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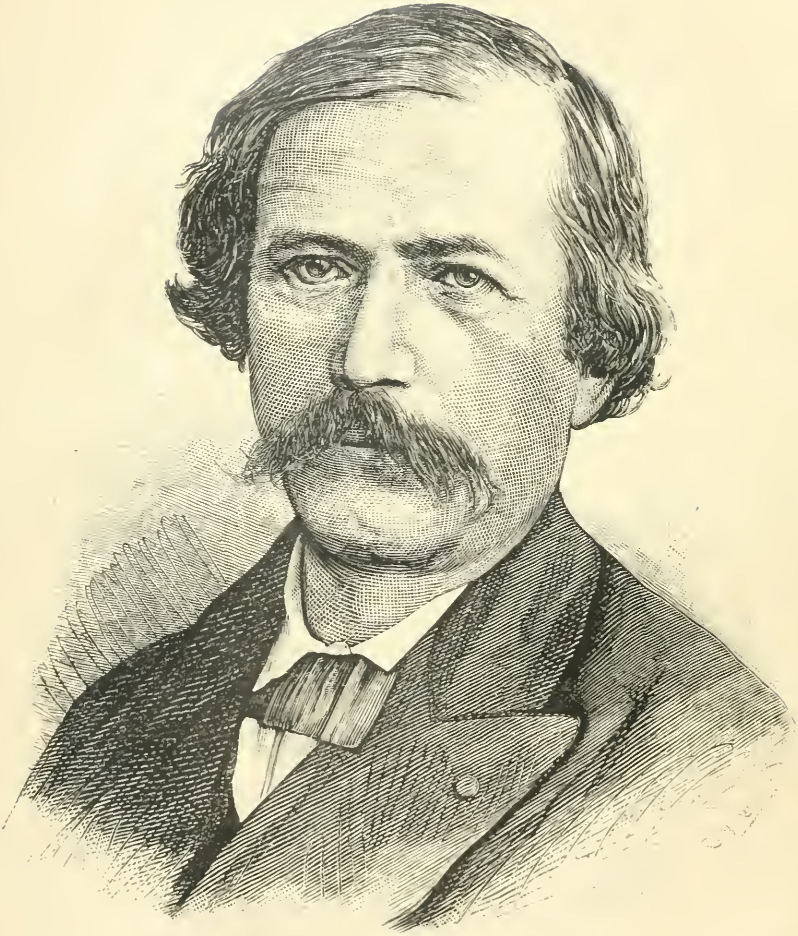

M. P. E. BERTHELOT.

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THE

POPULAR SCIENCE

MONTHLY.

MAY, 1885.

OUR RECENT DEBTS TO VIVISECTION.*

By WILLIAM W. KEEN, M. D.

PROFESSOR OF SURGERY.

LADIES: It is my happy privilege to congratulate you on the completion of your three years of preliminary study, and on your merited reward in receiving the degree of Doctor of Medicine from the oldest and largest medical college for women in the world.

By this degree you are permitted to enter the ranks of one of the most ancient, honorable, and laborious professions. With it you assume certain valued privileges, and have cast upon you certain weighty duties. Both the privileges and the duties will exact from you all the intelligence, skill, tact, and faithfulness which you possess.

You will observe that I said a moment since you had finished your "preliminary" studies; for your first and most pressing duty after graduation, and one for which happily you will at first have ample time, is to continue your medical studies. I do not say complete them, for, be your lives even prolonged far past the allotted threescore and ten, instant, constant, intense study is the imperative condition of the right kind of success. You know very little now. Happy both you and your patients, if even with gray hairs comes ever-growing knowledge.

But you have other duties than those to self—you have great duties to the communities in which you will live. Women especially will not only look to you in times of peril, whether in childbirth or sickness or accident, but also for guidance in that greatest duty and privilege—the prevention rather than the cure of disease. This is the glory of our times and the magnificent duty of our profession, that by enlightened

* The Address to the graduates of the Woman's Medical College of Pennsylvania, Philadelphia, delivered March 11, 1885.

care and wise instruction we can prevent much of the sickness and sorrow of the race, and bid back the Angel of Death.

Hygiene—well named after Hygeia, the goddess of good health—must be one of your principal future studies, and its lessons ever on your lips; line upon line, precept upon precept, here a little, and there a great deal. The greatest need of our College to-day is a Professorship of Hygiene. Would that in this vast audience some one could be found who would endow such a chair in the Woman's Medical College of Pennsylvania!

You must also direct public opinion, and especially the opinion of your own sex, in reference to medical questions; for your information and studies will fit you to be their instructors in all such technical questions.

It is to one of these medical issues of the day that I purpose to direct your attention at present—one as to which intense feeling, especially among women, has been aroused—viz., the question of experiments upon animals.

Epithets and invective have been freely used, but, as befits the audience and the occasion, I shall endeavor to approach it in a perfectly calm and fair spirit, seeking to lay before you only one aspect of a many-sided question, viz., the actual practical benefits it has conferred upon man and animals—a fact that is constantly denied, but which medical evidence proves to be incontestable.

I shall not consider the important older discoveries it has given us, but only those since 1850, almost all of which are within my own personal recollection. Even of these I must omit nearly all of its contributions to physiology and to pathology, though so much of our practice is based upon these, and confine myself to the advances it has enabled us to make in medical and surgical practice. I shall endeavor to state its claims with moderation, for an extravagant claim always produces a revulsion against the claimant, and is as unwise as it is unscientific.

Again, it must be borne in mind that, as in nearly every other advance in civilization and in society, so in medicine, causes are rarely single, but generally multiple and interwoven. While vivisection has been a most potent factor in medical progress, it is only one of several factors the disentanglement of which and the *exact* balancing of how much is due to this or to that are often difficult and sometimes impossible. Let me add one word more. All that I may say is purely upon my own responsibility. I commit the opinion of no one else to any view or any statement of fact.

Medicine in the future must either grow worse, stand still, or grow better.

To grow worse, we must forget our present knowledge—happily, an inconceivable idea.

To stand still, we must accept our present knowledge as a finality, complacently pursuing the well-worn paths; neither hoping nor trying for anything better—happily, again, an impossibility.

To grow better, we must try new methods, give new drugs, perform new operations, or perform old ones in new ways; that is to say, we must make experiments. To these experiments there must be a beginning: they must be tried first on some living body, for it is often forgotten that the dead body can only teach manual dexterity. They must then be tried either on an animal or on *you.* Which shall it be? In many cases, of course, which involve little or no risk to life or health, it is perfectly legitimate to test probable improvements on man first, although one of the gravest and most frequent charges made against us doctors is that we are experimenting upon our patients.

But in many cases they involve great risk to life or health. Here they can not, nay, they must not, be tested first upon man. Must we, then, absolutely forego them, no matter how much of promise for life and health and happiness they possess? If not, the only alternative we have is to try them on the lower animals, and we would be most unwise, nay, more, we would be cruel, cruel both to man and to animals, if we refused to pain or even to slay a few animals, that thousands, both of men and of animals, might live.

Who would think it right to put a few drops of the hydrochlorate of cocaine (a year ago almost an unknown drug) into the eye of a man, not knowing what frightful inflammation or even loss of sight might follow? Had one dared to do it, and had the result been disastrous, would not the law have held him guilty and punished him severely, and all of us said Amen? But so did Christison with Calabar bean, and well-nigh lost his own life. So did Toynbee with prussic acid on himself, and was found dead in his laboratory.* Accordingly, Koller,

* I add the following striking extract from a speech in defense of vivisection, on April 4, 1883, by Sir Lyon Playfair, deputy Speaker of the House of Commons—no mean authority. The italics are my own:

"For myself, although formerly a professor of chemistry in the greatest medical school of this country, I am only responsible for the death of two rabbits by poison, and I ask the attention of the House to the case as a strong justification for experiments on animals, *and yet I should have been treated as a criminal under the present act had it then existed.* Sir James Simpson, who introduced chloroform—that great alleviator of animal suffering—was then alive and in constant quest of new anæsthetics. He came to my laboratory one day to see if I had any new substances likely to suit his purpose. I showed him a liquid which had just been discovered by one of my assistants, and Sir James Simpson, who was bold to rashness in experimenting on himself, desired immediately to inhale it in my private room. I refused to give him any of the liquid unless it was first tried upon rabbits. Two rabbits were accordingly made to inhale it; they quickly passed into anæsthesia and apparently as quickly recovered, but from an after-action of the poison they both died a few hours afterward. *Now, was not this a justifiable experiment upon animals? Was not the sacrifice of two rabbits worth saving the life of the most distinguished physician of his time?* . . . Would that an experiment of a like of Vienna, properly and wisely tried cocaine first on animals,* and then, finding its beneficial effects, tried it upon man with like results, and one of the most remarkable drugs of modern times was thus made available. We are only on the threshold of its usefulness. It has been used in the eye, the ear, the nose, the mouth, the larynx and all other mucous membranes, in the removal of tumors, and as an internal medicine. When its physiological action has been still more thoroughly and systematically investigated, its poisonous dose ascertained, when we know how it works, what its effects are upon the blood-pressure, the heart, the nerves, the blood-vessels—effects that can not be accurately studied upon man—its usefulness may be increased to an extent as yet but little dreamed of. Should it only soothe the last painful hours of our great hero, General Grant, a nation will bless it and the experiments which gave it effect. Moreover, had the experiments of Dr. Isaac Ott, of Easton, † on this very drug, borne their due fruit, America would have had the honor and the human race the benefits of cocaine ten years ago—ten years of needless suffering!

This is but one illustration of the value of experiments upon animals in the realm of new drugs. In fact, substitute for cocaine other drugs, or new operations, or new methods of medical treatment, and the argument repeats itself for each. Within the last thirty years a multitude of new drugs have thus been discovered, and their effects have been either first tested upon animals, or their properties studied exhaustively in a manner impracticable upon man. I will only enumerate some of them, since time will not allow me to enter upon each in detail. Thus have been introduced lily-of-the-valley in heart-disease, yellow jasmine, in diseases of the heart and nervous system, paraldehyde and chloral-hydrate, so valuable for sleep, caffeine for headache, eucalyptus as an antiseptic and in medicine, nitro-glycerine for nervous maladies, Calabar bean for diseases of the eye and nervous system, naphthaline and iodoform in surgery, quebracho as an antispasmodic, antipyrin and kairin in fever, jaborandi in dropsy, salicylic acid in rheumatism, nitrite of amyl in epilepsy and intermittent fever, jequir-

kind on a rabbit or a Guinea-pig had been used by John Hunter, who probably shortened his own noble life by experimenting on himself! . . .

"Let me give one other instance. . . . A few years ago two young German chemists were assistants in a London laboratory. They were experimenting upon a poison which I will not even name, for its properties are so terrible. It is postponed in its action, and then produces idiocy or death. A experiment on a mouse or a rabbit would have taught them the danger of this frightful poison; but, in ignorance of its subtle properties, they became its unhappy victims, for one died and the other suffered intellectual death. Yet the promoters of this bill would not suffer us to make any experiments on the lower animals *so as to protect man* from such catastrophes. It is by experiments on animals that medicine has learned the benefits, but also has been taught to avoid the dangers of many potent drugs—as chloroform, chloral, and morphia."

* "Archives of Ophthalmology," September and December, 1884, p. 402, New York, Putnams.

† Ott, "Cocaïn, Veratrin, and Gelsemium," Philadelphia, 1874.

ity in ophthalmic surgery, piscidia as a substitute for opium, the hypodermic method of using drugs, and so on through a long list. And, as to the old drugs, it may be truly said that we have little exact, that is scientific, knowledge of any one except through experiments upon animals.*

Let us see now something of what America has done in advancing practical medicine by vivisection. In passing, I may say that the assertion that America has contributed but little, so far from being an argument for the restriction of vivisection, is a strong argument for its further cultivation, in order that greater good may result from remarkable discoveries here, equal to those that I shall show have been made in Europe.

Wounds of the abdomen, especially gunshot-wounds, are among the most fatal injuries known to surgery. A small, innocent-looking, external pistol-wound may cover multiple and almost inevitably fatal perforations of the abdominal contents. The recoveries from 3,717 such wounds during the late civil war only numbered 444, and of those with escape of the intestinal contents the recoveries, says Otis, may be counted on one's fingers. The prevailing treatment as laid down in our text-books has been purely conservative, treating symptoms as they arise. The brilliant results achieved in other abdominal operations have led a few bold spirits, such as our own Sims, Gross, Otis, McGuire, and others, to advocate the opening of the abdomen and the repair of the injuries found.

In May of last year, Parkes, of Chicago, reported to the American Medical Association † a series of systematic experiments on thirty-seven dogs, that were etherized, then shot, the abdomen opened, and the wounds of the intestines, arteries, mesentery, etc., treated by appropriate surgical methods. The results confirmed the belief awakened by earlier experiments and observations that surgery could grapple successfully with multiple and formidable wounds, by sewing them up in various ways, or even by removing a piece of the bowel and uniting the cut ends. Hard upon the heels of this important paper,

* For three hundred years digitalis, for instance, has been given as a *depressant* of the heart, and, when a student, I was taught to avoid it carefully when the heart was weak. But the accurate experiments of Bernard and others have shown that it is, on the contrary, actually a *heart tonic and stimulant*. So long as I live I shall never forget the intense joy of myself and the agonized parents, when one bright young life was brought back from the very grave, some five years ago, by the knowledge of this fact, and this is but one of many such cases. Thus have the action and dangers of our common anæsthetics been positively and accurately ascertained; thus the action of ergot on the blood-vessels, explaining alike its danger as an article of food and its wonderful use in certain tumors of the uterus and diseases of the nervous centers; thus, too, every one who gives opium in its various forms is a debtor to Bernard, and every one who gives strychnine a disciple of Magendie.

† "Medical News," May 17, 1884. I shall refer readers frequently to this journal, as it is often more accessible than foreign journals, and it will refer them to the original papers.

and largely as its result, comes a striking improvement in practice. And remember, that this is only the first fruit of a rich harvest for future time, in all countries, in peace and in war.

November 2d, of last year, a man was brought to the Chambers Street Hospital, in New York, with a pistol-shot wound in the abdomen. Under careful antiseptic precautions, and following the indications of Parkes, the abdomen was opened by Dr. Bull,* coil after coil of the intestines was drawn out, the bullet was found and removed, and seven wounds of the intestines were successively discovered and properly treated, and the patient made an uninterrupted recovery. A recovery, after so many wounds, any one of which would necessarily have been fatal under the old methods of treatment, shows that we have now entered upon a proper and successful method of treatment for such frightful accidents.

This is but one of the remarkable achievements of late years in abdominal surgery. The spleen has been removed, part of the stomach has been cut out for cancer, part of the bladder has been dissected away, the entire gall-bladder has been removed, and several inches of the intestine have been cut out, all with the most remarkable success. To all of these, experiments upon animals have either led the way, or have taught us better methods. To recite each in detail would occupy too much time, but one illustration I must not omit, for the improvement, produced by it and other experiments, affects every abdominal operation. When I was a student, the peritonæum was avoided by knife and needle wherever possible. After the death of his fourth case of ovariotomy, Mr. (now Sir Spencer) Wells, † in making the *post-mortem*, was led to believe that the then received treatment of the peritonæum was incorrect, and that he ought to bring its surfaces in contact in order to obtain secure union. Accordingly, instead of testing his ideas upon women, he experimented upon a few dogs, and found that his suspicions were correct. Since then it has been accepted as a cardinal point in all abdominal operations. Following this came improvements in the ligatures used, in the method of treating the pedicle, in the use of antiseptics, etc., all more or less the result of experiments upon animals, and what are the results? Taking successive hundreds of cases, Sir Spencer Wells's percentage of mortality has decreased steadily from thirty-four per cent to eleven per cent. In 1,000 operations he has saved 769 women from the grave and added a net gain of 17,880 years to human life, to say nothing of the happiness of the thousands related to them by ties of friendship and of blood—a proud boast indeed!

