspur, sword-lily, rose, in the leaves of the red poppy, etc.), the pigment is found dissolved in the flower-juice almost without an exception. The red pigment of the rose, dahlia, peony, and other flowers, as well as that of violet flowers, is, according to recent observations, only a blue colored into red (anthocyanogen), by vegetable acids or acid salts. This is plainly proved by the acid reaction of the juice of red flowers, and the occasionally feeble alkaline reaction of blue petals, as I have universally found, with only a few exceptions.

When contemplating the boundless diversity of the hues of flowers, the very natural question involuntarily arises within us: For whom does the flower blossom in the solitude? For whom does it bloom in all its lavish beauty? No human eye beholds it, and yet it is arrayed in a pomp of hues unsurpassable in the dreary solitude, regardless of human applause. Nevertheless, we must not accept the unnoticed wealth of these manifold hues as due to accident; there is nothing accidental or superfluous in creating Nature, although we fail to perceive its purposes; Nature never wastes its energies in aimless, purposeless productions. As the song of the bird ceases when its plumage is adorned with lustrous, pronounced colors, so also are the colors of the odorous flower found to be more modest when compared with the scentless one, dazzling in the gorgeous brightness of its hues. This well-known, generally correct fact must not be treated as unworthy of consideration or due to accident. The firm belief of a definite, well-arranged connection of all earthly occurrences is deeply implanted within our breast. A well-defined law governs the varied hues of flowers, as offered us by the munificence of Nature, and it will, ere long, be revealed unto the eye of the student.

The truth of the celebrated saying of Justus von Liebig, "The knowledge of Nature is the path that leads us to the admiration of the Creator," is also verified here in the soundless laboratory of the colors of flowers.—*Westermann's Monatshefte.*

SKETCH OF DR. MAX VON PETTENKOFER.

"A CHAMPION against the Cholera" is the designation which Dr. Karl Stieler gives to the subject of this sketch, in his admirable biography of him in a former volume of "Daheim," to which we shall be largely indebted for such parts of our own article as are not mere date and detail. Since Dr. Stieler's article was written, Dr. Pettenkofer has distinguished himself by intelligent and thorough investigations in other forms of disease and in more extended fields of sanitary science, to the practical results of which it is impossible to attach too much value.

Max von Pettenkofer was born December 3, 1818, at Lichtenheim, a quiet rural estate not far from Neuberg, on the Danube. When it came time to prepare for his life-career, he went to pursue his studies at Munich, where his uncle was court pharmacist, and there he occupied himself with such branches as were prescribed for students who intended to become physicians—branches which were sharply laid down in an inflexible course, for it at that time seemed a waste, says Dr. Stieler, to study anything that did not pertain to the class-examination. Happily, these studies were suited to the young man's taste; and, when he was graduated Doctor of Medicine in 1843, they pointed to the way which he had chosen. After graduation, led in that direction by Fuchs, he turned his attention to chemistry, and pursued that science, with physics, at Munich and Würzburg, and under Liebig at Giessen, steadily keeping his eye fixed on the relation of these branches to the healing art. In 1845 he was assistant in the chief office of the mint in Munich. In 1847, when not quite twenty-nine years old, he began his work as an academical teacher by accepting an appointment as extraordinary professor in the medical faculty at Munich. Six years later, in 1853, he became a regular professor, having in the mean time succeeded his uncle as director of the court pharmacy. Under his management this establishment became a real scientific laboratory. His first labors were predominantly technological, and related to the affinities of gold, the preparation of platinum, and the hydraulic lime of England and Germany. He also found a process for obtaining illuminating gases from wood, and investigated hæmatinon and aventurine glass. He made studies in oil-colors, in the course of which he discovered a valuable method of preserving oil-paintings.

The peculiar and most evident direction, however, in which his activity manifested itself was in the field of public hygiene, in which he has accomplished an extraordinary amount. His first important efforts in this region were his investigations of heating by stoves and by air, of the conditions of house-ventilation, of the influence of soil upon health, and of the physical relations of clothing. In short, this new domain of knowledge opened itself to him on all sides. The conviction had grown up in Germany that the care a people takes for its public health may be regarded as an index of its advance in civilization. This care, he taught, concerns not only the healing of diseases, but even more the guarding against them; by the side of the care for the sick should stand a regard for the preservation of health, which should avail itself of the most recent results of science, and should be exercised by the state as one of its most pressing duties. That these views so made their way in Bavaria that professorships of hygiene, of which he was assigned to that in the University of Munich, were established in the high-schools of that kingdom, was mainly due to Pettenkofer; and the interest in hygienic matters, which was minifested in other ways, was excited chiefly by his motion.

Hygiene of course acquired an increased importance during epidemics, when disease threatened not individuals only, but whole cities and countries. With this category we enter upon the region which Pettenkofer has made the objective point of his activity. The investigations which he published on the nature and spread of the cholera enjoy an authority that is hardly limited by geographical boundaries. Here, indeed, Science has to contend with many unknown factors, and we should contradict the views of our active investigator himself if we should assume to speak of conclusive results. Nearly all in the present theories is provisory; the most varied points of view are opposed one to another; but, notwithstanding this, the beginnings that have been made, and the few fixed points that have been verified with respect to the questions, are a priceless gain. Hardly any other kind of affliction, observes Dr. Stieler, has been in the past so surrounded with superstitions as that of great epidemics. Thousands of persons were murdered in the middle ages on charges of poisoning wells; and, even after this kind of barbarism had disappeared, the terror remained which every danger excites, before which we stand ignorant and defenseless. We have now entered an age of correct discernment; intelligent investigation has taken the place of superstitious fear, and has neutralized its grievous effects by seeking and finding out natural causes. The ghostly element which seemed peculiar to these diseases has been destroyed, for it is no longer able, after the fashion of ghosts, to evade every attack, but has been made accessible and tangible, like every other enemy. Dr. Pettenkofer has had a great part in bringing about the revolution that has taken place, by taking hold of the ghosts, as it were, and compelling them to stand and receive his attacks; and, instead of resigning himself to their supposed machinations, he has taken the chief and leading part in contending against them. His researches have established, however much we may still contend respecting the ultimate origin of cholera, that three conditions appertain to its outbreak in concrete cases, which may be designated as local, temporal, and that of the individual disposition. What we call the locality must have the infectious matter concealed within itself before persons abiding there are affected. Not every time is alike favorable to the infection; and, when place and time concur, only those persons are affected who offer a suitable personal disposition to the poison. Such persons, even in the worst cases, form hardly five per cent of the population. Thus, the spread of cholera is found to be governed by three factors, the operation of which can be comprehended by all. Further, Dr. Pettenkofer has taught that the danger of attack with cholera does not ordinarily come from persons who are sick, but primarily from the place, showing that the physicians are no more liable than others, and greatly relieving the duty of caring for the sick of its most formidable terrors. The rules respecting disinfection, the discovery of a term, not longer than fourteen days, to which the prevalence of cholera in a particular house is limited, and the prescription of the measures which every one should adopt in the matters of food and drink, clothing and cleanliness, are points of great value for the saving of lives, in which, says Dr. Stieler, Dr. Pettenkofer's determinations have been most definite. If any one makes the objection that these rules contain nothing particularly new, the answer is returned that modern medicine no longer deals in mysterious receipts, but is associated with the nearest and most diversified elements in our life, which not every one knows how to satisfy, or which are neglected because they are commonplace, every-day affairs. It appears now to be the chief purpose of hygiene to convince the masses that the commonest matters are the most important. No science can be less aristocratic, none has to be more intent on popularizing its results. In this popular spirit Dr. Pettenkofer prepared his treatises on "What we can do against the Cholera," and "The Present Condition of the Question of the Cholera." He was president of a cholera commission which met in Berlin at his suggestion, and was a member of the congress which met at Weimar in 1867, with similar objects. His investigations on the cholera, which were afterward extended to typhus and to the various sources of disease in the ground, the air, and the water, have given the impulse to the most comprehensive researches by hosts of inquirers. He constructed an apparatus for exact investigations in respiration, and undertook, in connection with Voit, a series of comprehensive labors on the respiration and nourishment of men and animals, through which many data were collected having an important bearing on the theory of metamorphoses of matter.

Dr. Pettenkofer's works have been published for the most part in professional journals. Since 1842 he has contributed numerous articles in chemistry and kindred subjects to "Büchner's Repertorium," "Dingler's Journal," and the "Denkschrift" of the Munich Academy of Sciences. His principal independent works are "Untersuchungen und Beobachtungen über die Verbreitensart der Cholera" ("Researches and Observations on the Way in which Cholera is spread," Munich, 1855); "Hauptbericht über die Choleraepidemie von 1854 in Bayern" ("Principal Report on the Cholera Epidemic of 1854 in Bavaria," Munich, 1857); "Ueber den Luftwechsel in Wohngebaüden" ("On Change of Air in Dwelling-Houses," Brunswick, 1858); "Die Atmosphärische Luft in Wohngebaüden" ("Atmospheric Air in Dwelling-Houses," Brunswick, 1858); "Cholera regulativ von Griesinger, P. und Wunderlich" ("Cholera regulation, by Griesinger, P. and Wunderlich," Munich, 1866); "Ueber Oelfarbe und Konservirung der Gemälde" ("On Oil-Colors and the Preservation of Pictures," Brunswick, 1869, second edition, 1872); "Verbreitungsart der Cholera in Indien" ("How the Cholera is spread in India," Brunswick, 1871); "Zur Ætiologie des Typhus" ("To the Etiology of Typhus," Munich, 1872); "Beziehungen der Luft zur Kleidung, Wohnung und Boden" ("Relations of the Air to the Clothing, the Dwelling, and the Soil," third edition, Brunswick, 1876); "Ueber den Werth der Gesundheit für eine Stadt" ("On the Value of Health to a City," Brunswick, 1873); "Ueber den Gegenwärtigen Stand der Cholerafrage" ("On the Present Condition of the Cholera Question," Munich, 1873); "Künftige Prophylaxis gegen Cholera" ("Future Prophylaxis against Cholera," Munich, 1875). With Buhl, Radlkofer, and Voit, he has published since 1876 the "Zeitschrift für Biologie," or "Journal of Biology." Articles from him have been published in "The Popular Science Monthly" on the "Relations of the Air to our Clothing" (vol. x, p. 654); "Relation of the Air to our Houses" (vol. xi, p. 196); "Ground-Air in its Hygienic Relations" (vol. xi, p. 280); "Hygienic Influence of Plants" (vol. xii, p. 417); and the "Sanitary Relations of the Soil" (vol. xx, pp. 332, 468).