Since then, others have reduced the percentage of deaths after ovariotomy to three in the hundred; and Martin, of Berlin, has lost but one patient from blood-poisoning in his last 130 cases.

* "Medical News," February 14, 1885.

† Wells, "Ovarian and Uterine Tumors," 1882, p. 197.

It can not be claimed, of course, as to *all* this wonderful history of abdominal surgery—and remember that in 1862, when I was a medical student, I heard ovariotomists denounced from a professor's chair as murderers!—that experiments upon animals have done the whole work. No one man, no one series of experiments has sufficed, and experiment *alone* would not have done it. But had such experiments not been made on animals, as to the peritonæum, the pedicle, the sutures, the ligatures, etc., we should be far behind where we now are, and still be ignorantly sacrificing human life and causing human suffering.

But to return to America. The first condition to successful treatment is an accurate knowledge of what any disease is—its cause and its course—then we may guide it, and in due time, it may be, cure it.

Before Dr. H. C. Wood's* accurate experiments on the effects of heat on animals, the nature and effects of sunstroke were almost matters of mere conjecture. Every one had his own theory, and the treatment was equally varied. Even the heat-effects of fever itself—the commonest of all symptoms of disease—were ill understood. Wood exposed animals to temperatures of 120° to 130° Fahr. and studied the effects. These experiments have often been alluded to as "baking animals alive." You will note that the heat was no greater than that to which laborers are frequently exposed in our hot summer-days, when working in the sun or in many industrial works. His experiments showed that the effects of sunstroke—or, as he happily termed it, Thermic or heat fever, a scientific name now widely adopted—were solely due to the heat, death following from coagulation of the muscular structure of the heart, or by its effects on the brain. They explained also many of the phenomena of ordinary fever as the result of heat alone. They have established the rational and now generally-adopted treatment of sunstroke by reduction of the body-temperature; and the same method is now beginning to be appreciated and employed in ordinary fever. †

The same observer, with Dr. Formad, has made important experiments on the nature of diphtheria, and when we learn, as we probably soon shall, how to deal with the microscopic forms of life which seem to be its cause, it will not be too much to hope that we may be able to cope far more successfully with a disease now desolating so many homes.

In India alone twenty thousand human beings die annually from snake-bite, ‡ and as yet no antidote has been discovered. How can we

* Wood, "Thermic Fever or Sunstroke," Philadelphia, 1872.

† Eighteen out of Wood's experiments were on the general effects of heat, as above alluded to. In six others the local effects of heat (135° to 190° Fahr.) on the brain, and in four others the local effects (up to 140° Fahr.) on the nerves were studied, and gave most valuable results, entirely and evidently unattainable on man.

‡ Fayrer, "Thanatophidia of India," p. 32.

search intelligently for an antidote until we know accurately the effects of the poison? This can not be studied on man; we must resort to animals, or else let the holocaust go on. Accordingly, Dr. T. Lauder Brunton began such a series of experiments in London, but was stopped by the stringent anti-vivisection laws there in force. But Drs. Weir Mitchell and Reichert,* in this city, have recently undertaken experiments on cobra and rattlesnake venom, the cobra-poison being furnished, be it observed, by the British Government, whose own laws have prevented investigations for the benefit of its own subjects! The results are as yet only partly made known, but they have been brilliantly successful in showing that there are two poisons in such venom, each of which has been isolated and its effects studied. The first step has been taken—the poison is known. Who will raise a finger to stop progress toward the second—the antidote? Can the sacrifice of a few score of animals each year in such research weigh for a moment against the continuous annual sacrifice of twenty thousand human beings? †

The modern history of anæsthetics is also of interest. To say nothing of ether and chloroform, whose safer use Bert has investigated in France, nor of cocaine, to which I have already alluded, let us see what experiments on animals have shown us as to bromide of ethyl—an anæsthetic lately revived in surgery. Its revival has quickly been followed by its abandonment on account of the frequent sacrifice of human life—that is to say, *experiments on human beings* have proved it to be deadly. Now, Dr. H. C. Wood, ‡ soon after its reintroduction, made a study of its effects on animals, and showed its physiological dangers. Had his warnings been heeded, not a few human lives would have been saved.

The ideal anæsthetic, that will abolish pain without abolishing consciousness, and do so without danger, is yet to be found. Cocaine is our nearest approach to it. Now, in all fairness and common sense, would it be real kindness or real cruelty to obstruct the search for such an anæsthetic—a search which will surely be rewarded by success, but which, if not carried on by experiments on animals, must be

* "Medical News," April 28, 1883.

† I am permitted by Rev. R. M. Luther, of this city, to state the following fact in illustration of the practical value of vivisection in snake-bite: When a missionary in Burmah, he and his brother-in-law, Rev. Mr. Vinton (two missionary vivisectionists!), made a number of experiments to discover an antidote to the poison of the "brown viper"—a snake but little less venomous than the cobra. They found a substance which is an antidote in about sixty per cent of the cases if applied at once. Thah Mway, one of their native preachers, when bitten by the brown viper, had some of this antidote with him, and by its use his life was saved when on the verge of death. This one life saved has been the means of leading, it is estimated, two thousand Karens to embrace Christianity. Was not this one life worth all the dogs used in the experiments—to make no mention of the many other lives that will be saved in all the future?

‡ "Philadelphia Medical Times," April 24, 1880.

tried by deadly experiments upon man, or else be hopelessly given up?

In 1869 I was called to see a man suffering to the last degree from an abscess in the loin. I recognized the fact that it arose from the kidney, but I was powerless. All that I could do was to mitigate, and that, alas! but little, his pitiless sufferings till death came to his relief, after nearly a year of untold agony. I have never forgotten his sufferings, nor the sharp pain I felt when I learned, two years later, how I might possibly have saved his life. In the very same year (1869), Simon, of Heidelberg,* had a woman under his care suffering from urinary fistulæ from a healthy kidney — a surgical accident he in vain tried to heal. That she could live with one kidney had the other gradually been disabled by disease was probable, for one such diseased kidney had been already removed three times when mistaken for ovarian disease; and physiologists had often removed one or both kidneys in animals. But no one had removed a healthy kidney, and then studied the effects on the remaining kidney and upon the heart; no one had tested what was the best method of reaching the kidney, whether by the abdomen or the loin, or how to deal with its capsule, or the hæmorrhage, or the surgical after-effects. Of course, Simon could have tried the experiment on his patient, blindly trusting to Providence for the result. But he chose the wiser course. He studied the previous literature, experimented on a number of dogs and watched the points above noted, tried various methods of operating upon the dead body, and, after weighing all the *pros* and *cons*, deliberately cut down upon the kidney of his patient after a carefully formulated plan, not by the abdomen, but through the loin, and saved her life. She died in 1877, after eight years of healthy life, free from her loathsome disorder.

Now, what have been the results of these experiments upon a few dogs? One hundred and ninety-eight times the kidney has been removed, and 105 human lives have been saved; 83 times abscesses in the kidney have been opened, and 66 lives saved; 17 times stones have been removed from the kidney without a single death—or, in all, in the last fifteen years, 298 operations, and 188 human lives saved. Besides this, as an extension of the operation in 17 cases, in which the kidney, having no such attachments as ought to anchor it in place, was floating loosely in the abdomen and a source of severe pain, it has been cut down upon and sewed fast in its proper place; and all of these patients but one recovered.

Looking to the future, when not hundreds but thousands of human beings will enjoy the benefits of these operations, and in increasing percentages of recoveries, are not the sufferings inflicted on these few dogs amply justified as in the highest sense kind and humane? †

* Simon, "Chirurgie der Nieren," 1871, preface.

† Very erroneous views prevail as to the sufferings of animals from experiments upon

Not long since Dr. Ferrier, of London, was prosecuted for the alleged performance of certain experiments on the brains of the lower animals. With Fritsch, Hitzig, Goltz, Yeo, and others, he had destroyed or galvanized certain limited areas of the brain (and it must not be forgotten that the brain is wholly without the sense of pain), and so determined the exact nervous centers for certain limited groups of muscles. As a result of their labors, the brain is now mapped out with reasonable accuracy, so that, given certain hitherto ill-understood or obscure localized symptoms, we can now say that there is certainly a tumor, an abscess, or other disease in precisely this or that locality. True, we can doubtfully infer somewhat of the same from the cruel experiments of disease on man. But Nature's experiments are rarely ever limited in area or uncomplicated ; they are never systematic and exhaustive ; it takes years to collect a fair number of her clumsy experiments, and the knowledge is diffused through many minds instead of being centered in one that will systematize the results.

Said Ferrier, a year ago, in the Marshall Hall oration, "There are already signs that we are within measurable distance of the successful treatment by surgery of some of the most distressing and otherwise hopeless forms of intra-cranial disease, which will vie with the splendid achievements of abdominal surgery."

Note the fulfillment ! Last fall, within a year of the foregoing prophecy, a man, aged twenty-five, entered the London Hospital for Epilepsy and Paralysis.* From the symptoms, which I need not detail, Dr. Hughes Bennett, basing his conclusions on Ferrier's experiments, diagnosticated a tumor of small size on the surface of the brain, involving the center of motion for the muscles of the hand. On November 15, 1884, at his instance, Mr. Godlee trephined the skull over the selected spot, and a quarter of an inch below the surface of the brain found a tumor as big as a walnut, and removed it. For three weeks the man did well, but died on the twenty-eighth day from blood-poisoning, such as might follow any operation, especially a new one. Macewen, of Glasgow, † has similarly trephined a woman, the victim of slow paralysis of body and mind, and opened an abscess a little distance below the surface, letting out two teaspoonfuls of pus, and followed by entire mental and physical recovery.

them. Many persons suppose that "vivisection" means deliberate "cutting up" of an animal, little by little, till not enough is left to live. So far is this from the truth, that Professor Gerald Yeo, from the actual reports of vivisectionists in England ("Fortnightly Review, March, 1882), estimates that of one hundred such experiments, there are:

Absolutely painless	75
As painful as vaccination	20
As painful as the healing of a wound	4
As painful as a surgical operation	1
Total	100

* "Medical News," January 17, 1885. † Ibid., January 3, 1885.

By these experiments and operations a wide door is open to surgery in the treatment of diseases within the skull—diseases heretofore so obscure and uncertain that we have hardly dared to attack them. The question is not whether death or recovery followed in these particular cases. The great, the startling, the encouraging fact is that, thanks to these experiments, we can now, with well-nigh absolute certainty, diagnosticate, and with the greatest accuracy locate such diseases, and therefore reach them by operation, and treat them successfully. Would that I had been born twenty-five years later, that I might enjoy with you the full luxury of such magnificent life-saving, health-giving discoveries!

It is, however, by the experimental study of the effects of minute organisms—microbes, as they are now called—that some of the latest and most remarkable results have been achieved. The labors of Koch, Pasteur, Klein, Cheyne, Tommasi-Crudeli, Wood, Formad, Sternberg, and others, are now known even to the daily press. Let us see what they have done.

It is but three years since Koch announced that consumption was caused by the "bacillus tuberculosis." Later he has studied cholera and found the "comma-bacillus," to which he ascribes that dreaded disease. In spite of the opposition of prominent scientists, his views have been in general accepted, and seem to be reasonable.

The method of experiment is simple, though difficult. The suspected expectoration or discharge is placed in a suitable soil, and after cultivation some of this growth is placed in another culture-soil, and so on till generation after generation is produced, the violence of the poison being modified by each culture. A small portion of any one of these cultures is then injected under the skin of a mouse or other animal, and in time it dies or is killed, and the results are verified by the *post-mortem.*

So exact is the knowledge in tuberculosis now that Koch can predict almost to an hour when the mouse will die of consumption, or that it will escape, according to the culture used.

It is far too early as yet to say that these studies have borne the immense practical fruit that the next few years will show; but they have already enabled us to recognize by the microscope doubtful cases of consumption in their earlier and more remediable stages, and have made certain what has hitherto been only a probability—that consumption is distinctly contagious.

By Gerlach's experiments on animals with the milk from tubercular cows, also, it has been shown that consumption may be contracted from such milk. How important this conclusion is, in so universal an article of food to young and old, I need not do aught than state.

The experiments of Wood and Formad on diphtheria I have already alluded to. Those of Tommasi-Crudeli also have shown that probably the poison of malaria is due to like organisms, while a large number of other diseases are being similarly investigated.

As to cholera, the classic experiments of Thiersch, in 1853,* are well known. He inoculated fifty-six mice with cholera-discharges. Of these, forty-four sickened and fourteen died from choleraic diseases. In the same year two water companies in London experimented on 500,000 human beings, one of them inoculating its patrons with cholera-discharges through its impure water-supply. This one sickened thousands and killed 3,476 human beings, most of whom might have escaped had the lessons of Thiersch's fourteen mice been heeded. To ask the question, which was the more cruel, is to answer it.†

At present our strenuous efforts are all in one direction—viz., to study these microbes by the microscope, by clinical observation, and by experiments on animals, in order to find out their origin, causes, growth, and effects, and to discover by what means their deadly results may be avoided, or by what remedies, without harm to the patient, they may themselves be destroyed. Evidently these studies can not be tried on our patients. They must either be tried on animals or be abandoned.

The inoculation experiments of modern times have recently borne rich fruit in still another pestilential disease—yellow fever—whose ravages in this country are fresh in our minds. November 10, 1884, M. Bouley reported to the Paris Academy of Sciences‡ that, since 1880, M. Freire, of Rio Janeiro, had experimented on Guinea-pigs with the virus of yellow fever, and believed that he had been able to produce such attenuation of the virus that by vaccination he could secure immunity from this dreadful scourge. Following the experiments, he and Rabourgeon tested the results on themselves, some students of medicine, and employés. Later the Emperor Dom Pedro authorized two hundred wharf-laborers to be inoculated. All these, after a three days' mild attack, remained free from the pestilence, while their fellow-laborers, similarly exposed to the fever, were dying on every hand. If, in an epidemic, this still prove true, as there seems every probability it will, from the five hundred lives already saved, we can hardly estimate either the medical or the commercial advantages to this coun-

* John Simon, "Proceedings International Medical Congress," London, 1881.

† The population supplied by the Southwark and Vauxhall Company, in the epidemic of 1848–'49, died at the rate of 118 in each 10,000, and, in that of 1853–'54, at the rate of 130 per 10,000. Those supplied by the Lambeth Company died in 1848–'49 at the rate of 125 per 10,000, but having improved its water-supply meantime, the death-rate, in 1853–'54, fell to 37 per 10,000.

If Thiersch lived in England to-day, he would have to take out a license to kill his fourteen mice in the interests of humanity—a license possibly refused, or only to be obtained after the most vexatious delays. But any house-maid might torture and kill them with arsenic or phosphorus, or Thiersch might give them to a favorite terrier without the slightest interference, provided only it be not for a scientific or a humane object!

‡ "Medical News," November 29, 1884.

try alone. Is this cruelty? Let Norfolk, and Memphis, and Pensacola, and New Orleans answer.

We are all familiar now with the numerous deaths from eating pork infested with trichina. While I was in Berlin, in 1865–'66, a terrible epidemic of the then new disease broke out at Hedersleben, a small town in Prussian Saxony. I well remember with what zeal Virchow and his assistants immediately investigated the disease, inoculated animals with the parasitic worm, studied its natural history, found out that heat killed it, and to-day, as a result of these and other experiments, we all know how to avert its dangers by proper cooking, or to avoid it altogether by the microscope. The value of these experiments, both to human life and to commerce, you know even from the daily papers.

You will find it difficult to make the non-medical public understand —nay, you yourselves as yet hardly understand—the enormous advance in medicine and surgery brought about by recent researches on inflammation, and by the use of antiseptics. My own professional life only covers twenty-three years, yet in that time I have seen our knowledge of inflammation wholly changed, and the practice of surgery so revolutionized that what would have been impossible audacity in 1862 has become ordinary practice in 1885.

It would seem that so old a process as inflammation would long ago have been known through and through, and that nothing new could be adduced. In 1851, however, Claude-Bernard, by a slight operation, divided the sympathetic nerve in a rabbit's neck and showed its influence on the caliber of the blood-vessels. In 1858 Virchow published his "Cellular Pathology." In 1867 Cohnheim (Virchow's "Archiv") published his studies on the part that the blood-cells played in inflammation as shown in the frog, followed by further papers by Dr. Norris, of this city, Stricker, Von Recklinghausen, Waldeyer, and many others. Already in my lectures I have pointed out to you in detail the advances made by these studies, both in theory and practice. They have brought about an entire reinvestigation of disease, and given us wholly new knowledge as to abscesses, ulceration, gangrene, the organization of clots in wounds, and after operations and ligature of blood-vessels for aneurism, as to thrombosis, and embolism, and paralysis, and apoplexy, and a score of other diseases through the diagnosis and treatment of which now runs the silver thread of knowledge instead of ignorance.

With this the brilliant results of the antiseptic system have joined to give us a new surgery. Sir Joseph Lister, to whom we chiefly owe this knowledge, has done more to save human life and diminish human suffering than any other man of the last fifty years. Had he only made practicable the use of animal ligatures, it would have been an untold boon, the value of which can only be appreciated by doctors; but he has done far more, he has founded a new system of surgery.

We may reject the spray and carbolic acid, but the surgical world, regardless of details, with few exceptions follows the principles upon which his method is founded and humanity is the gainer, by the nearly total abolition of inflammation, suppuration, secondary hæmorrhage, blood-poisoning, gangrene, and erysipelas, as sequels of accidents and operations; by the practicable relief from suffering and death, by operations formerly impossible; by rendering amputations and compound fractures safe and simple instead of deadly. Reflect on what each one of these brief but momentous statements means!

But we have by no means reached perfection. Lister himself, no tyro, but the great master, is still searching for further improvements. But when lately he desired to make some experiments on animals, still further to perfect our practice, so many obstructions were thrown in his way in England that he was driven to Toulouse to pursue his humane researches.

I had intended also to speak of many other practical benefits to man directly, but can only mention such important matters as the surgery of the thyroid gland, the seat of goitre; the surgery of the lungs, part of which have been removed; the surgery of the nerves, removal of the entire larynx, the remarkable researches of late years as to the periosteum in the reproduction of new bone after removal of dead or diseased bone; Bernard's important observations as to diabetes; Brown-Séquard's experiments on epilepsy, the modern extraordinary advance in nearly all the diseases of the nervous system, and a number of other discoveries, as to all of which experiments upon animals have added largely to our knowledge, and therefore to our means of diminishing suffering and saving human life. For many of these, as well as for the most judicial discussion of the vivisection question I have yet seen, I must refer you to that remarkable book, "Physiological Cruelty," written, not by a man, *but a woman*.*

I had also intended to refer in detail to the splendid results of vivisection in relieving the sufferings of animals, and in preventing enormous pecuniary loss to man. We are only beginning to see that vivisection is as humane to animal life and suffering as it is to human, and that for financial reasons as well as humane motives it is of the utmost importance to the State that such diseases as cattle-plague, splenic fever, chicken-cholera, swine-plague, and others, should be eradicated. Vivisection has shown us how this may be done, and has so conferred upon animals too the boon of life and health. For all this, however, I must refer you to the recent admirable lecture by Professor Robert Meade Smith, of the University of Pennsylvania.†

One subject, however, is so recent and of such interest, both to man and animals, that I must not pass it over—I mean that justly-

* See also the just issued "Life and Labors of Pasteur."

† Reprinted from the "Therapeutic Gazette," November, 1884.

dreaded disease hydrophobia. Thanks to vivisection, its abolition in the near future seems no longer to be a matter of doubt.

Within the last three years Pasteur has announced that, by passing the virus through the monkey, he has been able to protect dogs from hydrophobia by vaccination with this weakened virus. The French Government recently appointed an eminent scientific commission to report on the alleged discovery.* Pasteur furnished them with 23 vaccinated dogs. These 23, and 19 others unprotected, were all inoculated from rabid animals. Of the 19 unprotected, 14 died. Of the 23 protected dogs, one died of diarrhœa, and all the others escaped. It has yet to be tried on a man suffering from hydrophobia, but, should our reasonable hopes be realized, what a boon it will be!

With this brief summary of a few of the recent practical benefits from vivisection, I must close. I have given you only ascertained facts for your future use in the communities in which you may settle. They may assist you in forming public sentiment on a basis of fact, of reason, and of common sense. The sentiments of our own profession, so constantly and so conspicuously humane, are always against inflicting pain; but if in yielding to sentiment we actually increase disease, and pain, and death, both among animals and men, our aversion to present pain is both unwise and actually cruel.

In conclusion, let me wish you the greatest success in your professional life, and the richest blessings of our kind heavenly Father. Farewell.

CAN MAN BE MODIFIED BY SELECTION?†

By W. K. BROOKS.

THE certainty and rapidity with which our domesticated animals and plants may be modified in any desired direction by selective breeding must be regarded as a reason for believing that, if it were possible to pursue the same course with man, the human race also might be rapidly improved in the same way. It is difficult to prove this, for we are almost entirely removed, by our control over Nature and by our artificial life, from the influence of natural selection; and, as we can not dictate to men and women whom they shall marry, we can not bring about a union of those with the same congenital characteristics, or propagate for a number of generations a peculiarity which it is desirable to perpetuate and intensify.

There is reason to fear that our freedom from the influence of natural selection may lead to the degeneration of the race unless some

* "Medical News," August 30, 1884.

† Review of a paper by Alexander Graham Bell, read before the National Academy of Sciences, November 13, 1883, upon the "Formation of a Deaf Variety of the Human Race."

way to supply its place is discovered and adopted; and the first step in this direction is to prove by actual experiment that the race can be modified by selection like any other species of organism.

The researches of Professor Bell, which show that a race of deaf-mutes is actually growing up in the United States through an unfortunate application of the law of selection, therefore have a very great scientific value, which is entirely independent of the warning they give of a danger which threatens us.

In the paper which is quoted above he renders the community an important service by pointing out this danger; but it seems to me that the chief value of his work is not in this direct practical bearing, but in the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race, for, as soon as the truth is borne home to all men by facts like those which Professor Bell has brought together, some effective means of applying it to mankind will certainly be devised.

Mankind will not submit to any direct interference with personal liberty; but, if it is true that desirable characteristics can be perpetuated and developed by selection, indirect methods of influencing the choice of husbands and wives could undoubtedly be devised and employed.

If all the children which exhibit the desired peculiarity could be brought together as early as possible, and could be made to live together during their youth, carefully guarded from the possibility of making acquaintance with any other children, and if this restriction could be continued through the period when acquaintances and friendships and attachments are most easily established, this would be a great step toward selective breeding; for all the children with the desired peculiarity would become intimately acquainted with one another, while they would have few outside friendships. If, after the children had grown up and become scattered, they were encouraged to hold periodical reunions for promoting social intercourse between them in adult life, and if they were provided with newspapers and periodicals of their own, which should make a specialty of "personals" relating to them, giving a full account of their conventions and reunions, and keeping their readers informed of all their movements, their employments, their marriages, deaths, etc., the chances of intermarriage among them would be greatly increased.

If they were taught to speak and think in a language of their own, and were furnished with a literature of their own in this language, they would be very effectively cut off from intercourse with outsiders, and would be compelled to look to their own numbers for their companions and acquaintances; and there can be no doubt that, if all these influences were employed together generation after generation, they would soon lead to the establishment of a race sharply marked off from the rest of the world by the excessive development of the characteristic upon which the selection was based.

If the selection were a wise one, the result would be to the benefit of mankind ; but the result would follow just as surely if an injurious peculiarity or a defect were made the basis of the selection, for a natural law produces its effect, whether it is applied wisely or unwisely.

Professor Bell points out that our system of educating the deaf brings all these influences to bear, and that the means which have been adopted by philanthropists and others from the noblest and purest motives to ameliorate the condition of the deaf and dumb are unfortunately the most complete and efficient methods which it is possible to employ for inducing deaf-mutes to marry deaf-mutes, and that it would be difficult to devise a more certain means for increasing the number of unfortunate persons with this infirmity, and for producing by selection a deaf variety of the human race.

We separate them from other children as early in life as possible, taking them away from their homes and placing them by hundreds in institutions where they are isolated from early childhood to the commencement of adult life. Each deaf person is therefore intimately acquainted with nearly all the others of his own generation, while there are few opportunities for the formation of congenial and lasting intimacies with outsiders. The graduates of the institution organize themselves into societies or conventions for the promotion of social intercourse in adult life, and these societies are to be found in all large cities, in rooms where they meet for social intercourse, and for religious worship. They hold State and national conventions, which are attended by deaf-mutes of both sexes from all parts of the country, and they publish newspapers and periodicals of their own which are filled with personal items.

They are taught a special language which is as different from English as French or German or Russian, and they learn to think in the gesture-language, so that English is apt to remain a foreign tongue, while they often write in broken English as a foreigner would speak, so that they are in a great measure cut off from all of our literature except its very simplest forms, and they have imperfect sources of information upon topics which engage the interest of the rest of the community, such as social and political matters.

Although there is no compulsion or infringement of personal liberty, all these influences combine to induce deaf-mutes to select for their partners in life persons who are familiar with the gesture-language, and with whom they have been thrown from childhood. We have, therefore, adopted most of the means which tend toward the formation of a deaf-mute variety of the human race, and time alone is necessary to accomplish the result ; but there are still other means which might be employed to hasten it. Professor Bell says that, with this end in view, we might attempt to formulate some plan which should lead the deaf children of deaf-mutes to marry one another instead of marrying deaf-mutes who have not inherited their deafness, or to marry hearing persons belonging to families in which deafness is hereditary. If, for instance, a number of the large deaf-mute families of the United States were to settle in a common place so as to form a community largely composed of deaf-mutes, then the deaf children born in the colony would be thrown into association with one another, and would probably marry in adult life or marry hearing persons belonging to deaf-mute families, and each succeeding generation of deaf-mutes would increase the probability of the deaf-mute element being rendered permanent by heredity ; and we might anticipate that a very few generations would suffice for the establishment of a permanent race of deaf-mutes with a language and literature of their own.

Plans for the formation of such a community of deaf-mutes have many times been discussed by the deaf-mutes themselves, contributions of money for the purpose have been publicly offered, and it has even been proposed to procure the enactment of laws to secure the descent of the land and other property in the deaf-mute line alone, so that the hearing children would be led to leave the community. A colony of this sort has even been founded in Manitoba, and twenty-four deaf-mutes with their families have already arrived from Europe and have settled upon the land, while more are expected this year.

The analogy of all other organisms would lead us to expect that, with all these selective influences at work, the number of deaf-mutes should increase rapidly, and the interesting question, "How far do the facts justify this opinion?" at once presents itself, and we ask, first, whether deafness is hereditary; and, second, whether it is true that many deaf-mutes marry ; and, third, whether our system of education does lead those who marry to select deaf-mutes as their partners ; and, fourth, whether deafness is more frequent among their children than it is in the community at large.

If the published records answer all these questions in the affirmative, it is clear that, however much the present system may appeal to our sympathies, it is neither the best one for the interests of the whole community, nor the best for the deaf themselves, since it tends to increase the evil which it is designed to alleviate.

Few of the institutions publish any record regarding the relatives of pupils, but the records of the American Asylum, at Hartford, Connecticut, show that, of 2,106 pupils admitted to that institution, 693, or nearly 33 per cent, were known to have deaf-mute relatives, and in the majority of these cases the pupils have more than one relative deaf and dumb, while in a few cases as many as 15 deaf-mute relatives are recorded. The report of this institution for 1877 shows that

593 pupils had one or more brothers or sisters deaf and dumb.
100 " " cousins "

47 pupils had one or more parents deaf and dumb.					
38	"	"	"	uncles or aunts deaf and dumb.	
29	"	"	"	children	"
48	"	"	"	distant relatives	"
5	"	"	"	grandparents	"
1	"	"	"	great-grandparent	"
1	"	"	"	great-uncle or aunt	"

That this is not peculiar to the pupils of this particular institution, and that it holds true of deaf-mutes in general, is shown by the following table, compiled from the records of six institutions :

INSTITUTIONS.	Total number of pupils.	Number of pupils having deaf-mute relatives.	Percentage of pupils having deaf-mute relatives.
American Asylum	2,106	693	32·9
New York Institution..........	1,165	380	32·6
Ohio Institution...............	560	166	29·6
Indiana Institution	283	103	36·4
Illinois Institution.............	1,620	356	21·7
Texas Institution.............	89	21	23·6
Total....................	5,823	1,719	29·5

The table shows that, among 5,823 deaf-mutes taken from different parts of the country, 1,719, or 29½ per cent, are known to have had deaf-mute relatives, and that this is due to the influence of heredity is well shown when we contrast those who were born deaf with those who had afterward lost their hearing. Many of those who lose their hearing by accident or disease have no hereditary tendency to deafness, but a considerable number of those who lose their hearing at some time after birth are born with an hereditary predisposition to deafness. If, therefore, we contrast the congenitally deaf with those who have become deaf, we should expect the latter class to have a much smaller percentage of deaf relatives than the former class, but a greater percentage than the community at large.

Professor Bell has compiled the following two tables from the one which is given above, and they show that, while only about 13 per cent of the pupils which were not born deaf have deaf relatives, more than 54 per cent of the congenitally deaf pupils are recorded as having such relatives :

TABLE II.—*Proportion of the Non-congenitally Deaf who have Deaf Relatives.*

INSTITUTIONS.	Number of non-congenital deaf-mutes.	Number having deaf-mute relatives.	Percentage having deaf-mute relatives.
American Asylum	1,040	131	12·6
New York Institution..........	432	74	17·1
Ohio Institution...............	268	32	11·9
Indiana Institution	124	31	25·
Illinois Institution.............	947	120	12·7
Texas Institution	53	8	15·
Total....................	2,864	396	13·8

TABLE III.—*Proportion of the Congenitally Deaf who have Deaf-Mute Relatives.*

INSTITUTIONS.	Number of congenitally deaf pupils.	Number having deaf-mute relatives.	Percentage having deaf-mute relatives.
American Asylum	973	552	56·7
New York Institution	488	287	58·8
Ohio Institution	208	118	56·7
Indiana Institution	149	72	48·3
Illinois Institution	418	194	46·4
Texas Institution	26	11	42·3
Total	2,262	1,234	54·5

These tables show that, of 2,262 congenital deaf-mutes, more than half are known to have had deaf-mute relatives, and that, even in the case of those pupils who become deaf from apparently accidental causes, more than 13 per cent had other members of their families deaf and dumb.