Dr. Pettenkofer is a member of long standing of the Academy of Sciences of Munich. In 1880 he received the Royal Order of the Crown.

CORRESPONDENCE.

BLACK REPLIES TO OSWALD.

Messrs. Editors:

DR. F. L. OSWALD'S answer in your last issue to my criticism demands a reply, for the purpose of elucidating who is in the right on questions closely appertaining to every one's welfare.

His personal allusions may be at once thrust aside as irrelevant. The reading public can not be interested in me, but presumably in my statements, whether they are true or false—not whether I am assuming, which I am not, to represent some forty thousand physicians of the so-called orthodox school.

Dr. Oswald antagonizes my statement that the tendency to dyspepsia is an inherited one, by a glittering generality. Can I "deny that from the moment of birth millions of infants are overfed and drug-poisoned"? 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? Let him produce his proofs, or hold his peace. Such an answer to overthrow an established doctrine, unless verification be produced of causal relation between the antecedents and consequents, is not worth the paper on which it is written. To illustrate: I can with equal plausibility deny that insanity is hereditary by the assumption that it arises *de novo* from a source whose reality Dr. Oswald can not deny, that millions of children are from the moment of birth overfed and then overtaxed by brain-work at school; or, in the example of consumption, that heredity has nothing to do with it, for are not millions overfed and lung-poisoned by impure air from the moment of birth? Such is the style of sophomoric inanity which assumes to overthrow the doctrine established by vital statistics and by the observation of all competent men, that all organic defects, whether inherited or slowly acquired, are transmissible qualities.

Dr. Oswald answers to his inconsistency of cleansing his outside skin with soap and water, and allowing his much-abused and betimes very filthy inside one—the alimentary mucous membrane—to cleanse itself, by the inquiry, "Does Nature ever protest against soap and water?" She does, as every practical physician well knows. Turn to any standard author on skin-diseases, and the use of any kind of soap will be found to be prohibited in some cases, especially in those whose cuticles, like homœopathic remedies, are far too tenuous. The striking benefit of a cleansing cathartic which men and women often feel, after having suffered for days from a dead, heavy, aching languor, is such a common realization that Dr. Oswald may save himself the trouble of elaborating a specious theory to prove them deluded, for facts are such stubborn things.

And this brings me to the silly slang characteristic of all kinds of quacks—their never-ending harping about "poison-drugs." It is their shibboleth, the great hope of gain to themselves by acting on the fears of the afflicted. What is a poison? It is any substance taken into the body which with more or less rapidity tends to destroy life. This embraces every substance except foods, air, and drink—from the clay eaten by the Brazilian, to the alcohol in the beer of the Teuton. Do a few grains of santonine, to expel lumbricoides from the bowels, tend to destroy life or to preserve it? Do a few ounces of alcohol, to tide failing vital power over a dangerous depression, tend to destroy life or to preserve it? Do a few doses of quinine, to arrest an ague-chill, tend to destroy life or to preserve it? Or, to put the query in another form, Do the effects of the santonine, the alcohol, and the quinine, tend to aggravate or to render the disorders for which they are given more dangerous? Even a Dr. Oswald, or a Dio Lewis, who contradicts the almost universal experience that they tend to preserve life instead of destroying it (that is, do not act as poisons), may be asked for the evidence to show that nearly all the world are wrong, and they only are right. If a few doses of quinine could produce profound and dangerous vital disturbances at all approaching those of the fever for which the medicine is given, then Dr. Oswald might have at least one string to his harp. If, after taking fifteen grains of quinine, he was seized with a severe chill—with burning fever, with aching misery in every bone and nerve of his body—with vomiting, with protracted debility and wasting of the body, and, after a few doses more, with a congestive chill, ending life in a few hours, then Dr. Oswald might with good reason take up the battle-cry of quackery, "Poison! poison!" Until Dr. Oswald proves that the quinine *does not* preserve from these very dangers to health and life, leaving no ill effects except those that belong to the disease—his *ipse dixit* about drug-poisoning is on the same level and has exactly the same value as the venal drivel of other quacks whose shibboleth he adopts. Let me say to him that enlightened therapeutists give medicines nearly always on account of the fact that they can communicate certain kinds of energy to deranged functions, to modify, exalt, or depress—as may seem needful—in order to save life.

When a supercilious theorizer, a man who has not for a long series of years anxiously wrestled with the problem every day of his life how the sick can best be made well, thinks he can solve it far better than the tens of thousands who have so wrestled, one can only feel contempt for his inordinate vanity—to be merged into pity when he carries his bigotry about drug-poisoning so far as to leave Nature to war unaided with the putrescence of syphilis rather than take the potassium iodide. The outcome to such blood is its evolvement into extinction, as it deserves to be.

It is, Messrs. Editors, scarcely likely that one who had the privilege in his youth of sitting under the tutelage of such a master of organic chemistry as the late Professor Draper should not know the very elementary fact that digestion is a chemical process, or that he would fall into the blunder of a Dr. Oswald, who, in the last paragraph but one of his answer, writes of digestion and assimilation as being one and the same thing. But better things can not be expected of any one who quotes Dio Lewis, Graham—*et id genus omne*—as authorities in sanitary science, in place of Pettenkofer, Parkes, and Richardson. It is allowable to speak to the popular reader of a large meal as a load for the stomach, but it is presumable that Dr. Oswald, in his wrath at the application of a mechanical term to that process, is not acquainted with the views of some acute, recent philosophers, who think that all the phenomena of the universe can be explained on the laws of mechanics, from the motions of molecules up to those of the celestial masses.

Dr. Oswald asks, has observation not taught me that "the chronic hunger of the dyspeptic is as abnormal as the poison-thirst of the confirmed drunkard." Few things could more conspicuously display a man's ignorance of physiology and pathology than such a question. Not to enter into the several forms of dyspepsia, let me take the most common—a chronic deficiency of gastric juice to convert food into peptone. In such instances there is a dread of eating on account of suffering, with hunger because of the poverty of the blood and the gaunt wasting of the body from inanition. Yet the normal craving for food in a state of semi-starvation is held by our doctor as identical with the abnormal craving for alcohol by the diseased nervous system of the drunkard! The true remedy for the craving of the drunkard is complete abstinence from alcohol. Does Dr. Oswald, to carry out his parallel, recommend entire abstinence from food as a cure for the hunger of dyspepsia? Or would our astute M. D. prescribe a good large "drunk" once in twenty-four hours, even as he recommends one good large meal at a like interval for the dyspeptic? The ability to carry out the latter plan would take the tough *physique* of savages to endure, these being the order of men which he holds up for us to copy in our gastric performances. Dr. Oswald 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. For instance, among the sixty generations of barbarians of which he writes, all the weaklings were killed off in infancy by its perils; now, we nurse them up to adult life, and Dr. Oswald proposes to cure them of their weakness by the adoption of a savage habit—the one-meal-a-day system.

Perhaps Dr. Oswald will find that, in uttering a gratuitous insult in the closing sentence of his communication to that large body of medical men to whom alone is due the entire credit for all the great discoveries and improvements in anatomy, physiology, etiology, hygiene, pathology, surgery, gynæcology, materia medica, and practice, he has only succeeded in belittling and defiling himself. J. R. BLACK.

MORE SUPPOSED PRE-GLACIAL HUMAN TRACKS.

Messrs. Editors:

I NOTICED in a recent issue of the "Monthly," a note in the "Miscellany," referring to the presentation of fossil remains of the primitive horse by Professor Leidy, that the remark was made by Professor H. C. Lewis that, while evidences of post-glacial man were frequent, it was not known that any scientific observations of pre-glacial man had been found either in Europe or America, etc., etc. I wish to bring to the notice of the scientific men of America and Europe an incident which occurred in the town of Chatham in this State, some six or seven years ago, and which seems to me to distinctly prove the existence of pre-glacial man more decidedly than anything else that has come under my observation.

The town of Chatham, as may be seen by reference to the map, lies at what has been termed the "elbow of Cape Cod." It is exposed to the full sweep of the waves from the broad Atlantic, which during the storms from the southeast beat upon its shores with tremendous force. It was during such a storm—the exact date of which I can not now state—that the bluff upon which stood the two light-houses, was rapidly undermined; the bluff here was, on an average, some forty or more feet in height, and, like all the rest of the cape, was composed of drift. The lamps were removed from the two towers, and one of them soon after fell over; the previous morning they had stood nearly four hundred feet from the bank. The *detritus*, by the heavy pounding of the surf, was cleaned out, revealing the fact that the bottom, for half a mile along the line of coast, and more than one hundred yards landward, had been uncovered, and consisted of a hard blue clay, in which were imbedded many trunks of trees, and that the whole surface was covered with tracks of animals of different sizes and shapes; while, proceeding in a diagonal direction from the still-overhanging bluff, to the sea, were the perfectly preserved tracks of five pairs of naked human feet, evidently those of a woman and four children of different ages; three were upon one side of the woman and one upon the other. The tracks, as I have been assured by the most intelligent men of the place,* were as distinct and perfectly preserved in the clay bottom, as though made but the day before; they all had the same peculiarity noticed in those who live a free and unrestrained life—that the toes were not turned out, but that the step was straight forward. Around one stump, broken off several feet above the surface upon which these tracks appeared, were many confused tracks, and much hair.† From reports made me, I judge it must have been some animal of the deer or bison family, scratching himself upon the sharp, broken fragments of the stump. I sent some of the hair to the Secretary of the Museum of Natural History of Boston for a microscopical examination. Although quite a number of months have elapsed, no report has been made to me as yet of the result of it, although one was speedily promised at the time I sent it.