In answer to the second question, Do deaf-mutes marry? Professor Bell gives a number of tables, one of which shows that, out of 1,259 pupils at the American Asylum and the Illinois Institution who were born before 1840, 571, or nearly half (45·4 per cent), are recorded as married. The records for later years show a much smaller number of marriages in proportion to the total number of pupils; but this would necessarily be the case, because most of them are as yet children.

In order to determine how many of this 45 per cent of deaf persons who marry chose deaf-mutes for their partners, Professor Bell has compiled the following table from the records of five of our largest institutions for the deaf and dumb:

TABLE IV.—*Proportion of the Deaf and Dumb who marry Deaf-Mutes.*

INSTITUTIONS.	Total number of pupils recorded to have married.	Total number recorded to have married deaf-mutes.	Percentage.
American Asylum	642	502	78·2
New York Institution	191	142	74·3
Ohio Institution	56	39	69 6
Indiana Institution	26	21	80·8
Illinois Institution	174	152	87·3
Total	1,089	856	78·6

This shows that nearly 80 per cent of the deaf-mutes who marry at all marry deaf persons; but it does not follow that 80 per cent of the marriages were between deaf persons, for it is probable that nearly all of the 856 pupils who married deaf persons married pupils, so that there may possibly have been only 428 weddings; while the 1,089 *minus* 856, which equals 233 who married hearing persons, may represent only 233 weddings, so that, out of 661 marriages, only 428, or 65 per cent, may have been between deaf persons, but even this is an alarming frequency, if it is true that the children of such unions are predisposed to deafness.

If it is true that our system of educating the deaf is responsible for the number of marriages between deaf persons, we should expect to find these marriages increasing in numbers, and Professor Bell has compiled from the table above quoted the following table, which shows that this is the case :

YEAR OF BIRTH.	Total recorded to have married.	Total recorded to have married deaf-mutes.	Percentage.
Before 1810..................	129	72	55·8
1810 to 1839	715	577	80·7
1840 to 1859	233	196	84·1
1860 and after	12	11	91·7

These two tables show that the tendency of deaf-mutes to select deaf-mutes as their partners in marriage is very pronounced, and that it is much more developed now than it was during the early half of the century, and that it is steadily increasing.

Thus there is every indication that this process of selection will go on from generation to generation, and that a large proportion of the deaf children of deaf parents will themselves marry, and that, of those who marry, the majority will marry deaf-mutes.

If it is true that deafness is hereditary, this can have only one result—the increase of deafness.

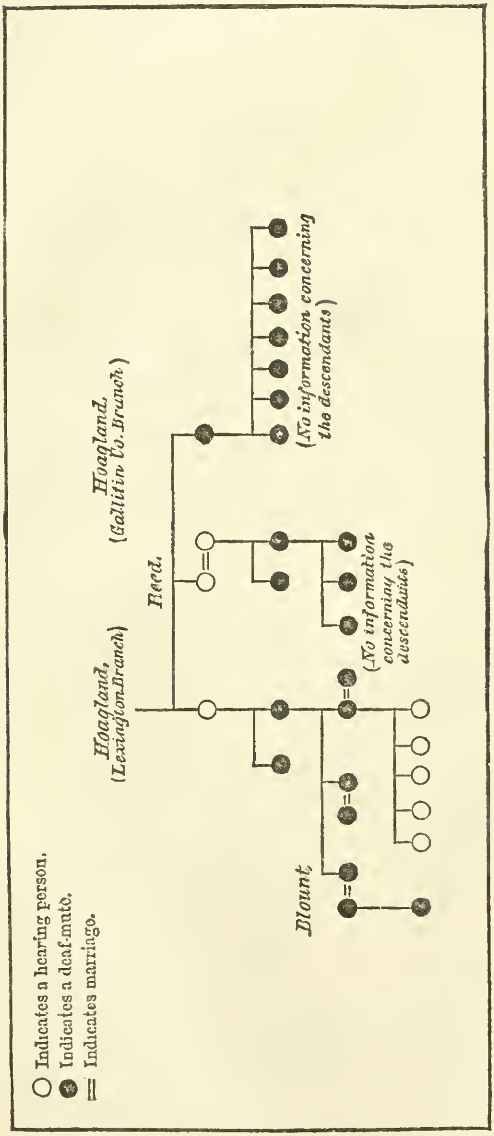
There are very few reliable statistics regarding the number of children born to deaf-mutes, or the proportion of deaf children, but Dr. Turner, formerly the Principal of the American Asylum, stated, in 1868, that statistics carefully collated from records kept of deaf-mutes, as they have met in conventions at Hartford, show that *in eighty-six families, with one parent a congenital deaf-mute, one tenth of the children were deaf; and in twenty-four families, with both parents congenital deaf-mutes, about one third were born deaf.*

In 1854 Dr. Peet, the Principal of the New York Institution, said that, of all the families of which he had records, "*about one in twenty have deaf-mute children where both parents are deaf-mutes, and about one in one hundred and thirty-five where only one is a deaf-mute; and that the brother and sister of a deaf-mute are about as liable to have deaf-mute children as the deaf-mute himself, supposing each to marry into families that have, or each into families that have not, shown a predisposition toward deaf-dumbness.*"

Our author has attempted to trace out from the scanty records the history of certain families in which deafness is hereditary, and he has expressed the facts in a number of graphic diagrams, two of which are here reproduced.

THE HOAGLAND FAMILY, OF KENTUCKY.

In this family nineteen out of twenty-six descendants were deaf, and it is interesting to note that, although one of the members of the family was a hearing person, and married a hearing husband (Reed), their two children and three grandchildren were all deaf. One of the descendants, No. 1, was deaf and married a deaf-mute, but their five children all hear. No one could refer to this branch of the family as a proof that deafness is not hereditary, however.



THE HOAGLAND FAMILY, OF KENTUCKY.

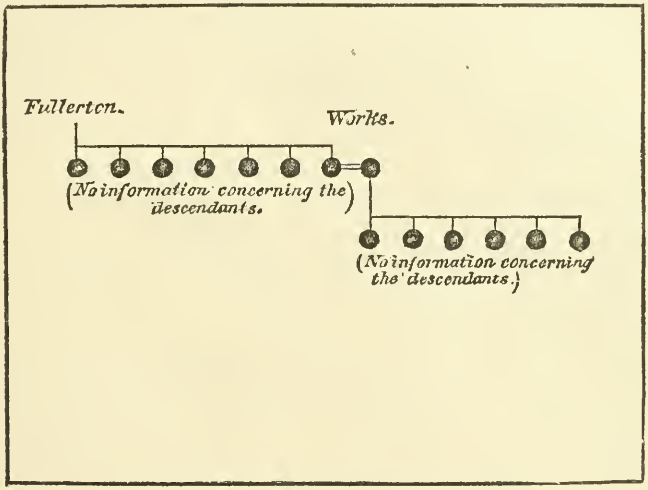
The diagram on the following page shows the genealogy of the Fullerton family, of Hebron, New York:

Fullerton had seven children, all deaf and dumb. There is no further information about six of these children or their descendants; but the seventh, Jane Fullerton (1), married Sayles Works (2), who was also a deaf-mute, and all their six children were deaf and dumb. No information was obtained regarding the descendants of these six children.

Those persons who are not familiar with logical reasoning will point to married deaf-mutes with hearing children as proof that such marriages are not to be condemned; but, in order to prove that deafness is hereditary, it is not necessary to show that all the children of deaf parents are deaf, but only that the number of deaf children, as compared with the hearing children, is greater than it is in the community as a whole, and this fact is proved beyond question by the statistics.

The census returns show that there are 33,878 deaf-mutes in the country, or that one person out of every 1,500 is deaf ; or that, out of each 1,500 children who are born, 1,499 retain their hearing throughout life, while only one is deaf.

If deaf children are no more numerous in the families of deaf parents than they are elsewhere in the community, only 23 out of the 33,878 deaf-mutes should have deaf parents ; but we have a record of nearly ten times this number, for Professor Bell states that, although



THE FULLERTON FAMILY OF HEBRON, NEW YORK.

only thirty-five of the fifty-eight institutions of the country have sent replies to his queries, the returns from these thirty-five show that no less than 207 deaf children of deaf parents have been admitted as pupils. Deaf children are, therefore, at least ten times as numerous in families where the parents are deaf as they are in the community at large, and it is impossible, after reading Professor Bell's paper, to doubt—1. That deafness is hereditary ; 2. That, of the deaf persons who marry, nearly all select deaf partners ; 3. That their children are especially liable to deafness ; and, 4. That the number of deaf-mutes who marry deaf-mutes is increasing, and that our educational system fosters this tendency, and is to a great extent responsible for it.

So far Professor Bell's conclusions seem to be unanswerable, and there is no room to doubt that the means that we have adopted for the amelioration of the conditions of the deaf have actually tended to increase the evil they were intended to diminish.

The question whether this can be avoided, while the system as a whole is retained, is one upon which there may well be a difference of opinion ; and the fact that the publication in 1868 of a paper on "Hereditary Deafness," by the Principal of the American Asylum, the Rev. W. W. Turner, has been followed by a decrease in the number of marriages between the pupils of that institution, seems to show that it may be possible to accomplish much by repressive influences. Our author believes, however, that the defect is inherent in our system, and that a complete change is necessary ; and that the segregation of deaf children in institutions, where they are kept by themselves, really lies at the root of the matter ; and that the grand central principle, which should guide us in our search for preventive measures, should be the retention of the normal environment during the period of education. The direction of change should therefore be toward the establishment of small schools and the extension of the day-school plan. The average cost of the education of a deaf child in an American institution is $223.28 per annum, and a small day-school could be maintained at no greater cost, although the parents would be compelled to furnish, in addition, the industrial training which is now provided by the State ; but this would give no concern, for so many deaf-mutes are now earning their livelihood by trades which are not taught in the institutions as to demonstrate the practicability of apprenticing deaf-mutes in ordinary shops.

The employment of the gesture-language and lack of articulate speech are efficient elements operating to separate deaf-mutes from hearing persons, and Professor Bell advises that all deaf pupils should receive instruction in articulation and in speech-reading. In the schools of Europe more than 65 per cent of the deaf and dumb were, in 1882, receiving efficient instruction in this way, and were taught to speak and understand the speech of hearing persons, while in our institutions 4,241 pupils received no instruction whatever in articulation, and only 886, or 14 per cent, were under oral instruction.

The question whether these remedies are the best and most practicable ones or not may safely be left to the judgment of the able men who have devoted their lives to the subject ; but all those whose sympathies for this unfortunate class are strongly excited must bear in mind that the interests of the whole community are also to be considered, and no one could, in the interest of humanity, or even in the interest of that small portion of the human race most directly concerned, advocate measures which lead to the perpetuation and increase of the evil.

Whether we approve of Professor Bell's recommendations or not, all persons, those who hear as well as those who do not, must feel that he has done good service to the community by calling attention to the danger which now attends our system, but his paper is far more than a warning : it is a promise, and its direct practical bearing is a very small part of its value, for the facts which he has brought together prove that man can be modified by selection as readily as any of our domesticated animals or plants, and that increased knowledge will ultimately enable us to bring about rapid improvements in our race.

CHOLERA.

By Dr. MAX VON PETTENKOFER.*

IV.—PREVENTION.

THE last sheet-anchor of the contagionists is always the linen of cholera-patients. But this view rests on such debatable ground that in the end it may prove to be fallacious. If cholera is really spread through human intercourse, then it is clear that the unknown specific something must accompany other vehicles, which may be man himself; and if this something can cause illness in man, then it must reside in the system of the patient, and ought to be found there. There can be no doubt of this; and I am prepared to admit as much. Thirty years ago I began my investigations on cholera in the belief that the germs of cholera were contained in the stools; but afterward, having made sure that cholera was dependent on locality as well as human intercourse, I endeavored to see how this relationship obtained by asking myself what was brought to the soil by man in his journeyings. The reply was, urine and stools—his excrements and nothing else. This view ripened into the belief that disinfection of the excreta and their receptacles ought to be a prophylactic measure against the spread of cholera, and excreta which had not been disinfected constituted a source of danger. These thoughts occupied me up to April, 1866, when I published with my lamented friends, Griesinger and Wunderlich, some regulations on cholera; and I first relinquished these views when further study showed the uselessness of measures of disinfection as well as the harmlessness of the undisinfected excreta of cholera-patients. If the poison of cholera be contained in the excreta, then, individual predisposition aside, those who mostly come in contact with the excreta ought to be most frequently affected. And these should be the various physicians and nurses in hospitals devoted to the care of cholera-patients. But experience has clearly shown that the medical attendants in cases of cholera are not more prone to take the disease than others. The like holds good of nurses. Let us first of all consider how the facts stand in the home of cholera, in India. During 1867, in which the epidemic at Hurdwar prevailed, James Cuningham investigated the relationship of cholera to nurses in forty garrison towns containing sixty-seven hospitals; of the sixty-seven hospitals only eight

* Reprint of a special translation made for the London "Lancet."

gave instances of cholera in the nurses; the largest number of cases occurred at Dharmsala, where there were eleven, Kasanli had three, Muttra and Moradabad each two, Fazabad, Lakhnau, Mirat, and two others one each. An epidemic among the nurses can therefore only be spoken of in the hospital of the First Ghorka Regiment stationed at Dharmsala, where eight nurses, two porters, and one other officer were taken ill of the disease. These statements show how exceptional such occurrences are. Why should not a hospital as well as a garrison now and again be a center of infection? Closer investigation proves, however, that the *personnel* of the hospital at Dharmsala was not affected in a greater degree than the population outside the hospitals. It may be shown that the percentage of cases of cholera among the outside population was 8·01; in other words, that eighty-six cases occurred out of 1,073, while of the hospital staff of 127 eleven fell ill, or a percentage of 8·66. Cuningham also inquired whether the immunity enjoyed by nurses could be explained by disinfection. He found from ancient sources that this striking immunity of nurses was by no means a new thing, and had certainly obtained before the days of disinfection. He draws attention, among other writings, to an experience of Dr. Bruce, who wrote: "In 1848 cholera broke out among the infantry at Caenpur from May to September. During the whole time the hospital was never free from single cases of cholera, and at times it was overfilled with them. The whole institution may be said to have lived in the rooms of the sick; the coolies did not leave the beds of the sick for an hour together, the physicians had much to do with the treatment of the patients; and yet not a man, whether European, half-caste, or native, showed a single symptom of cholera. I took the greatest pains to collect and sift these circumstances, but in this year not a single instance occurred." In India a practical use is made of this knowledge under the exceptional circumstances of the nurses being attacked. Nothing is said of isolation and disinfection; but the site on which the hospital stands is looked upon as unfavorable, and a change is made. This change of place is called by the English a movement, and as a prophylactic measure comes within the first ranks. If the site to which a movement has been made prove to be more unfavorable than that which was quitted—from the frying-pan into the fire—the movement has not availed anything. No good comes of the movement if the *personnel* has been already infected as much as possible. The Sixty-sixth Ghorka Regiment in its march through Tarai was not spared when it reached the Naini Valley; but, probably, if it had stayed a day longer in Tarai, the percentage of illness, instead of being ten, would have been twenty. It is the same as regards nurses and hospitals in Europe. I shall refer to Munich intentionally, not because it had so frequently been the seat of cholera (Munich had cholera once to Berlin's twelve times), but because I am better acquainted with the particulars. During the epidemic of 1873–'74 we had three hospitals

—the hospital on the left bank of the Isar, in Lindwurmstrasse, and that on the right bank of the river in Ismaningenstrasse, and the military hospital in Oberwiesenfeld. Cholera behaved in each hospital just as it behaved in the houses in their immediate neighborhood. Cases of cholera appeared in all three hospitals. In that on the left bank of the Isar there was rejoicing on account of the supposed success of isolation and disinfection until August 15th, when the summer epidemic reached its height; then an epidemic suddenly broke out. This was at the time that the epidemic developed in Lindwurmstrasse, in which the hospital was situate, and the epidemic in the hospital subsided as the epidemic in the street gave way. In the hospital on the right bank of the Isar the rejoicings lasted longer. The Ismaningenstrasse took no part in the summer epidemic, and neither did the residents of the hospital. But in the winter epidemic the same course of affairs took place as had occurred on the left bank of the river. The military hospital escaped all along. Of the seven barracks in Munich any cases or suspected cases of cholera were immediately sent to the military hospital. Now and again a surgical patient or a patient suffering from other illness than cholera was put among other patients, and later on suffered from cholera. Such cases were of course removed to the cholera division as soon as the stools betrayed the case. At times the cholera division was very full, and many nurses were employed therein; but none of these fell ill or gave the least indication of cholera, though many of them must have come in very close relation with the cholera-stools. In the military hospital in Müllerstrasse the same facts were observed as were met with in the case of the other hospitals. Seeing how little contagious cholera is among the nurses, it appears very remarkable that the washers of cholera-linen should suffer so much. I think I hear a contagionist say that why nurses of cholera-patients in hospitals are not infected may be easily explained when it is borne in mind that great cleanliness exists, that there is much washing of hands, that they do not eat with unwashed hands, and that whatever spurts on their clothes is rapidly dried, and dryness kills the bacillus. On the contrary, among the washers of cholera-linen it is easy to imagine that drops may be spurted into the mouth, or that infective material may be conveyed on wet fingers to the lips, and if a solitary bacillus gets into the intestines cholera may occur. How can this be seriously discussed? Can it be supposed that the nurses wash their hands only in certain hospitals, and during certain times, and that the chances of taking in the bacilli are less during the cleansing and attention to a patient than in washing the clothes? Do such nurses never put the moistened fingers to their lips? Do their noses never itch? The explanation of the contagionists appears to me to be very comical. And yet there are cases in which the infection must have been derived from the linen soiled by cholera-stools. A very interesting case came under my observation at Lyons in the washing-village of Craponne. In the "Gazette Médicale de Lyon" for 1854, page 252, we read from a letter by Dr. Gensoul: "In the month of July, 1854, two fugitives, a man and his wife, from cholera, alighted from Marseilles at the Milanese court. They had hardly arrived before they were attacked by cholera, the germs of which they had brought with them, and both died on July 17th. Some days later the washers of the Gasthof Bouchard in Craponne, a village about twelve kilometres from Lyons, came to fetch the linen for the wash. The soiled clothes and linen of the cases of cholera were given out in a separate bundle, placed in a separate part of the cart, and finally given to a washer-woman to clean. The washer-woman was struck down by a rapidly fatal cholera, and the washer's daughter shared the same fate. No other cases of cholera existed in the district on which the blame could be thrown. Such a choice of victims needs no comment." The cholera was not limited to the two cases. J. Garin ("Gazette Médicale," p. 309) says that eight cases of death followed in Craponne, and among them the washer's wife. From the statistics of Dr. Garin it is gathered that the disease attacked almost exclusively the washing-folk and their children. The population of Craponne numbers about 1,600 inhabitants, several families of which have charge of the washing for the hotels of Lyons. As a later report of Dr. Bouchet showed, there were besides twenty-five other cases of cholera, with fifteen recoveries and ten deaths, which occurred in the course of two months. The year 1854 was that in which the lower-lying parts of Lyons were invaded by an epidemic. It remains a striking fact that in the fair-sized village of Craponne cholera attacked almost exclusively the laundry-workers. With the exception of the washers, Craponne might be regarded as a place free from cholera. In 1855 severe epidemics prevailed in villages near Lyons—e. g., St. Bonnet and St. Laurent de Mure—though the outlying districts always enjoyed immunity from cholera. The same held good of other exempt districts. A very instructive example of this kind is furnished by Stuttgart in 1854, which is usually exempt from cholera. At the time when the severe epidemic prevailed at Munich an inhabitant of Stuttgart left Munich while he was suffering from diarrhœa, and arrived at Stuttgart, where he became worse and died of cholera. A few days later a case occurred in the person of a woman who had never left Stuttgart. She was the nurse of the case which had come from Munich. This case might be quoted as one of direct contagion. Again, after some days, a third case appeared, and this time it was the washer-woman who had cleaned the clothes of the first case. Finally, the washer-woman's husband suffered from cholerine. But no further cases appeared. Such cases are always wrongly interpreted by the contagionists as examples of direct infection, and such, at first sight, appears to be the case. If the case from Munich had infected the three at Stuttgart, how was it that none of the three infected other individuals? For it must be remembered that the cases at Stuttgart and at Craponne must have been tended and their linen washed. How was it that no further cases occurred, and that an epidemic was not started? The linen of the case from Munich was poisonous, but not that from the cases at Stuttgart! Must we not also suppose that another factor is necessary to explain the further spread of cases introduced from without? And this local factor was wanting at Craponne and Stuttgart. If a case from Munich caused three at Stuttgart, then the latter ought to produce nine. In places which enjoy immunity from epidemics it is conceivable that sporadic cases may occur, but, the conditions which are necessary for the production of an epidemic being wanting, no further development can take place. The soiled linen appears to me to be infective not because it comes from cases of cholera, but on account of its arrival from a locality where cholera prevails. Perhaps linen is a good vehicle for transmitting the infective material produced in a locality under the necessary circumstances of time and place. Man is the only creature that wears linen, and perhaps he alone spreads cholera, and it is possible that whether he were clothed or naked he would spread it just as much and no more. But, if we accept this doubtful solution of the Gordian knot, still the views of the contagionists on the dejecta of cholera and the soiled linen would not stand on a firmer basis, since we see not only individual cases but actual epidemics arising without the introduction of soiled linen. The infective material which produces cholera may be transmitted at all events in other ways along the paths of human intercourse. The germs of cholera may be brought from a locality to a place where the necessary relations of time and place are not favorable for the epidemic development of cholera, and they may there slumber for a month before they develop. There is every chance for the propagation of cholera in India, and yet cholera only shows itself fitfully in districts lying outside the endemic area. If the intercourse with India be reduced to the least possible, as it was in the last century, yet cholera might still at times visit us.

Finally, I shall ask myself what can be done to ward off cholera? The measures to be adopted will be very different according to the theory adopted. According to the contagionists, the spread of epidemic cholera depends on personal and material intercourse, as well as on conditions of time and space when the germs arrive at certain localities. Moreover, the severity of the epidemic is supposed to depend on the individual susceptibility. If one of these three factors be wanting, an epidemic of cholera can not develop. Preventive measures against cholera may be devised in one of three directions: (1) intercourse; (2) disposition in time and place; (3) individual predisposition. Measures to prevent the spread of cholera by interfering with human intercourse are, for many reasons, impracticable. If we ask ourselves what good has resulted from sanitary cordons, inspection, and quarantine, we are bound to answer, None. All these measures have failed because they simply treat the individual, the possible case of cholera. But the germs of cholera may be transmitted in the absence of the disease as manifested by illness. Even perfect sanitary cordons and quarantine would be also valueless, for the reason that they are commenced too late. It is true that quarantine and cordons may prevent a certain quantity of the germs of cholera from entering a country, so that it will serve as much purpose as a good custom-house against smuggling. But there is a great difference between articles of commerce and germs of cholera. The germs of disease are capable of multiplication, and so the smuggling through of a few may, under suitable circumstances, be the means for the development of millions and billions. The epidemics at Toulon and Marseilles afford excellent illustrations of my argument. Paris has not yet been attacked, while all the regulations have failed to prevent the appearance of cholera at Naples. No doubt inspection of ships is a good regulation as tending to discover unhygienic conditions, but it is useless as preventing the transmission of cholera. Inspection of places where cholera prevails, the disinfection of articles coming from localities where cholera is, as well also as the places where the dead are laid, are important matters, but too much is not to be expected from these measures. The prevalence of contagious diseases like small-pox can not be much diminished by attempts to limit intercommunication. Protection from small-pox by vaccination, which leaves human intercourse free, has been followed by success. But we have not at our command a simple and sovereign remedy by means of which the individual predisposition to cholera may be done away with, and yet we can do something in this direction. Everything which tends to lower the general health and cause depression, but especially those conditions which induce diarrhœa, predisposes to cholera. To these matters every one must look for himself, and his own efforts may be aided by the advice of doctors. The organs of public health may also effect much. Medical treatment should be obtained for the earliest cases of cholera and of diarrhœa. Care must be taken by the authorities and by the community to take measures for the treatment of the sick. But the difficult point in the prevention of cholera is the predisposition in time and place. It is no use urging, as the contagionists do, that we can not change the nature of the soil. One of the established facts concerning epidemics of cholera is the tendency of the disease to rage in those quarters where the greatest filth prevails. All towns which have been provided with good drainage and water-supply have lost their susceptibility to cholera. England affords the best example of this fact. In 1849 there were recorded 53,237 deaths from cholera, in 1854 the numbers were 20,097, and in 1866 only 14,378, while from 1872 to 1874, when several epidemics prevailed on the Continent, cholera did not reach England. I do not imagine that this immunity was due to the want of predisposition to cholera as regards conditions of time. The case of Fort William in Calcutta may be again referred to, as there, I believe, the immunity from cholera now enjoyed was due not merely to the introduction of a better supply of water, but largely also to the improvement in the other matters of hygiene.

METHODS OF TEACHING POLITICAL ECONOMY.

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A NATION is sometimes so bitterly taught by sad experience in financial errors—as was the case with France in John Law's time, and again in the issue of paper assignats during the Revolution —that, on the principle of the "burned child," it ever afterward finds that it unconsciously keeps to the right and avoids the wrong path. So that to-day France is a country where correct conceptions of money are almost universal, and her public monetary experiments are, as a rule, most admirably conducted. In somewhat the same way does the individual gain his proper knowledge of political economy. Principles must be seen working in a concrete form. The key to efficient teaching of the subject is to connect principles with actual facts; and this process must go on in the beginner's mind only through experience. By experience, I mean the personal (subjective) effort of each one to realize the working of the principle for himself in the facts of his own knowledge. The pupil must be put in the way of assimilating for himself the principles of his subject, in such a manner that he feels their truth because they are apparent in explanation of concrete things all around him. And for this purpose nothing is so useful as a sharp struggle, an effort, a keen discussion, or possibly a failure of comprehension at the time; for nothing will so awaken one to intellectual effort and finally result in the safe lodgment of the principle within one's thinking as an obstruction and its removal. That this is the aim to be always kept in view by the teacher and student is made clear, it is to be hoped, by the previous analysis of the "Character and Discipline of Political Economy." It is now my purpose to make some suggestions as to the practical methods of teaching by which this can be carried into effect:

1. The relative advantages of lectures and recitations in political economy have never, to my knowledge, been openly discussed. An experience with both methods of teaching leads me to think that the lecture system, pure and simple, is so ineffective that it ought to be set aside at once as entirely undesirable. No matter how clear the exposition of the principles may be, no matter how fresh and striking the illustrations, it still remains that the student is relieved by the instructor

from carrying on the mental processes which he ought to go through for himself. In fact, the clearer the exposition by the lecturer, the less is left to the student—the lecturer, in fact, is the chief gainer by the system. Moreover, while listening to a connected and logical unfolding of the principles, the student is lulled into a false belief that, as he understands all that has been so clearly presented to him, he knows the subject quite well enough ; and the result is to send out a number of conceited men who really can not carry on a rational economic discussion. They wholly miss the discipline which gives exactitude, mental breadth, keenness, and power to express themselves plainly and to the point. Then, not being forced to think over a principle in its application to various phases of concrete phenomena, they know the principle only in connection with the illustrations given by the lecturer, while they utterly fail to assimilate the principles into their own thinking. The subject then becomes to them a matter of memory. They memorize the general statements without ever realizing their practical side, and that which is memorized for the day of examination is forgotten more speedily than it is learned, and the sum total of the discipline has been simply a stretching of the memory. In fact, with the average student in almost any subject the lecture system leads to cramming, At the best, it affords a constant temptation to put off that kind of internal struggle which must be gone through with—a period of doubts and questions—by which alone a clearer conception of the subject ultimately emerges. In fact, it is doubtful if the student ever gets much, if any, of that mental attrition on the subject which is the most valuable part of the work. An experience of a year in lecturing to a class of two hundred and fifty, including the best and the poorest men in the university, convinced me of the truth of the above position ; and their examination-books were the most unsatisfactory I had read for years.

The usual alternative to the lecture system is the plan of recitations from a text-book. Even the simplest form of recitations is, in my opinion, better than listening to lectures. At least, the student is put to it to express the sense in words under the criticism of the teacher. But this plan has its evident difficulties. If the pupil is called upon for only what is contained in the book, he falls into the habit of memorizing, and fails to think for himself. If you give him the clew, he can tell you on what part of the page the statement is found, and can put the idea in the language of the book ; but he knows nothing of the power of applying it to what he sees. If the learner is very clever and inquisitive, he may do something for himself, but the average pupil quite misses the real good of such a course.

2. As it is evident that neither lectures nor formal recitations in the old fashion are satisfactory, we are inevitably led to adopt a plan which possesses the advantages of both. Some text-book is essential as a basis for the instruction. In it the pupil should find an exposition

of the principles and a provocation to apply them to practical things as he reads. Then he comes to the class-room as intelligently familiar with the principles as his reading can make him. Now comes the work of the instructor. At first it is surprising how easy it is to show even to the best men a gap in their knowledge, or a misunderstanding of the principle. Present an illustration different from that of the book, and ask them to explain the situation. The necessity of seeing the essential point in the facts, and the attempt to describe the operation of the principle, will effectually rout the man who has merely memorized the book, and teach him to think out the matter more thoroughly for himself in the future. The teacher, also, will try to find out the accidental obstacles which in a young mind obstruct the understanding of the point in question. Let the pupil be asked to state the matter, and let the teacher note the imperfections. Now he can stimulate another student by questioning him as to one of these imperfections. If a clear correction is not obtained from a member of the class, let the instructor apply the Socratic method. At first ask a question which the learner readily understands, and then lead him naturally and gradually by logical steps up to the point wherein he had failed of understanding. He will then see his own difficulty, and at the same time he has had a little robust exercise for his mind. If this is carried on before his fellows, it will the better cultivate coolness and self-control before an audience.