The question that appeals to the scientist for solution is, "When were these human foot-prints made?" It is one more easy to be asked than answered; yet it is plain to any observer that they could only have been made prior to the Drift epoch, which piled, by glacial action, over forty feet of stones and dirt above them. This deposit was made—or at least begun—suddenly. We see too many tracks to allow us to believe that this bottom could have been at the ancient sea, for then the tidal action and storms must have obliterated the impressions; for they were too numerous and of too diverse a character to permit the idea that they did not require a considerable period of time for their formation; the children were walking along by the side of their adult companion, without fear or hurry; close by where they passed, an animal "with feet as large as a big ox's, and the same shape," before or after they passed, relieved himself of his winter's growth of hair; for the hair was all of four or five inches long, and was trodden into the clay, and adhered to the stump in large quantities. There were also marks of feet showing a most perfect *fac-simile* to the bear of to-day—some form of *plantigrade*, surely; and they would not have taken the course they did had not the coast been clear. It was spring when this was covered by the drift, for this animal was not only getting rid of a heavy coat of hair, in immense quantities, but the woman and children were barefoot, conclusively proving that the weather, at the time these impressions were made, was moderately or quite warm, and that it was in the early spring; that a severe winter was the rule, by the length and great abundance of the hair rubbed off by this bison, moose, or elk, or whatever he might be; that the coast-line was lower than it now is, as proved by the growth of trees, which served the people living near the beach for fuel many weeks. But the great question of *when* all this took place, is one that I leave for others to answer. The fact that the whole of Barnstable County, commonly known as Cape Cod, shows, in all its parts, unmistakable proofs of long-continued glacial action, with large bowlders thickly planted in many localities; while, by boring for wells in nearly all parts of the town of Chatham, down to a depth of thirty feet or thereabout, evidences of the drift only are found, and then a stratum of blue clay to an unknown depth; and that this same clay is found all over the cape at varying distances from the surface—would mark it as the original pre-glacial bottom, and the impressions I have mentioned those of the true aboriginal inhabitants, belonging to the Pliocene period. C. J. Ricker, M. D.

Newton, Mass., *May* 12, 1883.

* One of the principal gentlemen from whom the above information was derived is Captain George Eldredge, author of "Eldredge's Charts," "Eldredge's Coast Pilot," etc. Another is Levi Atwood, Esq., editor of the "Chatham Monitor." Both these gentlemen live in Chatham, and from long personal acquaintance I can speak highly of them as men of truth and general trustworthiness. Both they, and many others, equally reliable, will confirm all the facts I have stated above.

† Captain Eldredge told me he should judge that, were it all collected, there would be two quarts of it. He showed me some that he had gathered and preserved; it was coarse, reddish-brown, and about four inches in length, or varying from three and one half to four and one half inches long. It may be well to state that after a few storms the whole of the uncovered portion was covered once more with sand, and all these wonderful phenomena were obliterated. Under the bluff are yet concealed sights, perhaps still more useful to archæology.

HOMŒOPATHY AND QUACKERY.

Messrs. Editors:

In the June number of "The Popular Science Monthly" is an article on "Quacks and Quackeries," which, in its allusion to homœopathy, should not go unnoticed. The very fact of homœopathy being classed with quackeries is an insult to the nearly nine thousand physicians of that school in the United States, and their hundreds of thousands of patrons from the most intelligent and enlightened portion of the community. The writer of the article makes an utterly unfair and garbled presentation of our system of medicine, and some of his statements are absolutely false; as, for instance, he pretends to quote from an address delivered at the meeting of the American Institute of Homœopathy, held in Milwaukee in 1880. I have before me the proceedings of that meeting, and there is absolutely nothing, from the first page to the last, that could be even willfully distorted into such a statement as he makes regarding the progress of homœopathy. As for the legal recognition of homœopathy, let our fifty-four hospitals, our twelve fully-equipped colleges, our forty dispensaries, our medical departments in State universities, our insane asylums and hospitals under State and city patronage, speak for themselves.

As a reader of your excellent journal for many years, I protest against such treatment of a recognized system of medicine, and trust that you will permit a fair and just presentation of homœopathy to be made in the journal.

Respectfully yours,
H. R. Stout, M.D.

Jacksonville, Fla., *July* 2, 1883.

INTELLIGENCE SHOWN BY ELEPHANTS.

Messrs. Editors:

The article on the "Mental Capacity of the Elephant," in the August number of "The Popular Science Monthly" was of much interest, and I beg to add a few more instances of the intelligence shown by these animals. In my childhood, when circuses or menageries exhibited near my home, it was my custom to rise early the next morning and feed the elephants with biscuit and grass. On one occasion, an elephant seemed to be trying to attract my attention, and when I approached he began moving the end of his trunk over the surface of his body, as if to rub himself, but not touching it. It was his method of begging in pantomime for a piece of wood. I picked up a piece of the thin end of a shingle, about the size of a page of "The Popular Science Monthly," and gave it to the elephant, so that he would be obliged to take it on the side, thinking that he would break it when it was put to use. To my surprise, after looking at the piece of shingle, he dropped it and picked it up by the end, and scratched himself, without breaking it. It has always seemed to me that this act of pantomime, and subsequent use of a piece of wood in the direction of maximum strength, involved a higher degree of animal intelligence than I ever saw exhibited elsewhere.

I attended Forepaugh's circus at Brockton, Massachusetts, on the 8th of last June, and I recollect seeing other feats than those cited by Mr. Hornaday, such as tilting on a see-saw, sitting with the fore-legs straight, "like a cat," and then saluting with the trunk; also dancing in various steps. But, shortly after the afternoon performance, two of the elephants were called upon to perform a task requiring more intelligence than any of the conventional ring feats. The facts are given in the following extract from the Boston "Herald" of June 10th:

> The incident referred to took place on the fair-grounds at Brockton, where Mr. Forepaugh's show was exhibiting. Shortly after the *matinée* performance had concluded, a one-story frame building, used as a police-station, caught fire, and in a few moments the entire building was enveloped in flames. Attached to the station-house was a row of horse-sheds, and connecting with the latter was the grand stand, in close proximity to which were Mr. Forepaugh's tents. There being no fire appliances on the grounds, it may well be assumed that the burning building gave serious alarm to the circus-people, as well as to the citizens, many of whom had not yet left the grounds. At this juncture, Mr. Forepaugh and his general manager, C. W. Fuller, appeared on the scene. It was plainly apparent that, unless the horse-sheds were torn down, the grand stand would burn, and, in that event, the destruction of the circus-tents was inevitable. While all were excited and making futile attempts to pull down the building with their hands, Adam Forepaugh, Jr., came running up, and, taking in the situation at a glance, called his colored assistant and hastened to the elephant quarters, soon after appearing with Bolivar and Basil, the latter being next to the former in point of size. The two huge beasts were hurried over to the fire, and, much to the surprise of the spectators, began pulling down the horse-sheds, in obedience to the direction of the junior Forepaugh. The by-standers removed the *débris* as fast as it accumulated under the mighty blows of the elephantine firemen, who seemingly looked upon the affair as a matter of little moment. In an incredibly short space of time the horse-sheds were demolished, the grand stand was saved, and the circus-tents loomed up as proudly as ever.

C. J. H. W.

Boston, *August* 1, 1883.

ASSOCIATION OF COLORS WITH SOUNDS.

Messrs. Editors:

In the August number of your "Monthly" you present a translation of a notice on the "Association of Colors with Sounds." The phenomena in question occur also in the sphere of other senses. Two Zurich students * notice association of sounds with lights: e. g., to one subject the full moon looked at through a red glass brings up the sound of an *l* joined to an *o*. Tastes, smells, even the shapes of bodies, pains, warmth, and cold arouse color visualizations in some subjects. All these are far less common

* Bleuler and Lehmann, "Zwangsmässige Lichtempfindung durch Schall," etc., Leipsic, 1881.

than "color-hearing," and more vague as well as individualistic. While in some instances the "photism," or associated color, is distinct for every note in the octave, and even for the overtones, in the associations with sounds, those with tastes, smells, etc., are barely more distinct than that fine, pleasant tastes and smells suggest bright colors, and contrariwise.

There seems to be an appropriateness in these general associations somewhat as we find in such expressions as a "*sweet* child." No one, I venture to say, if asked to associate colors with sounds, would make light colors correspond to low notes. More than this: Bleuler and Lehmann give a table of the number of cases in which certain colors are the "photisms" for the different vowel-sounds. On asking several persons to force themselves to make similar associations, I was surprised to find how well their answers agreed with the table. The answers were sometimes given with great reluctance, and, when evidently little more than guess-work, often disagreed with the tables.*

In the case of musical notes, tastes, smells, etc., the association seems to be effected by the "*sensational* element chiefly, if not entirely," in the vowel associations, and still more, in those with words, an "*intellectual* element seems to play a part." The sight as well as the sound of some letters and words brings up the "photism." We all know that some words have a *character;* words alike in meaning, the one of Latin, the other of Anglo-Saxon origin, often differ more in *character* than in anything else. In some cases it seems to be the *character* that forms the ground of association.

We find also visualizations of numbers; by some they are seen rising in a scale up to ten or twelve, and then breaking off, by others going around the body, and in one case even moral character and sex are attributed to them. These associations seem to be taken out of the sphere of the senses into that of the intellect. It is to be noticed that the *intellectual* associations are more individualistic than the *sensational* ones. The "photism" of the same *tone* is probably similar in two persons; if the same word, probably entirely different.

Of 596 persons (383 males, 213 females) examined, 76 cases were found, i. e., about 12½ per cent. Slightly more (proportionately) cases were found in females than in males. The young seem to be subject to these visualizations rather than the old; the educated than the uneducated. The tendency to these phenomena seems to be hereditary.

There are many interesting and curious facts to be noted in these phenomena; the time for their explanation has not yet come. The method that seems most promising is that of careful compilation and judicious comparison of individual cases; and I take the liberty of adding that I would be very much indebted to your readers for any reports of similar phenomena observed in themselves or others. JOSEPH JOSTROW.

GERMANTOWN (PHILADELPHIA, PA.),
August 1, 1883.

* In one case the answer to the call for an association with *o* was "orange, but it may be because that begins with an *o*." Bleuler and Lehmann give an exactly similar case when the color was visualized. Even more accidental circumstances than this form the ground of such associations. I found one person to whom Sunday always calls up the color blue (similar cases are reported by the Zurich students), and who traces the circumstance to his having worn a blue frock on Sundays in early childhood.

EDITOR'S TABLE.

THE MINNEAPOLIS MEETING.