3. Above all, the hour should not be wasted in simply rehearsing what has been read in the book. The student should go away from the class-room feeling that he has received some new idea, or some interesting fact which illustrates his subject. The work of the class-room should be cumulative in its effect as compared with the fruits of text-book reading. The teacher should in every way stimulate questions from members of his class, and urge the statement by them, either orally or in writing, of their doubts and difficulties. If there is some timidity in presenting a weakness in the presence of a class, ask some more manly person of the number, and the timid student will soon see that others are not much better off than he. In fact, all will have difficulties in understanding, or in interpreting principles, some trivial, some serious; and the pupil will become discouraged unless these are removed. When each one sees that others are also hindered by obstacles, there will be a greater freedom in asking questions. Moreover, in order to keep up a steady and regular training, which will produce the best disciplinary results, let the questions of the instructor every day run backward in review, and especially aim to bring out the connection of one part of the subject with another. It will be very effective if done just about the time that the past work is growing a little dim before the presence of newer ideas. In no subject, perhaps, more than in political economy, is it necessary to know the preliminary stages in order to understand the later work; so that

the pupil must be actually in possession of principles previously expounded for which he may be called upon at any time. It is simply impossible for a person to be absent and neglectful for a time in his study, and then come into the class-room to make a brilliant show on an intermediate fragment of the subject. He can be too easily exposed as a humbug to attempt it a second time. Moreover, thus to force him to do the work as he goes along is the greatest favor one can do for the pupil; and the usual cramming before the examination becomes, in reality, a general review, which is very useful in bringing him to see the connection existing throughout the whole subject.

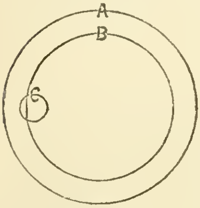
4. If the class is too large to reach each member as often as the instructor might wish in the above method, there is one device which is more or less useful. At the beginning of the hour let him write a question upon the blackboard, to be answered by each one in writing within the first fifteen minutes. The attempt to write out an explanation clearly, without hint or clew from the instructor, will reveal to the best student the deficiencies and gaps in his knowledge. Each one will then have the keenest interest to know what is considered a satisfactory answer to the question. At the next exercise of the class, the instructor can read some good and some bad answers, point out the general mistakes, and advise them for the future. No exercise can be better than this in cultivating the habit of careful expression, and in learning how to make a clear and pointed exposition of a subject in a brief space of time. This practice tends to secure the accuracy which in the oral discussions is made second to fluency and readiness.

5. Since the chief work of the class-room is not to enable students to discover principles, but rather to understand and apply them, probably the most useful method of interesting a class is to present to them by extracts from the newspapers of the day bits of fallacious discussions which may come under the head of the subject in hand, and ask for criticism and discussion of them. The appositeness of a timely topic is peculiarly valuable for such purposes. In fact, the practical matters of our own country will never fail to excite a lively interest in almost any class; and through this interest the teacher can find a way of leading men to study principles more carefully. A national or State campaign is very likely to furnish an instructor with a plentiful supply of extracts for discussion by his class. The learner in political economy is not hindered by the same disagreeable obstacles, as impede the medical student, in finding subjects on which to put his learning into practice.

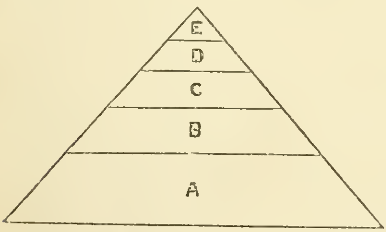
6. Many minds are unable to keep hold of an abstraction, or general principle; or they have been untrained in making nice distinctions between ideas or definitions. Just as in beginning a strange language, when words of widely different meaning have a similarity to the untutored eye, the distinctions do not make much impression. So it is in regard to ideas and definitions in political economy. There-

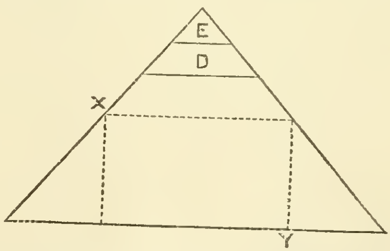
fore, visible expression of the abstract relationships, by diagrams, or by any figures which represent the abstract in a concrete form, will be of very considerable service to the ordinary student. This matter seems to me to be of such practical importance in teaching that it will be worth while to illustrate my meaning by a few examples:

(*a*.) Since material wealth comprises all things that have value; since capital is only that wealth employed in reproduction, and not used by the owner himself; and since money is that part of wealth in circulation aiding in the transfer of goods—the relations between the three may be expressed to the commonest apprehension by some such device as the following, in which the area of circle A represents the amount of wealth; B, the capital saved out of the total wealth; and C, the money by which goods are transferred—only that part of circle C being capital which, inside of circle B, is being used as a means to production.



Again (*b*), it is seen that different classes of laborers, arranged according to their skill, form, as it were, social strata, of which the largest and the poorest paid is composed of the unskilled laborers at the bottom. This may be shown to the eye at once by the sections of a pyramid, in which A represents the largest and least paid class; B, C, and D, etc., the better-educated, and relatively more skillful laborers; ending finally in the few, at the top, of the most competent executive managers. Now, if A were to become as fully skilled as B, and competi-





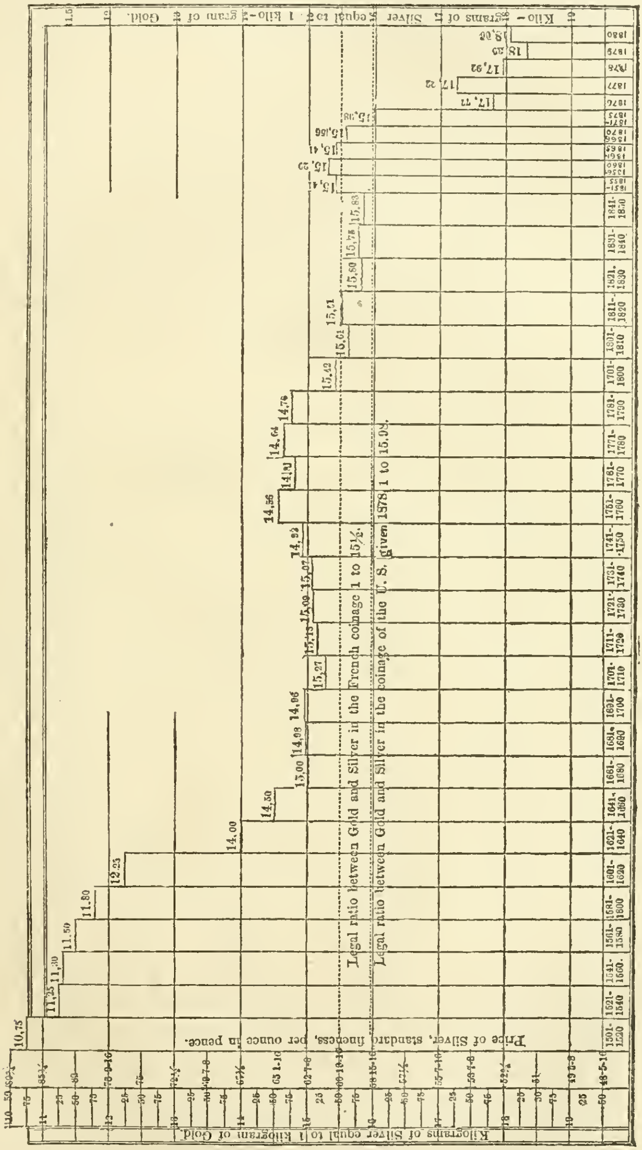
tion should become free between all members of A and B; and if this were to go on in the same way to include C—the effects of this breaking down of the barriers which hinder competition might be illustrated by the following changes in the above pyramid: the areas of A, B, and C may be thrown together into one area within the whole of which movement and choice is perfectly free to the laborer, and wherein wages are in proportion to sacrifice. This can be done by striking out the lines of division between A, B, and C, and by representing the change by the area included between the base and the dotted lines.

Examples might be continued in illustration of my method, but these must suffice. By this means there can be planted inside even the dull mind an outline of an idea which can then be modeled and shaded to the condition of a natural truth. The teacher will find, by experience, that an idea thus given is very seldom forgotten. The pupil has thus once turned the abstraction into a concrete form, and he can now use it for himself after he has once grasped it. It does not at all imply that he will get hard and definite conceptions of human affairs by this process ; for he is shown that the principle which he has once seen in a concrete form, appears in other forms, and he is constantly seeing that it is so.

7. In close connection with this method, but having an entirely different purpose in view, is the use of charts and graphic representations of statistics. The method just described above aimed to help in finding concrete expressions for the general principles ; but graphic methods usually have as their object to assist in that part of the economic process heretofore referred to as verification. Every one knows the common dislike of dreary statistics ; to many persons columns of statistics are repellent or meaningless. Collections of facts regarding banking, finance, taxation, and wages become a tangle in which one's direction is constantly lost. But arranged graphically the whole direction of a movement is seen at once, and the mind takes in new and unexpected changes, which force an investigation into their cause. Moreover, there comes a certain breadth of treatment, when, in looking at the facts graphically expressed, one is able to see the whole field at once. There is no waste of thought on temporary and accidental movements, for the action is seen from beginning to end at one glance. There are many charts which would illustrate this meaning very distinctly ; but perhaps none are simpler than the one here appended, showing the steady and continuous fall in the value of silver relatively to gold since the discovery of the New World. No one has ever claimed that there has been any "unfriendliness" displayed toward silver in the legislation of the chief countries of the world before 1816, at the farthest, and yet the white metal had been steadily on the decline ever since the Spanish galleons, in the fifteenth century, began to pour the precious metals of America into the coffers of Spain.

In short, the more extended collection of economic data is now rendered possible by the better methods employed in census and statistical bureaus, and the resort to the work of verification of economic principles by the examination of these data is the one thing only which can redeem political economy from the baseless and common charge of being a set of impractical formulæ. Into this work one can carry no instrument so effective and helpful as graphic representations. In fact, the investigator, after having collected his tables and columns of figures, will find his gain in first putting them in some graphic form, before he can intelligently see exactly with what he has to grapple ; then he can turn his energies directly upon the problems disclosed by the chart to every other eye as well as his own.

The slow and painful work of months is in this way presented to a class in a few minutes, and the practical lessons caught at a glance. Indeed, in most problems the difficulty is to put others in possession of



the facts which one is about to discuss. For this purpose, charts are the labor-saving machine of statistics. They can be made on common white cotton cloth (called sarcenet), which receives ink (black or red or blue) or water-colors ; or on heavy manila paper, made large enough by sticking two large sheets together. Some printers can now rule this paper in squares to suit the convenience of the worker; but these guiding-lines ought to be faint, and not so heavy as to overpower the lines of the chart. So far I have been speaking of charts for the class-room. Perhaps, in their own good time, such economic charts can be bought of educational agencies. But ordinary co-ordinate paper, on a small scale, is the best form in which to first arrange the chart. It can be purchased in sheets at a small price, and is invaluable for both student and instructor. In fact, no lesson is more stimulating to a class than to give them the data of a subject and ask them to put it into graphic form. For the first time they begin to realize that statistics are not dry; indeed, any one who has turned over the pages of Walker's "Statistical Atlas" will find out for himself how the columns of census tables can talk to him in forms and colors without producing weariness, but even with a power to give a sense of surprise at the interest they excite.

8. When the instructor comes to examinations he will find several difficulties. In making out questions he ought to keep in view that they should be arranged so as to test not the memory, but the power of the pupil to apply principles. For this reason the ideal paper should contain nothing which the student has seen in that form before. The facts he is called upon to explain ought to be fresh ones, and the fallacies he is to examine should be such as he had not previously considered. But for practical purposes it seems best to remember that a class is composed of all kinds of persons, and, while the majority of the questions should be of the character which I have described, yet at least a few easier and more encouraging questions should be set. The student should be instructed to study each question with care; and avoid haste in answering, before he is sure that he has really caught the point and essential idea of the question. Fairly good students often write about the question, but do not answer it. It should be definitely understood that no credit is given for such answers. Then, also, the examination can be used as a teaching process; since, by inserting an important subject, the attention given to it at these times will be such as to keep it from speedy oblivion. Moreover, it will be well, after the examination, to read a good and a poor answer to each question before the class. They will know better what is expected of them in the future—like troops after their first fight. After such an examination the instructor will find his class much more disciplined and more ready to exert themselves in the intellectual wrestling. The vigorous preparation for the examination has really given them a better grasp of the subject, and the teacher can easily bring on a warm discussion now, because they really know something and feel that they know it.

9. When first approaching the study, it has been found to be of service to some students to suggest that on the first reading of the

text-book they note in the margins in a few penciled words the gist of each paragraph as it is read; then, at the close of the chapter, to advise the reader to review it by means of his marginal notes, and then make a general but brief synopsis of the chapter. This will both save time and teach that essential thing—how to study rapidly but thoroughly. It will destroy aimless reading, which is so common in these days of many books.

10. In advanced courses, much of what has been said in regard to these details will be less important, for the teaching is necessarily different in kind. Such courses naturally fall either (1) into those which continue to study principles, as the systems of various writers or schools of political economy in the past and present, or (2) into those which treat historical or practical questions. In the former the lecture system is unsatisfactory for reasons given above; and the class should themselves be constantly wrestling with the fuller discussion of subjects in which they can hitherto have had only a general knowledge. Experience seems to show that a topic, furnished with references to writers, affords the best method of procedure. This, of course, implies a good working library and a list of reserved books.

In the practical courses a large part of the training consists in teaching the student how to use books, how to familiarize himself with the principal storehouses of statistics, such, for example, as the English "Parliamentary Documents," or our own Government publications; how to collect his materials in a useful form; and then how to apply graphic representation wherever possible. The greatest good comes, of course, from putting the student on his own resources at once and forcing him to find his own materials, look up his own books and authorities, and come to a conclusion on the subject assigned to him independently of all aid or suggestion. The instructor can then at the conferences take up a paper for criticism and discussion, or first assign it to another member for that purpose. This is a feasible plan; but, if carried on throughout a whole course, it requires of the student so much time that his other work must suffer, and, in addition, but few subjects can be taken up in this thorough and leisurely way. In practice it has been found best to use the lecture system partially. One subject can be taken up by the instructor at regular exercises, for which he furnishes beforehand the references, and partly lectures and partly discusses the subject with his class, thus guiding them steadily over the field and directing the disposition of the time to be devoted to each subject. In this way many more subjects can be reached during the year. But the advantages of the investigating method can be partly retained by requiring a monograph from each member of the class on a practical subject of his own selection from a list prepared by the instructor, and this thesis can count for attendance on part of the lecture-work. In this thesis the student is pushed to do his best to give a really serious study to some particular topic, and he is expected to do it independently of any aid beyond general oversight and direction; and he is warned that the paper will be of greater value, provided it contain the bibliography of the subject and constant reference by page and volume to his authorities.

11. The preparation of bibliographies is part of a teacher's duty. Moreover, he who has access to a rich and well-appointed library can do a service to the rest of his guild by leaving behind him notes of his bookish experiences. He can in a few words say whether a book is good or bad for a particular purpose, or indicate what part of it contains a valuable discussion, or furnishes useful facts in a subject within the study. For this purpose it has been a great convenience to have little blank-books of ordinary stiff manila paper, six inches by three, with each page perforated like postage-stamps near the butt of the book, so that each page can be torn off smoothly. On this page a book can be entered under a suitable heading, with its exact title and author, and room still be left for a very generous amount of criticism or commendation, or for noting the contents of the book. The cards can be laid away alphabetically by subjects in a drawer, and will prove of invaluable aid at many times. Books of which one has heard but never seen, can also be entered with a star, to be erased when a book has been examined. This systematic habit is peculiarly desirable when one is hunting for the facts on a certain subject. One will in this way lose nothing by forgetting where a statement has once been seen.

In this brief and inadequate way I have attempted to suggest from my own experience what may enable others to avoid difficulties, and possibly to aid in a more rational method of teaching political economy. It is scarcely more probable that what I have said is all new than that others should agree with me throughout in what I have advanced; nor is it unlikely that other teachers may have many other suggestions to make in addition to mine. If my efforts may call them out and aid in better methods of teaching, I shall be amply repaid.

LOST COLONIES OF NORTHMEN AND PORTUGUESE.*

By R. G. HALIBURTON.

NO one can find a "message from the sea," telling of the fate of some long-missing vessel, without a feeling of emotion; but the stray waifs that throw light on the history of lost colonies are of a deeper interest, for they supply missing chapters in the annals of colonization and early maritime enterprise.

* Abridged from a paper read before the Geographical Section of the British Association at Montreal.

The probable dates of those that are the subject of this paper are: 1. Vinland the Good, discovered A. D. 994; 2. Fagundes's settlement in Cape Breton, A. D. 1521; 3. A second Portuguese settlement in Cape Breton, A. D. 1567; 4. A Spanish settlement in Cape Breton, between 1580 and 1597.

I. VINLAND THE GOOD.—It is unfortunate that the early settlers ever thought of calling a place near Rhode Island *Martha's Vineyard*, for its resemblance to *Vinland* has led Danish and American archæologists to identify them as the same locality. They seem not to have remembered, that wild grapes are found on the south shore of the gulf and river St. Lawrence, from Cape North to Quebec, the Island of Orleans having for this reason been called the Island of Bacchus. Wild grapes, too, are found on the west coast of Newfoundland, according to Anspach; and in 1521 the Portuguese colonists in Cape Breton sent word home that among the products of that country were grapes. The writer of this paper has tasted some excellent wine made by a relative living at Fredericton, New Brunswick, from the wild grapes that are to be seen hanging in clusters from the elm-trees on the intervale lands along the St. John River.

But as Vinland and Martha's Vineyard were assumed to be the same, a voyage by the Northmen from Greenland, not exceeding seven or eight days, has been extended to Rhode Island, and the circumnavigation of Newfoundland and Nova Scotia has been assumed, although the Saga of Eric the Red is silent as to it, and though such a voyage, still a perilous one, was at that time a most difficult and dangerous undertaking.

The Saga of Eric the Red was written in Greenland by, or in honor of, Eric and his family, who were the discoverers, explorers, and chroniclers of Vinland the Good.

The later Saga of his son-in-law, Karlsefne, which, like the geographical notices quoted by Rafn, was written in Iceland, was evidently based, not on information derived from people who had been in Vinland, but on an imperfect version of the Greenland Saga, for almost all the courses described by them differ 90° from those given in the Saga of Eric the Red, a uniformity of error which must have arisen from the use of a sketch-map of the voyage to Vinland, in which the points of the compass were omitted or incorrectly placed. What is north in the one is generally east in the other.

We have therefore to depend on the Greenland Saga, and what are its claims to be considered a credible authority? It was written in glorification of Eric and his family, and describes the discoveries made by his sons or sons-in-law, and testified to by no one outside of his family circle.

Two persons, father and son, the latter of whom was named Eric the Red, having been guilty of murder in Norway, took refuge in Iceland, where Eric committed one if not two more murders, and in consequence of them, and of his constant broils and feuds with his neighbors, was banished and outlawed. As the world was too small for him, he was tempted to try to discover and explore the new land in the West, of the existence of which there were rumors. He therefore sailed west, and discovered an ice bound country, which he called "Greenland," because, quoth he, "people will be attracted to it if the land has a good name."

This intended fraud upon emigrants was an example that was followed in his own day, as well as in later times, for an imaginative chronicler subsequently asserted that "there is the best of wheat in Greenland."

In A. D. 994 Eric and his son Leif, having heard of new lands farther west having been sighted by Bjarne, made up their minds to explore them, and for that purpose bought and fitted out Bjarne's vessel. But Eric while on his way to the port was thrown by his horse, and took his fall as an omen that he was not destined to give any more Greenlands to the world, and he therefore allowed Leif to sail without him. But, from what we know of his proclivities, we may be quite sure that he had a wonderful name already coined for that new land—*Vinland the Good.* Could words picture a more attractive bait for emigrants?

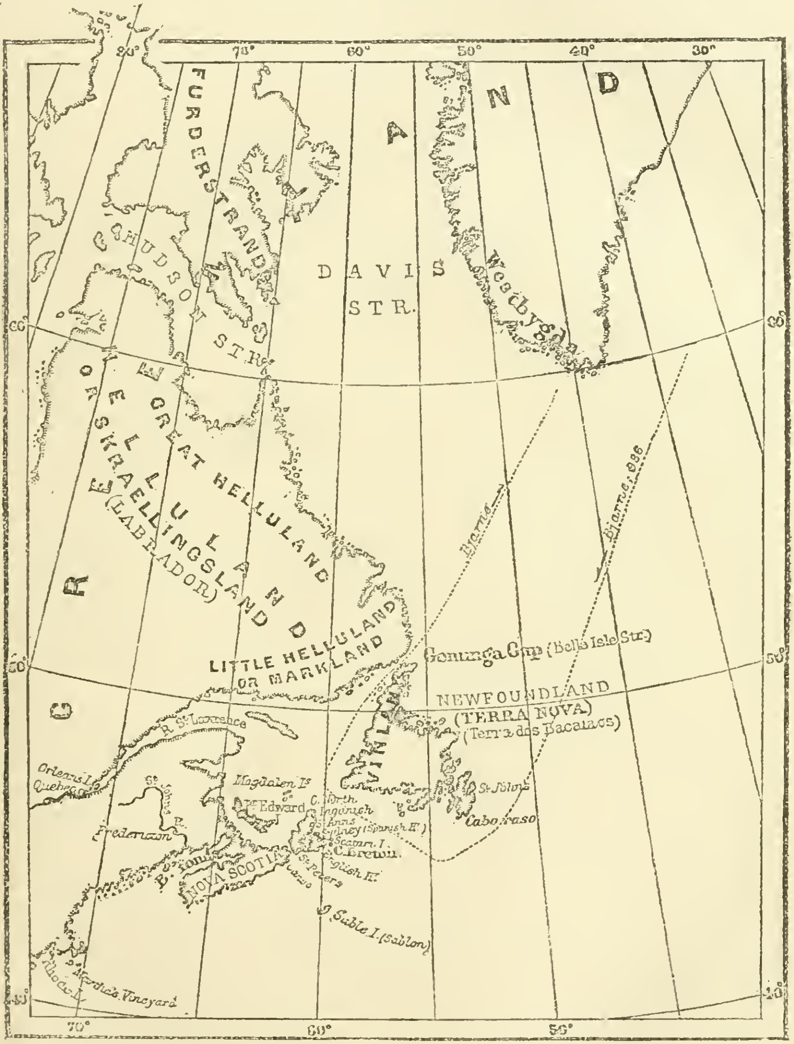
How much of the story of the subsequent exploration of Vinland by his son Leif is purely imaginary it is difficult to say. All that relates to ship-loads of grapes, self-sown fields of wheat, and the genial semi-tropical winter climate of that favored land, we may dismiss as myths or exaggerations. Where, then, was Vinland situated?

We have one test, viz., the length of the shortest day there. Professor Thorfaeus, who wrote at the beginning of the last century, found that it indicated 49° north, i. e., the latitude of Newfoundland, which was probably very near the mark, for, though Rafn contends for the latitude of Rhode Island, 41° 24′ 10″ north, the latest authority, the Icelandic-English Dictionary by Gudbrand Vigfasson (Oxford, 1874), makes the hours of sunrise and sunset 8.30 A. M. and 3.30 P. M. (instead of 7.30 A. M. and 4.30 P. M., as Rafn contends), and therefore carries back Vinland to Greenland.

There is no part of the coast from Greenland to Rhode Island which has not been pounced upon by some writer as the site of Vinland.

We can not depend on the sailing directions of the Sagas, and Captain Graah has shown that, preserved for a long time only by oral traditions, they have been changed to suit the fancy of the different persons to whom we are indebted for their preservation. We have, however, besides the length of the shortest day, another guide, viz., that the natives met at Vinland were Eskimos, or a race resembling them in their boats, etc.—such as the Naskapi, or "Mountaineers," who are found occasionally in Newfoundland. The advocates of the Rhode

Island theory, in order to explain the presence of Eskimos so far south, have started the hypothesis that the Skraellings at the beginning of the eleventh century inhabited the eastern coast of North America as far south as Rhode Island, but were driven into the Arctic regions by the races now found on the sea-coast. Not a particle of evidence can be ad-



duced to support this idea, and the authorities cited by Rafn disprove it, for an Icelandic geographer describes the more northern country, Furderstrands, as too cold for human habitations, and as bounded on the south by Skraellingsland. Their home, therefore, was then, as it still is, Labrador.

From the various accounts given by Rafn, I prepared a map, showing Helluland, Markland, and Vinland, which proved to agree almost with the maps of the Northern Atlantic by the Icelander Sigurd Stephanius (1570), and by Gudbrandius Torlacius (1606), except that I made Genunga Gap run between Markland and Vinland, in accordance with one of the authorities quoted by him.

It is clear that what is now called Greenland was assumed to be an extension of the north of Europe, and that "Greenland" embraced all the country north of the Strait of Belleisle. Davis Strait was looked upon as an inlet running into Greenland, but not as a strait separating Greenland from the land to the westward. The land north of Hudson Strait was called Furderstrands, and was so cold as not to be habitable. All the country south of Hudson Strait was called Helluland, as well as Skraellingsland (our Labrador), and it was divided into Great Helluland to the north, and Little Helluland or Markland to the south. In one account, however, Little Helluland is omitted and Labrador divided into Helluland and Markland, the latter being to the south. The Westbygda of Greenland, so often referred to, was on the east side of Davis Strait, and was the site of the cathedral. Assuming such to be the case, the accounts quoted by Rafn will at once become intelligible and consistent, though totally at variance with his theory, which identifies Great Helluland with Labrador, Little Helluland with Newfoundland, and Markland with Nova Scotia.

Rafn quotes the following notice of Vinland from a fragment of the "Vellum Codex," No. 192, supposed to have been written about the end of the fourteenth century: "From Bjarmeland [in Europe] extends uninhabited land toward the north, until Greenland begins; south of Greenland is Helluland; next lies Markland; thence it is not far to Vinland the Good, which some think goes out of Africa; and if so, the sea must run between Vinland and Markland."

This, I contend, points to Newfoundland, which extends toward Africa, and is separated from Markland (Labrador) by the Strait of Belleisle. He adds, "All these countries are in that part of the world called Europe," an idea that prevailed even after the discovery of America by Columbus.

With this account agrees one of a very early date:* "Now is to be told what lies opposite Greenland, out from the bay which has been before named. The land is called Furderstrands. There are so strong frosts there that it is not habitable, so far as one knows. South from that is Helluland, which is called Skraellingsland; from thence it is not far to Vinland the Good, which some think goes out from Africa."

Hence it is clear that the Northmen placed the land of the Eskimos between a northerly uninhabitable region and the more southern Vinland.

The same description says, "Between Vinland and Greenland is Genunga Gap, which flows from the sea called Mare Oceanum, and

* "Gripla. Antiq. Am.," p. 280.

surrounds the whole earth." This is the "River Ocean" of Homer, and is used in the Eddas as the name of the watery wastes of Chaos.

Bjarne's voyage to Vinland seems to have really taken place, and to have been accurately described. The accounts of subsequent voyages appear to have been based on Bjarne's, and to be as nearly as possible mere transcripts of it reversed. In 906 Bjarne sailed from Iceland to Greenland, but "after three days' sailing, . . . the land was out of sight under the water," he was driven southward by north winds, with foggy weather for many days. At length he once more saw the sun, and having sailed one day more he sighted land. As the wind had changed from north to southwest, in which quarter it remained steady, it is evident that the northerly gale went round with the sun, i. e., to the east, then to the south, and then to southwest. Had the wind "backed" to the west and southwest, the weather would have been continued unsettled. Hence we conclude that Bjarne's vessel was driven to the banks of Newfoundland, where fogs constantly prevail, whence, the wind veering to the east, south, and southwest, he was driven into the Gulf of St. Lawrence and around Newfoundland. The land he first saw was "without mountains, and covered with wood, and had small heights." It was on his larboard side, and was probably one of the Magdalen Islands, or possibly the eastern end of Prince Edward Island. Afterward they sailed *two days*, when they saw "a flat land covered with wood." This may have been the northwest coast of Newfoundland near the west end of the Strait of Belleisle, which for a long distance is marked on Bayfield's chart as a "low limestone coast." I am informed that there are woods on it, though they may be small compared with the vast forests that are found up the rivers, whence extensive lumbering operations are now being carried on. Bjarne then put to sea for *three days*, with a southwesterly wind, and saw a third land, which was "high and covered with mountains and ice-hills." They coasted along it, and "saw it was an island." They probably sighted Labrador, and, rounding its southeast point, supposed it to be an island. Thence they sailed with the same favorable southwesterly wind (which grew into a gale) for *four days*, when they sighted a "fourth land, which was Greenland."

Leif's voyage to Vinland seems, as nearly as possible, a version of Bjarne's reversed. Neither time nor bearings are given, and we are merely told that Leif "found the land first which Bjarne had found last."* They saw no grass there. "Great icebergs were over all up the country, but like a plain of flat stones was all from the sea to the mountains." This they called Helluland. They then sailed thence and found another land which was "flat and covered with wood, and white sands were far around where they went, and the

* In the account of the Saga of Eric the Red, of Karlsefne's voyage, it is simply stated that he sailed to Vinland. The Icelandic Saga of a later date was less cautious, and gives many impossible courses.

shore was low." This was therefore called "Markland," i. e., woodland. They sailed thence for *two days* with a northeasterly wind (the opposite to that which Bjarne met with), when they sighted an island to the northward of the land, and sailed into a sound between it and a cape which ran out northwardly from the land. Thence they sailed westwardly round the cape into a place where at ebb-tide the vessel was left high and dry some distance from the shore; and when the tide rose they towed the vessel into a river, which led into a lake (or inlet?), where they landed and built booths.

If this narrative is something more than a Norse "Odyssey" or a fiction, we must infer that Leif touched at Labrador (called by him Helluland), sailed thence to some more southern part of Labrador (called by him Markland), and thence past the Island of Belleisle into one of the many shallow inlets on the south side of the Strait of Belleisle. The "low land covered with wood" and its "white sands" may possibly be the part of Newfoundland sighted by Bjarne, or it may be *Blanc Sablon*, near Bradore Bay, on the south coast of Labrador. It is, however, evident that Leif can not have reached the south coast of the Gulf of St. Lawrence, judging by the number of days expended on the voyage. The Saga of Karlsefne says that the voyage from Greenland to Helluland only took *two* days, and that from Helluland to Markland *three days*. Now, Leif's voyage from Markland to Vinland took *two days*, or the number of days spent by Bjarne in going from the land first sighted by him to the "flat land covered with wood." Bjarne's voyage from the first land sighted by him to Greenland occupied in all $2 + 3 + 4 = 9$ days.