WE are gratified in being able to report that the recent meeting of the American Association for the Advancement of Science, held this year at Minneapolis, was most satisfactory and successful. It was, of course, not so large as it would have been if convened in a more central and accessible place, but we have attended smaller gatherings of this body a good deal nearer the seaboard. About three hundred members were in attendance, which, considering the obstacle of distance to be overcome by many of them, shows that there is a strong and well-sustained interest in the work of the Association. But the success of such a meeting is by no means dependent upon the extent of the congregated membership, for it may be assumed that those present were mainly selected by the earnestness of their interest in the objects of the organization. A successful scientific meeting, so remote from the great centers of population, is the best test of the vigor and prosperity of the body. No doubt it is desirable that it should most frequently meet at points of average accessibility; but, as the policy of the Association embraces the whole country in the sphere of its influence, and as it is designed, at least partially, to encourage the popular interest in science by visiting successively all the leading cities, it is well that outlying places should not be habitually neglected. The strangers were welcomed with the most hospitable entertainment by the citizens of Minneapolis, and everything was done to make their visit agreeable.

The work of the American Association on this occasion was excellent on the whole, and does not suffer by comparison with that of previous gatherings. There was a large list of papers of quite average merit, and some of them of unusual interest. Able addresses were delivered by the chairmen of the sections, and the one by Professor Rowland, of Johns Hopkins University, before the Section of Physics, we hope to give our readers in the next number of the "Monthly." The retiring president, Principal Dawson, of Montreal, gave an able address on "Some Unsolved Problems in Geology," the first part of which will be found in our columns this month. It is mainly devoted to a discussion of the evolution hypothesis, of which Dr. Dawson can not be claimed as an adherent, and he improved the occasion to give a forcible exposition of its difficulties from the geological point of view. It is undeniable that these difficulties 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 absolute completeness 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, acknowledge that it is now indispensable as a guide to the most multifarious investigations. It is gratifying to observe that the spirit of passion, dogmatism, and prejudice, which has been so rife in connection with this discussion during the past generation, is measurably subsiding, and that the controverted questions that remain are considered with increasing calmness, candor, and loyalty to truth.

CONCERNING QUACKERY.

Some offense has been taken at parts of Dr. Shepherd's article on "Medical Quacks and Quackeries," which appeared in our June issue. The writer ranked homœopathy as a form of quackery, and cited certain of the dogmas of Hahnemann, founder of the school, in justification of his charge. "The Popular Science Monthly" is censured for lending the weight of its authority to this accusation, and we have received sundry replies to Dr. Shepherd's strictures, of various merit, one of which, from an eminent source, is herewith printed.

It seems hardly correct to charge the "Monthly" with lending its influence to partisan objects in this matter, because the expression of an opinion on the part of a contributor by no means commits the magazine to it. Many periodicals advertise that the editors do not hold themselves responsible for the views of their writers: we have not done this, because it seemed superfluous. We often print statements with which we do not agree, and sometimes express dissent; but it by no means follows that a failure to protest is to be construed into an indorsement of all that appears in our pages; while certainly no one would expect that we should limit ourselves to printing only that which perfectly accords with our own notions. That we are not partisans in this matter should have been inferred from our frequent habit of giving replies to one-sided statements, as is done in the present number, and also from the fact that we have published sharp reflections upon the regular school of medicine. The article entitled "Quackery within the Profession," which appeared in the March number of the "Monthly" of last year, sufficiently attests this: it was an unsparing denunciation of the quackish tendencies that are growing up within the limits of the old orthodox medical school.

We are much inclined to accept the view taken in that article, which is that "*systems* and *cures* of any class or description" adopted by any school of medicine are of the nature of quackery. We agree with the writer when he says: "There is no system, or cure, or charm, or nostrum, known to the profession; our calling consists solely in the rational study and treatment of disease on common-sense principles." Whether a valid "system" of practical medicine will ever become possible is doubtful, but it is sufficiently certain that the present state of science does not warrant it; and, in this condition of things, any one method of cure to be generally followed must be misleading and injurious. Yet, to the mass of the people, there is something fascinating in a medical theory that can be put into a neat and simple formula. And the effect of this is more pernicious in proportion as these formulas are made the rallying-cries of the different schools of medical practice. These schools are candidates for popular favor. The patronage of the physician comes from the people; the people are ignorant and prejudiced, and easily taken by catch-words and clap-trap; while the doctors, as a class, are sufficiently human to avail themselves more or less of this state of facts in the way of business. The tendency of practitioners is to magnify the differences among the several 'pathies, and thus to favor the notion that some one of them contains the fundamental truth, while all others are essentially erroneous, and, as the people are generally educated to identify themselves with sects and parties, they are well prepared to become partisans in the matter of medical treatment. Thus doctors and laymen react upon each other to strengthen injurious prejudices. As Dr. R. O. Beard remarked, in an article upon "The Schools of Medicine," which we printed last February: "Rooted in the professional ignorance and bigotry of almost a century ago, fostered by the bitter rivalries and exclusivism of opposing theorists, these differences have been taken up and fed by popular opinion, until they seriously embarrass the progress of medical knowledge, and tend to destroy all faith in the science and art of healing. The medical fraternity at large, and of both schools alike, is responsible for this unfortunate condition of affairs. When professional men, who, supposably, represent the best phases of liberal thought and scientific culture, lend their names to the partisanship of mere theory, and array themselves under sectarian titles which signify their adherence to an exclusive dogma, it is small wonder that the laity should follow in their footsteps, and cast their views into the yet narrower mold of unreasoning prejudice."

The fact is, medical practice is far in advance of medical theory. Physicians can do a good deal more than they can explain. The advice of the old judge to the young judge—"Refrain from too much expounding, for you will generally be right in your decisions and wrong in your reasons for them"—is not without its bearing upon the medical profession. Medical philosophizing may be well, but it must be kept within limits, or it will certainly mislead in practice. The doctor who has a hobby in which he profoundly believes will be dangerous in the sick-room. The most important revolution in medicine that has ever taken place is that modern change of view by which the practitioner leaves more and more to nature in the conduct of his art and, as a consequence, assigns an ever-increasing value to hygienic considerations.

In regard to homœopathy, there can be little doubt that its practical influence has very much coincided with the inevitable modern tendency to abandon heroic treatment, and give nature a better chance. But homœopathic theory is quite another thing. Dr. Bayard, in the paper we publish, written to vindicate its claims, says that "homœopathy, as a science, is the law of the vital force"; and, again, "disease is the impairment of the equalization of the vital force." But the most advanced scientific thinkers are seriously asking, Is there any such thing as the vital force? or, if there be such a thing, what is it? Certainly it is a something which played a far larger part in medicine when the scientific knowledge of life was in its lowest condition. Everything in the organic economy not understood was then ascribed to "the vital force." Every step of physiological progress has consisted in wresting something from "the vital force," and explaining it in some intelligible way. As physiological problems have been resolved by physical and chemical principles, and taken their place among the proved results of science, "the vital force" is no longer invoked to account for them. Its sphere has, therefore, been gradually restricted, and its intrenchment is still in the narrowing field of physiological mystery. To ascribe an effect to "the vital force" is now but another way of saying that we do not understand its cause. How the mysterious and the inexplicable can become the basis of a special and distinctive science is itself something of a mystery. The article of Mr. Shipman on "Matter Living and Not-Living" will be read with interest in connection with that of Dr. Bayard.

LITERARY NOTICES.

Spencer's Descriptive Sociology: A Cyclopædia of Social Facts, representing the Constitution of Every Type and Grade of Human Society, Past and Present, Stationary and Progressive. In Eight Parts, large folio. D. Appleton & Co. Price, $35.

We have from time to time made reference to this great work as its parts have successively appeared during the last fifteen years; but, having now assumed its completed or final form, we desire to call attention to it as a whole, and calculated to meet the wants of modern students in the way of a valuable work of reference.

As we have repeatedly explained, this comprehensive cyclopædia of social data is novel in form, the whole work being planned and executed with a view to the utmost facility in getting at the multitudinous facts which it records. Mr. Spencer had before him a task of great difficulty when he attempted to present the materials that are descriptive of all phases of human society within an available compass, and by a plan that shall make them in the highest degree accessible for reference, and at the same time instructive for comparative study. After long reflection and various trials, he was compelled to adopt the tabular mode of arranging the facts, which necessitated the folio form of publication, with very large pages. This, of course, was undesirable, but it was unavoidable; yet, as the work is one rather for consultation than for continuous reading, there is really an immense gain in the plan chosen by which any one of its multifarious subjects may be followed out in its broadest relations with ease and dispatch.

Of course, the first thing Mr. Spencer had to do was to arrive at a classification of those elements and activities of human society which are the objects of study by the sociologist. These elements and factors exist in nearly every human society, but with the widest differences of form and development. In low and rude communities, the parts that make up the social state are rudimental, while in the ascending grade of social progress they are developed to all degrees of complexity. Some societies, as the savages, are stationary, that is, without historic change, and the descriptions of their composition and character are therefore simple, and occupy the least space. But other communities have had a long historical development, which has, of course, consisted in the evolution of the constituent parts, and these have therefore to be separately traced through all the stages of progress.

To understand how difficult the mode of presentation was, we have but to refer to the extent of the subjects dealt with. Among the social structures and activities, are the forms of government, both general and local; industrial, educational, and military institutions; domestic relations, and the constitution of families; religious systems and ideas, and ecclesiastical organizations; ceremonial customs, and social habits; recreations and amusements; useful arts, inventions, industries, and the progress and condition of knowledge; moral sentiments, ideals, and practices, and the cultivation of taste and æsthetic art; the physical, intellectual, and emotional characters of different peoples and races; and the widely varied conditions of nature, and the environing circumstances that influence the social state. These are the fundamental facts of all communities which are to be inquired into by the student of social science, and Mr. Spencer's problem was to bring these facts into such relation by classification and tabular representation as will facilitate comparison for scientific purposes. It was indispensable that two conditions be fulfilled: In the first place, the facts required to be so presented as to bring out coexisting conditions, or to show how the various factors were combined and correlated in the social structure at any one period. In the next place, it was imperative that the movement of progressive societies from epoch to epoch should be so exhibited that each constituent should be separately traced, while at the same time the consensus of advancement is displayed. Progressive societies grow unequally. Some advance rapidly in certain lines, and slowly or not at all in others, and to deduce the laws of social growth, the first condition is that of comprehensive comparative study, and Spencer's cyclopædia is conformed throughout to the attainment of this object.

It will be seen that in the nature of the case the work must have been on a very comprehensive scale. A treatise for this purpose within moderate limits would have been good for nothing; and the treatment of the subject in the ordinary form of books would have been of but very little service. But, by getting rid of all that is superfluous, by eliminating irrelevant statements, and rejecting comment and speculation, in short, by confining the digest to the essential things concerning human society to which science must be confined in its work of estabishing general truths, it became possible to condense immense amounts of historic and descriptive matter within comparatively narrow spaces. It is the merit of Spencer's work to have accomplished this object with remarkable success. Of course, anything like a really universal description of human societies, no matter how condensed, would be practically impossible, nor would it be at all necessary. What is wanted for general instruction, and scientific induction, is an array of social data that shall largely represent all the types, forms, and grades of the social state. The greatest number of human societies upon the earth are still in the low and comparatively stationary condition, although in this respect no two are alike. A large number must therefore be studied, sufficient for the derivation of general principles, but it would be needless to extend the list to unmanageable proportions. Then there are societies which have advanced to certain stages of civilization where they have been arrested and fallen into decay. A sufficient number of these require to be represented to teach the lessons they are calculated to enforce. Then there are societies which illustrate a long and slow historic progress through many centuries, and which stand at the head of the present civilization of the world. These are selected for the study of social development in its highest degree as hitherto attained. Mr. Spencer's work covers this broad field, and is thus fully adequate for the scientific demands of the age in pursuing comprehensive sociological inquiries.

So large and laborious was the undertaking upon which he engaged and so difficult was it to command capable assistance in carrying out the project, so heavy the expense of the undertaking, both in securing the protracted services of capable assistants and in the publication of the works, which Mr. Spencer had to meet alone, and so intensely was Mr. Spencer himself absorbed in the execution of his elaborate system of philosophy, that the "Descriptive Sociology" proceeded slowly, and was published irregularly as the parts were successively brought to completion. They therefore appear in an order that was determined by the circumstances of their preparation. Of all the savage races upon the globe, the very lowest are the Negritto tribes and the Malayo-Polynesian races. These are dealt with in Part III of the cyclopædia. Seventeen examples are given as types of the lowest races, viz.: the Fuegians, Andamanese, Veddahs, Australians, Tasmanians, New Caledonians, New Guinea people, Fijians, Sandwich Islanders, Tahitians, Tongans, Samoans, New Zealanders, Dyaks, Javans, Sumatrans, Malagasy. Part IV is devoted to thirteen of the representative African races; Part V to fifteen of the Asiatic races; and Part VI to seventeen of the principal American races. These four parts exemplify the undeveloped, or the but rudely developed forms of social life which are to be taken as starting-points in studying the development of mankind. Part II is devoted to more advanced forms of society, the imperfect civilizations of which are decayed or extinct, and it embraces the Mexicans, the Central Americans, the Chibchas, and the Peruvians. This line of study is also still further pursued in Part VII, which delineates the social life and the form of civilization attained by the Hebrews and the Phœnicians. Part I and Part VIII, the first and last issued, are devoted to the sociological history of the English and the French as old historic and still flourishing civilizations. There is a more or less continuous social history of England and France, running through some two thousand years and culminating in their present high development, which makes them the best examples for tracing the slow-working agencies by which the highest social conditions have been attained. The sociology of the French is the most elaborately worked out of all, the part devoted to it being so large as to rank it as a double number.

It was Mr. Spencer's original intention to include some other societies in his project, but, as its execution threatened to become pecuniarily ruinous, he closed the undertaking with Part VIII. But the scholarship of the world owes him its best thanks for having carried this great, original, and invaluable work to such satisfactory completion as it has actually attained. The history of the advance of knowledge hardly furnishes a parallel to this enterprise. Mr. Spencer foresaw many years ago that the establishment upon a sound and permanent basis of the highest and most important of all the sciences, that of human society, would depend upon such a collection and systematization of its immense data as had never been attempted or even dreamed of by inquirers upon social subjects. All science rests upon the foundation of observed facts, and these facts must be as extensive as the generalizations to be built upon them. And, because such data were neither at hand nor forthcoming, nor deemed possible of procurement, it was held that sociology could never become a legitimate and well-grounded science. It might be a region of speculation, but it could have no valid inductive basis. Mr. Spencer perceived that there was no reason in the necessity of things for this hopeless conclusion, and he accordingly undertook the preliminary work of preparing a solid foundation for the new science. Nor is it too much to say that the issue of the first part of the "Descriptive Sociology" settled the question. So eminent an authority upon this class of subjects as Mr. E. B. Tylor, author of the "Early History of Mankind," remarked upon its appearance, "It is a sufficient answer to all disbelievers in the possibility of a science of history."

That this great work should not have been appreciated by the age to which it was offered is not surprising. The sciences that have been long established are still struggling for educational recognition, and no form of intellectual labor is so ill appreciated in these times and especially in this country as that which aims at the extension of knowledge and the establishment of new truth. But this state of things can not last. Science is destined to make its way, and the science which furnishes a new method and new aids in the study of human affairs is bound to force the recognition that has not yet been accorded. There are many gropers in the field of so-called "Social Science," and, although their results are of but little value, they attest a vague belief in the social order as something capable of rational elucidation. What we want is better methods of conducting the investigation and a truer spirit of science in their pursuit. The work here noticed, in proportion as it becomes known, is certain to be tributary in an eminent degree to this desirable end.

Report on the Thermal Springs of the Yellowstone National Park. By A. C. Peale. Author's edition. Washington. Pp. 454, with Plates and Charts.

The report is a Part extracted from the report of Dr. Hayden's "Geological and Geographical Survey of the Territories for 1878," and well deserves the distinction of a separate publication. It gives full accounts of all the geysers and hot springs of the park, arranged in the order of the river systems to which they belong, with the history of our knowledge of them, and of the region as a whole, accompanied by illustrations tinted in the natural colors, and maps, in which each spring and phenomenon described is indicated by a corresponding number. The reader of the historical introduction will be surprised to learn how short a time these wonders, now familiar and world-renowned, have been known. John Coulter, of Lewis and Clark's expedition, was the first man who ever saw them, and his accounts of them, first given in 1810, were not believed at all. James Bridger next told of them, in 1844, and was likewise discredited. Even the newspapers were afraid to publish any of his stories. Captain John Mullan, in 1853, heard something about the hot springs and geysers from the Indians; and Captain Reynolds, in a report to the Fortieth Congress, admitted that Bridger might possibly have seen such springs as he described. The first authentic description of the springs was published by David E. Folsom in the "Lakeside Monthly," Chicago, in 1870. Other explorations were made at about this time, and other magazine articles, some of them illustrated, were published concerning the phenomena; and the first scientific accounts of the region were given by the geological surveys of 1871 and 1872.

The Diseases of the Liver, with and without Jaundice. By George Harley, M. D., F. R. S. Philadelphia: P. Blakiston, Son & Co. Pp. 751. Price, $5.

The author published in 1863 a monograph on "Jaundice," with observations on the special application of pathological chemistry to the detection and treatment of diseases of the liver and pancreas. With the fruit of twenty years of additional experience, he has again gone over the subject and produced the present treatise, which, although it embodies the whole substance of the original monograph, "bears no more resemblance to it than a mature adult does to the suckling from which he sprung." While the scientific principles on which both works are founded are identical, the present one is much larger than the former, and contains in a condensed form a considerable amount of clinical and scientific data that have never before been collected into one volume. As in other branches of science, many old theories have been abandoned. The work being intended for the use of the "qualified brethren" of the author, he does not undertake to discuss them, but, in order that the reader may see how many of them have been given up and how many new ones espoused, he has put his own views, in accordance with the facts and arguments expressed throughout the volume, into a concise and diagrammatic tabular form.

"Bulletin of the American Museum of Natural History." Vol. I, No. 4. New York: Printed for the Museum. Pp. 40, with Plates.

The present number of the "Bulletin" is wholly occupied with a contribution by Joseph B. Holder on "The Atlantic Right Whales," in which he maintains that the black whale so called of the temperate Atlantic, which was lately introduced to science as a recent discovery, and is now after a long period of nearly total extinction rapidly increasing in numbers, "is the one which our forefathers found abundant along the Atlantic coast, from Newfoundland to Florida. It is the one which was first hunted by the Cape Cod and Nantucket whalers; and is not the one now and latterly captured in the Arctic seas." Facilities have been given for the study of the animal by the existence of five skeletons in America and Europe, and by the capture of an adult specimen in 1882 off the New Jersey coast. To the results of the author's studies of the American specimens are added criticisms of previous accounts of the right whale, and a summary of historical mentions relating to the present and allied species. Some of Dr. Holder's conclusions have been disputed by Mr. J. A. Allen.

Saxon Tithing-Men in America. By Herbert B. Adams, Ph. D. Baltimore: Johns Hopkins University ("Studies in Historical and Political Science"). Pp. 23. Price, 25 cents.

The tithing-man's duties in Massachusetts and Plymouth colonies were very much like those of the constable, and, though he was preceded by officers of that name in New England, he was a far more ancient officer than the constable in the old country. While the constable had the care of public order, the tithing-man's duties were rather connected with the preservation of order and morals in families. Originally one was appointed for every ten families. Dr. Adams follows his account of the functions of the New England tithing-man with a review of the history of the office, which he traces back to the Saxon rule in England.

Medical Economy during the Middle Ages. By George F. Fort. New York: J. W. Bouton. Pp. 488.

The author styles his work "A Contribution to the History of European Morals, from the Time of the Roman Empire to the Close of the Fourteenth Century." Its general purpose is stated to be that of an historical inquiry into the practical effect upon social life throughout the period traversed, of that singular credence which involved preternatural agencies. This belief appears to have been particularly general and controlling in respect to matters appertaining to the preservation and restoration of bodily vigor. Superstition seems to have reigned supreme down to the time of Charlemagne. From that epoch the slow growth of better ideas and a more intelligent practice may be traced, beginning with the schools fostered by that enlightened ruler, and the scholars he called around him. The scope of Mr. Fort's work includes the condition of medical art under the Roman emperors to Galen's time; the influence of the Alexandrine schools in producing a regular system of magic cures, and the progress of the magic system as a moralistic episode of the middle ages, concurrent with ancient medical text-books in the cloisters; the gradual development of the science, aided by Arabic erudition at the Italian universities; and the bloom of alchemy and astrology. Among special features receiving attention are the curative powers ascribed to gems, incantations, etc., the manner of dealing with abandoned women, and the status of physicians, of both sexes, at different epochs.

A Dictionary of Practical Medicine. By Various Writers, edited by Richard Quain, M. D., F. R. S. Fourth edition. New Xork: D. Appleton & Co. In one large 8vo vol. By 1,834, with 138 illustrations. Price, $8.

This work, which has engaged the editorial labors of Dr. Quain for several years, is a single octavo volume of some eighteen hundred pages. No dictionary of medicine so compendious, and at the same time so authoritative, has yet appeared in any language. One hundred and sixty writers contribute an immense number of articles, varying in length from a column or less to thirty pages. Each contributor "volunteered or was invited to write on a subject with which he was specially familiar"; and the list of authors is as representative of the best literature of the profession in England, Ireland, and Scotland, as any that could have been framed. If the name of a distinguished authority is missed here and there, this is only the inevitable result of there being other and sometimes younger men, equally qualified and more conveniently situated for the particular purpose. Dr. Quain's editorial resources have been, indeed, of the amplest kind; he has marshaled an array of professional talent which is not only creditable to the position of the editor among his colleagues, but creditable likewise to the profession as a whole. Those who know nothing of dictionary-editing will hardly appreciate the editorial labor that this work represents. A sense of proportion in assigning the space to the several subjects in a vast field of knowledge must be constantly and watchfully observed, along with a due consideration for the value of everything that a distinguished contributor would wish to write on his favorite theme. It is given only to a firm hand and a delicate tact to achieve success in such an enterprise; and the measure of Dr. Quain's success must be, on the one hand, the compact form and size of his dictionary, and, on the other, the endless variety of the articles and the value of the signatures that they bear. An encyclopedic undertaking of this compass and quality brings to light both the wealth of our home resources in the particular learned profession, as well as the distinctively English characteristics of brevity and point. The new "Dictionary of Medicine" will take rank with the corresponding works in other departments of knowledge, for which the English press has acquired a certain distinction abroad; and it does not surprise one to hear that steps are being taken to have it translated into more than one Continental language.

The work is primarily a dictionary of practical medicine for the use of practitioners. It includes naturally all the diseases that come more particularly within the province of the physician as distinguished from that of the surgeon; but in the numerous articles on general pathology, general therapeutics, hygiene, medical jurisprudence, diseases peculiar to women and children, and subjects on the border-land of medicine and surgery, it includes all but the most technical parts of surgery also. It is, therefore, a work in which the general practitioner of medicine will find articles, in alphabetical order, on all the subjects that are likely to come under his notice in the course of his every-day work. The direct interest of it for the laity—the interest of the subject-matter, if not of the volume itself—is proved by the liberal allowance of space given to many matters that are a concern to all educated persons. Chief among the articles of this class are those on "Nursing the Sick and the Training of Nurses" (Miss Nightingale), "Administration of Hospitals, and the Construction of Hospitals" (Captain Douglas Galton), "Public Health" (the late Dr. Parkes), "Vaccination" (the late Dr. Seaton), "Contagion" (Mr. Simon), "Personal Health" (Dr. Southey), and "Predisposition to Disease" (Dr. W. B. Carpenter). Shorter signed articles of general interest are those on "Diet," "Climate," "Health Resorts," "Mineral Waters," "Sea-Air," "Sea-Baths," "Sea-Voyages," "Sea-Sickness," "Baths," "Douche," "Hydrotherapeutics," "Exercise," "Fatigue," "Effects of Extreme Cold and Extreme Heat," "Sunstroke," "Malaria," "Periodicity in Disease," "Epidemics," "Plague," "Quarantine," "Disinfection," "Mortality," "Alcohol and Alcoholism," "Criminal Irresponsibility," "Civil-Incapacity," and many more.

Many of the subjects of that class were, of course, ably handled by the older writers; and, more particularly, diet, climate, sea-voyages, and the like, were matters familiar to the contemporaries of Hippocrates and Galen. But there are not a few articles in this dictionary of which even the headings would have been looked for in vain in a similar work as recently as fifty or sixty years ago. "Anæsthetics," "Ophthalmoscope," "Laryngoscope," "Microscope in Medicine," "Clinical Thermometry," "Physical Examination"—how great an increase in the useful power of medicine and surgery do these new titles represent! "Addison's Disease," "Lymphadenoma," "Leucocythemia," "Pernicious Anæmia," "Myxœdema," "Locomotor Ataxy," "Pseudo-hypertrophic Muscular Paralysis," "Diseases of the Spinal Cord," "Pneumogastric Nerve," "Sympathetic Nervous System"—how much is there here that is quite new and curious, and may one day be even useful! "Diphtheria," "Typhoid Fever," "Malignant Pustule," "Micrococci," "Bacilli," "Parasitic Skin Diseases," "Chyluria," "Thrombosis and Embolism," "Fatty Degeneration"—how much of progressive theory, better discrimination, and rational suggestion is contained in those! The headings "Antiseptic Treatment" and "Diseases of the Ovaries" will call to mind a degree of success in formidable surgical undertakings which no previous generation has known. It would be an endless task, and much too technical, to enter into details about these numerous additions to the catalogue of diseases, to the stock of pathological ideas, and to the resources of treatment. The enumeration will serve to show that the alleged progress of medical science can be substantiated, if need be, by full particulars. It may be more generally interesting to give some account of the modern position of medical science—of its precision, and of what its precision depends upon.

PUBLICATIONS RECEIVED.

On the Characters of the Skull in the Hadrosauridæ; and on some Vertebrata from the Permian of Illinois. By E. D. Cope. Pp. 13, with Four Plates.

"Paleontological Bulletin," No. 36. First Addition to the Fauna of the Puerco-Eocene; On the Brains of the Eocene Mammalia Phenacodus and Periptychus; and Fourth Contribution to the History of the Permian Formation of Texas. By Professor E. D. Cope. Philadelphia: A. E. Foote.

Proceedings of the Third Annual Meeting of the Wisconsin Pharmaceutical Association held in Oshkosh, August 8–10, 1882. E. B. Heimstreet, Janesville, Secretary. Pp. 98.

Ætiology and Non-Infection of Sewer Gases. By Washington Ayer, M. D. San Francisco. 1883. Pp. 25.

Study of Neglected Lacerations of the Cervix Uteri and Perinæum. By Thomas A. Ashby, M. D. Baltimore, Md. Pp. 11.

The Nature of Heat and Gravity. By William Coutie. Troy, N. Y. 1883. Pp. 19.

Remarks on Hydrophobia. By Charles W. Dalles, M. D. Philadelphia. 1883. Pp. 12.

Third Annual Report of the Astronomer in Charge of the Horological and Thermometric Bureaus in the Observatory of Yale College, 1882–'83. By Leonard Waldo. New Haven. 1883. Pp. 20.

Acute Articular Rheumatism. By E. O. Bardwell, M. D. Emporium, Pa. 1883. Pp. 7.

The Newport Natural History Society. Document 1. Newport, R. I. 1883. Pp. 15.

Signal-Service Notes, No. 4. The Use of the Spectroscope in Meteorological Observations. By Winslow Upton, A. M. Pp. 7. No. 5, Work of the Signal-Service in the Arctic Regions. Pp. 40. Washington: Government Printing-Office. 1883.

Q. P. Indexes, No. XIII. An Index to Articles relating to History, Biography, Literature, Society, and Travel, contained in Collections of Essays. By W. M. Griswold, A. B. Bangor, U. S. A. Q. P. Index, Publisher. 1883. Pp. 56.

Pemphigus and the Diseases liable to be mistaken for it. pp. 11; Hints on the Treatment of some Parasitic Skin Diseases, pp. 11; The Treatment of Various Forms of Acne. pp. 7. By George H. Rohé, M. D. Baltimore, Md.

"The American Psychological Journal." Edited by Joseph Parrish, M. D. Quarterly. Vol I, No. 2. July, 1883. Philadelphia: P. Blakiston, Son & Co. Pp. 112. $2 a year.

The Calendar of the Departments of Law, Science, and Literature of the University of Tokio, Japan. 1881–'82. Pp. 125.

Measurement of the Force of Gravity at Sapporo, Yesso. Published by the University of Tokio. 1882. Pp. 21.

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POPULAR MISCELLANY.

The American Association.—The thirty-second annual meeting of the American Association for the Advancement of Science was opened at Minneapolis, Minnesota, August 15th, with the usual forms. The welcoming addresses were made by the Governor of the State, the mayor of the city, and Dr. Folwell, President of the State University, in whose halls the sessions were held. The address of the retiring president, Professor Dawson, was delivered in the evening, after which the members of the Association were entertained at a citizens' reception. Professor William A. Rogers, Vice-President of the Section of Mathematics and Astronomy, read an address on the "German Survey of the Northern Heavens." Professor H. A. Rowland, of Baltimore, Vice-President of the Physical Section, made "A Plea for Pure Science," in a paper which was marked by many strong thoughts. Professor Hitchcock, of the Geological and

Geographical Section, gave a review of the "Early History of the North American Continent." In the General Sciences, Professor E. D. Cope presented in a lecture "The Evidence for Evolution in the History of the Extinct Mammalia," and Dr. T. Sterry Hunt outlined "A Classification of the Natural Sciences." The Committee on Indexing the Literature of Chemical Elements reported progress to the Chemical Section. Among the other papers read in the various sections we notice that of Professor Holden, of Madison, Wisconsin, on the total solar eclipse of May 6, 1883, and Dr. Janssen's letter on the French observations of the same phenomenon. Mr. G. W. Hough, of Chicago, discussed some "Physical Phenomena on the Planet Jupiter." Mr. O. S. Wolcott, of Chicago, considered "Some Hitherto Undeveloped Properties of Squares." Professor W. A. Rogers continued from the Montreal meeting the subject of the determination of the relation between the imperial yard and the metre of the archives. Mr. F. E. Nipher, of St. Louis, gave an account of the magnetic survey of Missouri. The Signal Service received attention in a criticism of its operations and efficiency by Gustavus Heinrichs; in an account by Professor Mendenhall, of a method for the distribution of weather forecasts by means of emblems fixed upon railway-trains, which has been tried in Ohio; and in a plan for a State signal service, by Professor Nipher. Professor Macfarland, of Towanda, Pennsylvania, endeavored to show, in his paper on "The New Madrid Earthquake" of 1811, that the phenomenon was not an earthquake, but a subsidence of land which had been undermined by limestone caverns. Julius Pohlman, of Buffalo, presented a new view of the "Life History of Niagara River"; Professor Warren Upham read a paper on "The Minnesota Valley in the Ice Age." Much attention was given to topics bearing on agriculture, in the address of Professor Beal on that subject, and in papers by Professor Richardson on the composition of American wheat, of Professor Sturtevant on maize and sorghum kernels and on agricultural botany, and of Professor H. W. Wiley on American butter. Professor E. S. Morse gave an interesting account of the manner in which he had made use of the sun's rays for ventilating and partly warming his rooms, and presented papers on Japanese games and Eastern kitchens. Among the remaining papers we remark those of Elizur Wright on "Life-Insurance and Self-Insurance"; of Professor J. C. Arthur on a sea-weed of the Wisconsin lakes which produces poisonous effects at particular seasons; of T. R. Baker on terra-cotta lumber; of Professor Claypole on the potato-beetle and the Hessian fly; of Professor Riley on an insect exterminator; and observations on caverns, and on cyclones and tornadoes. We propose to publish abstracts or full reports in future numbers of such of these papers as may be of more general and popular interest. The next meeting of the Association was appointed to be held in Philadelphia. Dr. J. P. Lesley, of Philadelphia, was chosen President for the year, and sectional vice-presidents were appointed as follows: A (Mathematics and Astronomy), Professor H. T. Eddy, of Cincinnati; B (Physics), Professor John Trowbridge, of Cambridge; C (Chemistry), Professor J. W. Langley, of Ann Arbor; D (Mechanical Science), Professor H. B. Thurston, of Hoboken; E (Geology and Geography), Professor N. H. Winchell, of Minneapolis; F (Biology), Professor E. D. Cope, of Philadelphia; G (Histology and Microscopy), Professor T. G. Wormley, of Philadelphia; H (Anthropology), Professor E. S. Morse, of Salem; I (Economic Science and Statistics), Hon. John Eaton, of Washington. Permanent Secretary, Mr. F. W. Putnam, of Cambridge; General Secretary, Dr. Alfred Springer, of Cincinnati.

Dr. Harkness on the Nevada Footprints.—Dr. D. W. Harkness has contributed a paper to the San Francisco Academy of Sciences stating his reasons for maintaining, against the arguments of Professor Marsh and others, that the Carson (Nevada) "footprints" were made by a man, "*homo Nevadensis*," and not by a quadruped. The reasons are founded on the evidence given by the impressions that they were not made by a natural foot, but by one supplied with an artificial protection. Among the points of evidence adduced by Dr. Harkness is that the marks of the pads or cushions, with which the feet of all animals are provided, and by which their foot-prints are distinguished, are wholly absent from the impressions. The absence of any evidence that the maker of the tracks had more than two feet is also insisted upon. "The curve of the foot is so regular and so constant as to show that in every instance the hind-foot—if of a quadruped—was at all times placed exactly upon the forward foot, or that both the forward and the hind feet were of exactly the same form—conditions which, to say the least, are extremely improbable." Evidence appears to be afforded in the shape of the tracks of one or two of the series that they were made by a yielding material which, like leather softened by moisture, gave way and was bent up at the sides. Unless something of this kind is admitted, the tracks must be believed to have been made by animals of different species. Other variations in the shapes of the tracks may be more readily accounted for by supposing them to have been made by sandals of different cuts than by quadrupeds having differently shaped feet. Dr. Harkness accounts for the width of the straddle, which has been urged against the human origin of the tracks, by suggesting that it would be one of the natural results of the exertion of walking in mud with the feet encumbered by such an unwieldy load as the enormous sandals.

Hygienic Qualities of Electric and Gas Lights.—Mr. B. H. Thwaite suggested, some years ago, that the intense heat developed in the arc electric light would produce a rearrangement in the gaseous contents of the atmosphere, by changing a mechanical combination into a chemical one, with the resultant development of deleterious nitrogen oxides. Mr. Wills, F. C. S., showed by experiment that ten to twelve grains of nitric acid were developed in an hour by the electric lamp. This rearrangement of gases is not produced in the incandescent lamps, for, besides the less development of heat, the filaments are kept in a vacuum. Hence, *per se*, the electric light of the incandescent type is hygienically satisfactory; but neither the incandescent nor the arc electric light assists vegetation. Besides the nitrogen oxides produced by the arc-light, says Mr. Thwaite, probably as much carbon dioxide is produced for the same illuminating power as is produced by the combustion of coal-gas. In both lights, the luminosity proceeds from the same cause—carbon heated to incandescence. The light produced by incandescent lamps is in almost perfect accord with the laws of visual or ocular hygiene, for it permits a choice of colors, but the arc-light is not so satisfactory, because it induces fatigue by its variations and its glare. The products of the combustion of coal-gas are aqueous vapor and carbon dioxide, with sulphuric acid resulting from the oxidation of the bisulphide of carbon contained in the gas. Besides these, nitrogen is set free from its mechanical combination with oxygen, but it is practically harmless. These gases may be removed by putting over the burners pipes for conveying them to the open air; and, if this were done, as it ought always to be done, the greatest disadvantage of the system of coal-gas lighting would be removed, and adequate ventilation would at the same time be provided. With regenerative burners, the intensity of combustion could be increased to such a degree that the light would be white and neutral, permitting colors of the most delicate hues to be easily distinguished. We should then have a light not only hygienically perfect, but, to the extent that it is utilized for assisting ventilation, superior in that respect to the best electric light.

Aëration of Peaty Water.—Professor W. N. Hartley and Mr. Gerard A. Kinchan, of Dublin, have made experiments with reference to the alleged power of aëration to purify the water of rivers from peaty matter they may have in solution, from which they are led to deny the existence of such power to any measurable extent. Their first experiment was made at the Powerscourt Fall of the Dargle River, where the water descends 360 feet vertically, and mostly in the form of spray. Here, if anywhere, aëration should have been general and effective; yet analyses of specimens from above and below the fall showed no variation in the amount of carbon beyond what could be attributed to experimental error. Next, samples of the water of Carawaystick Brook were taken, from distances 1,600 feet apart, between which a fall of 700 feet took place. These specimens were likewise found to be nearly identical in composition, with neither the carbon nor the nitrogen diminished by the aëration consequent upon the fall. The introduction of mineral matters often produced very much greater effects than it was possible to show to be connected with aëration, and which varied in a considerable degree according to the nature of the matters added. From his experiments on this point, Professor Hartley derives the conclusion that the peaty coloring-matter in water "acts like an organic acid, and that it is probably a body of the type of alizarine or litmus, and is only slightly soluble, or is even insoluble in pure water, but is readily dissolved in water containing traces of alkali, or of soluble carbonate, such as ammonia or potash. With metallic oxides, iron and alumina, it forms insoluble compounds of the nature of lakes. Lime-water also precipitates it. Mineral acids, sulphuric, hydrochloric, and nitric, precipitate it. Peaty water may be perfectly bright and free from turbidity. These facts, and a further observation that subsidence will not clear a peaty water of its coloring-matter, lead to the conclusion that the coloring-matter is held in solution, and is precipitated as a lake, by various mineral bases." These conclusions are applicable to organic matter of a peaty character only.

Traits of Ancient American Civilization.—Max Steffer, in a recently published book on the "Agricultural Economy of the Civilized Ancient American Peoples," declares that it is really shameful to our boasted Caucasian superiority that European agency, instead of advancing the civilization of those nations, utterly destroyed it. The relics we have of them represent the vestiges of a civilization which in its way not only yielded nothing to that of the avaricious Spaniards, but in many respects surpassed it. They furnish evidences of a thorough systematic regulation of affairs, and of the cultivation of the soil by steady industry, with careful foresight and skilled practice. The Mexican people had secured an irrigation of the soil by means of canals without machines, to which the only counterparts in Spain were the works, not more ingenious, which the Moors had left; and the Spaniards betrayed their incapacity to appreciate the value of such constructions by allowing them to go to ruin, and sometimes destroying them in the expectation of finding golden water-pipes within them. The cultivation and irrigation of the soil were matters of public interest, and agriculture was placed under similar regulations to those which prevail in China and Japan. The division of the land and all changes in possession were made under the direction of the magistrates. Many conditions in the details of management were similar to those prevailing in Japan. Both people were without yoke-animals, and their estates were so small, and their manner of living such, that the employment of such animals was not necessary. The cultivation was rather that of the garden than of the field, and, as animals were not kept, the additional land they demand was not required. In the absence of domestic animals, minute and painstaking devices to get manure, like those prevailing in China, were adopted. The Peruvians enjoyed an advantage in having guano. Like the Eastern Asiatics, the ancient Americans also had no milk, although they possessed in the llama an animal that might have furnished them that aliment, with all its products.

Hints on Furnace-heating and Ventilation.—Mr. E. S. Philbrick, C. E., of Boston, has given some useful hints in "The Sanitary Engineer" on the management of heating apparatus and furnace-ventilation. If the air-box of the furnace is not opened after a wind subsides, if it is not open enough at any time, or, if, during windy weather, the air-box is not large enough to supply all the demand, the air is often taken by natural laws from one room down to the furnace and through it, to supply another room. The former room then becomes cooled off. In the last case the rooms on the windward side of the house are always the ones cooled, for it is hard to force the air into them from the hot-air pipes, unless an open fire is supplied to draw off the surplus pressure. Open fireplaces are efficient, generally, in promoting the comfort of the family, even if no fires are lighted in them. Air can not be induced to enter a tight room unless some means of escape is given it, and the fire-places furnish that. The course of the air entering the room from the heating apparatus is to rise to the ceiling and spread out there. It then descends along the sides of the room exposed to the open air, and is withdrawn by the fireplace if there is any which thus serves to facilitate the distribution of the heat in the lower part of the room. If the opening in the chimney is near the ceiling, the warm air will go out there without descending to the floor. It is important, in providing cold-air inlets for any kind of heating apparatus, to see that they take the air from a point where it is pure. They should also take it from the north or northwest, for the coldest winds come from that direction, and the heating of the house at such times is made much more convenient and safe if the prevailing draughts are made to assist it. If the inlets are on the south side of the house, the furnace is liable to be supplied, as is sometimes the case, with air from the northern rooms, entering the house through window-cracks or down a cold chimney, and sending the heated air out through the cold-air box into the back yard. There are limits, and they are not very wide, to the horizontal heating capacity of the best furnaces. Hence, if the ground-plan of the house is extensive, two or more furnaces should be provided rather than to depend upon one. Steam and hot-water apparatus are better horizontal distributors of heat than hot-air furnaces. As between the two, Mr. Philbrick prefers the hot-water apparatus as more easily managed, and more adjustable to mild temperatures, though its first cost is greater than that of steam apparatus. With either, the main dependence for heat should be upon air that has been heated by passing through the apparatus, rather than by direct radiation from pipes or surfaces in the rooms, which should be used only as auxiliaries.

Long Days and Plant-Growth. — The Norwegian plant-geographer, Schübeler, a short time ago called attention to some striking and surprising peculiarities manifested by vegetation in high latitudes, which he ascribed to the intensive light-effects of the long days. Most plants in these regions produce much larger and heavier seeds than in lower latitudes; and the difference is in some cases astonishing. Dwarf beans taken from Christiania to Drontheim gained more than sixty per cent in weight; and thyme from Lyons when planted at Drontheim showed a gain of seventy-one per cent. Grain is heavier in the north than in more southern latitudes; and Norwegian seed planted at Breslau fell off greatly in the first year. Another remarkable fact is that the increase of weight in northern latitudes takes place through the assimilation of non-nitrogenous substances, while the protein products have no part in it. The leaves also of most plants grow larger in high latitudes, and at the same time take on a deeper, darker color. This peculiarity, first noticed by Grisebach and Martins, has been observed not only in most of the wild trees and shrubs, but also in fruit-trees, and even in kitchen-garden plants. It has further been observed that the flowers of most plants are larger and more deeply colored, and that many flowers which are white in the south become in the far north violet.

Brain-Work under Pressure.—A writer in "The Journal of Science," on "Cram and its Amenities," only utters a truism when he remarks that brain-work is not *per se* physically injurious, but that, when kept within reasonable bounds and right conditions, it appears distinctly favorable to health and long life. He enforces the fact by some happy illustrations. An essential condition to the prosecution of brain-work without injury is that the organ must be sufficiently mature before it is subjected to much exertion; hence, it is disastrous to crowd the brains of children. Another important condition under which study is wholesome "is freedom from anxiety, hurry, and worry. This condition is admirably illustrated in the career of almost all great investigators of nature. Woehler (who died at eighty-two), for instance, contributed no fewer than two hundred and twenty-five memoirs to the scientific journals or to the transactions of learned societies. Almost all of these papers are of great value, and many of them embody the outcome of months of careful and delicate experimentation. But in no one case was he compelled to finish any of these researches at a certain date, under appropriate pains and penalties. Precisely the same was the case with Darwin: he was able to pursue his inquiries calmly and dispassionately; able always to take two or three years, if his task could not be finished in one, and in no fear of unpleasant consequences if some idea which he had taken up should lead to nothing. But, if we say to a youth, or, worse still, to a child, 'You must, by a given date, reach a certain standard of knowledge, a certain grade of culture, to be judged of in a summary way . . .,' we place him in the very conditions wherein study becomes unsanitary, even ruinous, and that the more decidedly the more immature the brain." This is the tendency in hosts of schools, where everything is made to depend on examinations, the winning of honors at exhibitions, or on prizes and competitions.

Troubles of a Transfusionist in the Olden Time.—The "Union Médicale" quotes from an old book a curious story of the troubles which beset a physician who experimented in transfusion of blood in the seventeenth century. A Dr. Denys, of Rheims, a strong believer in transfusion, tried that remedy, using calf's blood, with great success, upon a young man whom he found mad in the streets. The patient recovered, and continued well for two months, when he relapsed into dementia. A second experiment worked improvement, but not a cure. The young man soon lost his senses entirely, and his wife brought him again to Denys. A new operation only increased the patient's pains, and he died in a few hours. The widow then brought suit against Denys for killing her husband, and the doctor brought a counter-action against the woman for trying to poison him. The suit went in favor of the woman, but was afterward carried, through a course of appeals, to the Parliament. The case seems ultimately to have been discharged, but an edict was issued forbidding the practice of transfusion, under pain of corporal punishment.

Fertilizers and Savages.—"To what extent is the use of agricultural fertilizers known among uncivilized people?" is one of the questions raised in a paper by Mr. G. Browne Goode, on "The Uses of Agricultural Fertilizers by the American Indians and the Early English Colonists." Mr. Goode finds clear evidence in his historical readings that the Indians of New England used and taught the early settlers to use the menhaden as a manure. The aboriginal name, *munnawhatteaug*, whence our menhaden is derived, means fertilizer, and another name, *paghaden*, is derived from a verb which means to enrich the land. Governor Bradford tells, in his "History of Plimouth Plantation," how the Indian Squanto taught the colonists in planting their corn, that, "excepte they got fish, and set with it (in these old grounds), it would come to nothing." George Mourt, in a journal published in 1622, in speaking of the planting, says, "According to the manner of Indians, we manured our ground with herrings, or rather shads." No other direct reference to its use by Indians is quoted, but several instances are found in which the employment by the colonists of fish for manure is mentioned. Dr. Rau has met with but one allusion to the use of fertilizers by uncivilized races. It is in the writings of Garcilasso de Vega, who mentions the use of guano by the Peruvians. Mr. H. H. Bancroft has found in a translation of the Quiche MS., by Brasseur de Bourbourg, a notice of the Maya custom of cutting and burning the growth on the corn-fields, and allowing the ashes to remain as manure. This, however, was accidental rather than intentional fertilization, as the main object of the burning was to clear away rubbish. Professor Atwater has learned that the Indians of the north shore of Lake Superior use white-fish and lake-trout in manuring their fields, and Mr. Dall says that the Indians of Alaska have learned a rude system of agriculture from the Russians.

NOTES.

H. C. Lewis and G. F. Wright have made a detailed study of the southern boundary of the glaciated area of Ohio, which they find to be sharply defined, though not everywhere marked by such a relative excess of moraine accumulation as in Long Island, New Jersey, and Pennsylvania. The line enters the State from the east in Columbiana County twelve miles north of the Ohio River, runs nearly west into Stark County, where it turns more to the south, and, continuing so to Knox County, it turns then at right angles to the south; thence south and southwest to the Ohio River near Higginsport. "Cincinnati was completely enveloped by ice during the glacial period, and extensive glacial deposits exist in the northern part of Campbell and Boone Counties, Kentucky, and near Aurora, in Dearborn County, Indiana."

The London "Academy" says that "a duel took place the other day at Pesth between two noblemen, one a son of Count Andrassy, which arose out of a quarrel about the truth of Darwanism. The supporter of Darwinism, we regret to hear, was seriously wounded." From which we may conclude that his opponent now believes in the doctrine of the "survival of the fittest."

Dr. A. A. Julien, of Columbia College, in a paper on the "Decay of Building-Stones," read before the New York Academy of Science, remarked that the principle that stones are more lasting when laid "on bed" is demonstrated in all the varieties used in building. Defining "life" as the period during which the stone will present a decent appearance, he gave the following as the approximate duration of life of several kinds of stone in New York: Coarse brown-stone, best used out of the sun, from five to fifteen years; laminated fine brown-stone, twenty-five to fifty years; compact fine brown stone, one hundred to two hundred years; Nova Scotia stone, fifty to one hundred years; Ohio sand-stone, the best of the sand-stones, one hundred years; Caen stone, thirty-five to forty years; coarse dolomite marble, forty years; fine marble, sixty years; pure calcareous marble, fifty to one hundred years; granite, seventy-five to two hundred years, according to the variety. Some of the best kinds of building-stone have not yet been brought to the city.

Mr. C. J. H. Woodbury, of Boston, has had sent to him by the Société Industrielle de Mulhouse of Alsace, Germany, its silver prize medal, in recognition of his recent work on the best means of protecting cotton and woolen mills from fire. It is believed that this is the first time an American has been the recipient of this award.

Professor Joseph Le Conte sums up the conclusions of a paper on the "Genesis of Metalliferous Veins," which is based on the examination of phenomena of metalliferous deposit by solfataric action in Nevada and California, by saying that "subterranean waters of any kind, but especially alkaline, at any temperature, but mostly hot, circulating in any direction, but mainly up-coming, and in any kind of water-way, but mainly in open fissures, by deposit form metalliferous veins. It is evident, therefore, that the form, appearance, and mode of occurrence of veins must be infinitely various, but the mode of formation is substantially one." The study of the varieties of formation may be important to the miner, but is of little value to science proper, except as it illustrates the one principle.

One of the finest crinoid beds in the world is at Crawfordsville, Indiana. It is more extensive and affords more perfect specimens than the bed at Keokuk, Iowa. Some of the specimens are twelve inches in length, and several have been sold for eight and ten dollars each. The fossils are imbedded in hard blue clay, and are so brittle that the work of removing them is exceedingly delicate and difficult.

A supposed stone implement has been found in Philadelphia, in a loose "water-gravel" twenty-four feet below the surface. It is an oblong rectangle in shape, sixteen and a half inches long, nearly four inches wide, and varies in thickness from half an inch at the sides to one and a half inch in the middle. Each extremity is ground to a smooth cutting edge. The specimen is of compact, yellowish-brown sandstone, and is the first that has been discovered in the Philadelphia gravel. If it should prove to belong to the gravel, and to be artificial, it will carry back the antiquity of man to glacial times.

Selective breeding of fish seems at hand. Seth Green has crossed the striped bass with shad, herring with shad, whitefish with salmon, salmon with brook-trout, and brook-trout with salmon-trout. The last cross is the most successful, and gives fine fish and good breeders. A cross between it and brook-trout promises to make a large trout, suitable for rivers and lakes. Mr. Green purposes next season to produce a seven-eighths brook-trout. He would try a cross between brook-trout and grayling provided both fish spawned at the same time of year, and has hopes of yet securing a cross between the grayling and the California mountain-trout, with which this condition is fulfilled.

Captain R. N. Schufeldt, of the Medical Corps, U. S. Army, has been making a scientific exploration of the vicinity of New Orleans, and has forwarded to the Smithsonian Institution a collection of some three thousand specimens of vertebrates and invertebrates of the region, together with the contents of an Indian shell-mound situated back of Carrollton. Among the vertebrates are some very uncommon forms of bats, and other rare species.

M. Ch. Montigny, of Brussels, has observed that the intensity of the scintillation of the stars is greatly increased during the presence of an aurora borealis, and that the increase is more marked in winter than in summer.

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