From the Sagas of Eric the Red and of Karlsefne, we learn that the voyages from Greenland to Vinland took six days in all. Hence, Vinland, if beyond Labrador, must be sought for in Newfoundland, either in one of the shallow inlets near the Island of Belleisle, or in some place along the northwest coast of that island. The fact that grapes are found there, according to Anspach, lends some weight to this view. It is possible, too, that the Naskapi, sometimes found in Newfoundland and resembling the Eskimos in many respects, may have been included under the name Skraellings by the Northmen.

It is clear that, like Greenland, Vinland the Good was a fraud on emigrants; that the stories as to ship-loads of grapes, self-sown fields of wheat, genial winter weather, etc., were the productions of Eric's prolific brain; and that we must first succeed in finding Greenland's verdant mountains before we can hope to discover the vine-clad hills of Vinland the Good.

II. The Colony of Terra Nova, or the "Land of the Corte Reals."—The history of European colonization north of Florida has been hitherto supposed to have begun at the commencement of the seventeenth century, except perhaps a small English settlement at St. John's, Newfoundland. It has not hitherto been known to historians that the eastern portion of British North America was the first part of the New World that was constituted a colony, that from 1500 to 1579 commissions were regularly issued to the Corte Reals as governors of Terra Nova, and that by virtue of this claim on the part of the Portuguese at least three settlements were made by the Portuguese themselves, and later by the Spaniards (after they had annexed Portugal), one of these colonies being the earliest European settlement in North America after the discovery of the New World by Cabot.

A flood of light has been shed upon this early colonization by Senhor Ernesto do Canto, of San Miguel, Azores, whose most recent publication on early Portuguese exploration consists mainly of a selection of documents connected with the family of the Corte Reals, the explorers and first governors of Northeastern America.

The information contained in Senhor do Canto's work enables me to claim for the northeastern parts of America almost a century of historical existence prior to the seventeenth century. This colony, embracing Labrador, Newfoundland, and Nova Scotia, and, under the grant to Fagundes, probably a large portion on the east coast of the present United States, was far the earliest European colony (excepting perhaps Vinland) not only in North America, but also in the New World, for the commissions of the Corte Reals date in regular succession from 1500 (i. e., two years after America had been discovered by Columbus, and six years after its discovery by Cabot) until 1579, soon after which Portugal and its possessions were annexed to Spain.

This colony of the Corte Reals was not merely a nominal one, for in the course of the sixteenth century the Portuguese made a settlement in Cape Breton in 1521, and another in 1567, while the Spaniards —their successors—sent a third to the same country. Of these three colonies little or nothing is known; even the colony of Terra Nova has lost its place in history, which begins the annals of British North America a century later with the arrival of French settlers in La Nouvelle France.

In 1500 Gaspar Corte Real explored the coast of Labrador, probably nearly as far north as Hudson Strait, and also Newfoundland and Nova Scotia. He brought back several of the natives, who resembled the present Micmac Indians. He went there again, in 1501, with three vessels, but that in which he sailed never returned. In 1502 his brother, Miguel, sailed in search of Gaspar, and met with the same fate. Again, in 1503, an expedition was sent out to try to get some tidings of the two gallant brothers, but without success, and the king, discouraged by these disasters, refused to allow Vasco Annes, the elder brother, and one of the ornaments of his court, to continue the search.

In early charts of this continent the Portuguese flag is frequently represented as waving over Labrador, Newfoundland (Baccalaos), and

Nova Scotia, which were sometimes described as the "Land of the Corte Reals," and as the "country discovered by João Alvares."

We now know that the person to whom these Christian names belonged was João Alvares Fagundes, who early in the sixteenth century carried on explorations in Northeastern America, and who, in 1521, had a grant of the country between the land of the Corte Reals and the northern boundary of the Spanish colonies, including the "terra firma and islands" discovered by him, a grant which for the first time included a portion of the United States.

Traditions as to an early settlement still linger among the Micmacs, who aver that certain earth-mounds at St. Peter's, Cape Breton, were built by white men before the arrival of the French. This belief received many years ago a confirmation by the discovery in one of these mounds of an archaic cannon formed of bars of iron fastened with iron bands or hoops, those toward the breech being the strongest. This gun attracted little attention at the time, and was broken up. My knowledge of this circumstance is derived from the historian of that province,* who for more than twenty years was on circuit in Cape Breton once, if not twice, a year. He frequently spoke of the enigma, and regretted the stupidity and utter want of interest which prevailed at that time with respect to the early history of the country. An inquiry into the date of the manufacture of such guns showed clearly that it must have been brought out before the arrival of the French in Cape Breton. † Were these remains at St. Peter's vestiges of this early Portuguese colony?

From a rare pamphlet, "Tractado das Ilhas Novas," by Francisco de Sousa, written in 1570, and published at San Miguel in 1877, Senhor do Canto, in his "Os Corte-Reaes" (pp. 89–93) copies an account of the colony in question, and has also given us a description of the discoveries, and a copy of the commission of João Alvares Fagundes.

It appears from this that the colony was planned by some noblemen at Viana, consequent upon the discoveries made by João Alvares Fagundes. They sent out a ship and a caravel, but Newfoundland (Baccalaos) having been found too cold, the settlers sailed to the west and southwest, and, having lost their ships, were obliged to remain. News was subsequently received from them through Biscayans, who were then in the habit of frequenting that coast. They asked for priests; said that the natives were well disposed; and that the country produced "nuts, chestnuts, grapes, and other fruits, showing the goodness of the soil."

Allusions in early writers point to the existence of this early Portuguese colony. Anthony Parkhurst, in a letter published in 1578, when speaking of the excellent timber in Cape Breton, says: "I could not

* Judge Haliburton, the author's father.

† The article "Artillery," in the "Encyclopædia Britannica," says that such guns were made from 1500 to 1545, when cast-iron guns were first introduced.

find it in my heart to make proof whether it be true or no, that I have read, and heard, of Frenchmen and Portugals to be in that river" (the St. Lawrence) "and about Cape Breton. If I had not been deceived by the vile Portuguese descending of the Jews and the Judas kind, I had not failed to have searched that river and the coast of Cape Breton which might have been found out to have benefitted our country." The colony of Fagundes of 1521 has been unknown to historians, though the circumstances that led to the attempt to colonize Terra Nova have not escaped attention. Fagundes had already been an explorer, and his name is connected with the northeast coast of America by early charts, while his discoveries, as we have seen, are referred to in his commission.

We also meet with a probable reference to this colony in connection with the cattle and swine which Champlain (1618) says "were left there" (Sable Island) "more than sixty years ago" (i. e., before 1558) by the Portuguese. In Haies's report of the voyage of Sir Humphrey Gilbert, given by Hakluyt, and probably written about 1583, he says, "Sablon lyeth about twenty-five leagues to the seaward of Cape Breton, whither we were determined to go upon intelligence we had of a Portugal during our abode at St John's, who was himself present when the Portuguese (about thirty years past) did put on the said island both neat and swine to breed, which were since exceedingly multiplying."

It appears that the Baron de Lery, in 1518, landed some cattle at Canso, and the remainder on Sable Island, on his abandoning his intention of forming a settlement in Nova Scotia. It seems also probable that the Portuguese must for the same reasons have landed their cattle at Sable Island, and that the date is the probable time when the settlement of Fagundes was broken up.

III. A Portuguese Settlement at Inganish, Cape Breton, 1567.—De Laet (book ii, chapter v) tells us that the Portuguese placed Port Ningani from eighteen to twenty leagues to the northwest of the cape which afterward gave its name to the Island Cape Breton, "where they formerly had a settlement, which they have since abandoned." Champlain says that the Portuguese were forced to do this by the cold and rigorous climate.

Until recently this was all we knew about this colony, but Senhor E. do Canto has now discovered a MS. charter in the Torre do Tombo, at Lisbon, from which it appears that the king, on May 4, 1567, appointed Manuel Corte Real notary public of a colony about to be founded in Terra Nova, and for which two ships and a caravel were then about to start from Terceira. In 1579 the captaincy of that colony was conferred upon Vasco Annes, the fourth in succession of the Corte Reals. The author of the "Tractado das Ilhas Novas" appears to have sailed with the expedition of 1567, and it is quite clear that up till then no tidings from the colony founded by Fagundes had been received. It is also clear that a Portuguese colony existed for some time at Inganish, which was abandoned on account of the cold. Was Inganish the site also of Fagundes's colony, as well as of the settlement made in 1567? It seems improbable that the colony of 1521, cut off from all communication from the mother-country for half a century, should have survived until 1567, and we are forced to conclude that the cattle and swine left on Sable Island in 1553 were the property of the Fagundes colonists, who had abandoned their settlements. It seems clear, at the same time, that the colonists who sailed in 1567 were aware that Fagundes had found Newfoundland too cold for a settlement, and had given the preference to Cape Breton. We must assume, therefore, that the colonists of 1567 settled some place in Cape Breton or Nova Scotia. Champlain says the Portuguese abandoned their settlement at Ningani (Inganish) on account of the cold. A Portuguese gentleman informed me last winter that there existed a tradition at Viana that the colony of Terra Nova was sold to the English on account of the cold climate. Senhor do Canto refers to a similar tradition, but applies it to the colony of 1521, instead of to that of 1567. This sale must have taken place after 1567, for otherwise the Portuguese, having sold out their rights to the English, would hardly have attempted, after the transfer, to make a settlement in that country.

IV. A Spanish Settlement at Sydney, Cape Breton (Spanish Harbor), between 1580–'97.—We are told that in the seventeenth century Louisburg (called English Harbor) was frequented by the English fishermen; St Ann's by the French; and Spanish Harbor by the Spaniards. Why was Sydney—at one time known as Spanish Harbor—the favorite resort of Spanish fishermen? About the time Fagundes sailed to Cape Breton, the Spaniards seemed to question his right to that country, as appears from the Spanish map of 1527, where the Spanish line of demarkation includes Cape Breton and Nova Scotia, leaving Newfoundland to the Portuguese. It is probable, however, that the Spaniards did not practically question the claims of the Portuguese, which were specially guarded in commissions to Spanish explorers. In 1580, however, the question was settled by the annexation of Portugal and its dominions by Spain. We know that toward the close of the sixteenth century a Spanish colony was sent to Cape Breton, and we can assume that it sailed some time after 1580. Our only account of it is a melancholy one, for Charlevoix says that the forty poor wretches whom the Marquis de la Roche left on Sable Island (1598) "found on the sea-shore some wrecks of vessels, out of which they built barracks to protect themselves. They were the *remains of Spanish vessels which had sailed to settle Cape Breton.*" Any one who has seen the wreck-strewed coast of Sable Island must remember it as suggesting a graveyard of vessels. Those that have been there a few years are soon covered by the drifting sands, and the half-buried skeletons of later wrecks are to be counted by the dozen, in different stages of sepulture and decay. It is probable, therefore, that these wrecks, which were used by the French convicts, can not have been there many years previously. The date, therefore, of this Spanish expedition to Cape Breton must have been between 1580 and 1598.

An inlet in Sydney Harbor is still known as the "Northwest Arm of Spanish River."

We have no account of the fate of this colony, but we may infer that it only existed for a short time. The French took possession of and colonized that country early in the seventeenth century, and their writers are silent as to the existence of any Spanish settlement there at that time.

So thoroughly forgotten is this lost colony of Terra Nova that, though there are many Portuguese names that survive on the map of Northeastern America, they no longer suggest their origin or meaning. Few persons imagine that the Bay of Fundy is the "Deep Bay," or Baya Fonda ; or that Cape Race means the "Bare Cape" or Cabo raso. The "Land of the Corte Reals" knows them no more.

RELIGION WITHOUT DOGMA.*

By GEORGE ILES.

NO purpose in the study of history is more instructive than that by which we trace the progress of freedom against authority, of inquiry as opposed to dogmatic assertion, of reason and right against arbitrary power.

As I shall have frequent need to speak of authority, it may be well to discriminate between its various species, and state with what specific meaning the term is to be used in this discourse. In the instruction of the young we all admit that authority must be the principal method employed. In early years many lessons were taught us chiefly on that principle—the rules of arithmetic, the relations of geometry, the formulas of logic, the rudiments of physics, with sundry theories as to the fluid nature of electricity and the atomic structure of matter. Besides these were lessons in history, which included the statement that Charles I was a martyr ; and lastly the Church Catechism—all these did we diligently commit to memory and regard as truth. With the lapse of years came the perception that the lessons of childhood and youth were not all of equal validity. The mathematics and logic which appealed to the understanding remained, so did the largest part of physics ; the hypothetic nature of electricity, however, and of the ultimate structure of matter, being deemed something else than cer-

* A lecture delivered at Montreal, Sunday, March 30, 1884.

tain. Our views of history underwent some change, and Charles I was removed from our roll of the army of martyrs. The revered sentences of the Catechism, which so tersely told the origin and destiny of all things, the nature and intentions of the Supreme Cause, were submitted to tests which left them of somewhat less force than of old. The maturing powers of reason passed judgment on the authorities, left some of them undisputed, regarded others as approaching correctness with more or less probability, and placed others, again, in the category of unsupported assertion.

As a typical case of allowable and legitimate authority, let us take the statement by Dr. Tyndall, that watery vapor, suspended in the atmosphere, acts as a powerful absorbent of heat radiant from the earth. We accept the statement because it is undisputed by physicists who are competent to execute tests of it, and because, should we choose to become instructed in the methods of research which Dr. Tyndall employs, we could verify his conclusions as many inquirers have done. Genuine authority gives us proofs, it predicts, and fulfillment follows: The geologist declares that certain strata may be coal-bearing; we sink a shaft and find the fuel. The meteorologist forecasts the weather twenty-four hours ahead, and the skies verify his prognostications. Venus, we are told from the observatory, is to cross the solar disk at a specified time, and punctually to the instant the planet appears. From elaborate consideration of the molecular groupings of certain compounds of carbon, a German chemist thought that a substance which he sought to build up from its elements would possess great beauty and value as a dye-stuff. Success rewarded his patient labor, and a new hue was placed at the disposal of the textile manufacturer. The kind of authority which men of scientific achievement exert, and which all men of special gifts of talent and character enjoy, is an authority to which we owe intelligent and cheerful allegiance. The world advances by leadership of this kind and by loyalty to such leadership. But, when a theologian says that the world was made from nothing, that man was created from the dust of the earth by instantaneous fiat, and then caused to be tempted to his fall—when we find all these assumptions made the basis of an elaborate and definite scheme of supernatural theology—we confront what seems to us the authority of unproved assertion, which reason questions and science ignores.

The history of every thinking man, in his separation of the authorities contending around him for obedience into valid and invalid, is a summary in some sort of the history of the race in its gradual emancipation from dictatorship in science, in the state, and in theology. The records of science show us the common case where men of extraordinary genius have risen so high above their fellows as to excite reverence for their results, rather than emulation of their methods. The price paid by mankind for towering ability has often been the production of generations of mere quoters and commentators, who revered the work of a master as too sacred to require addition or improvement. Ptolemy's system of the universe was so great an advance on the explanations which preceded it, that for sixteen dreary centuries it was imposed upon students of the heavens. Not until the time of Copernicus was the theory established that the sun is the center of our system, as against the notion that the sun and planets revolve around the earth. Aristotle had such a wonderful grasp of mind, had so comprehensive knowledge, and was a man of so much constructive genius, that admiration of him paralyzed research in science for nearly two thousand years. Whewell, the historian of the inductive sciences, shows how Aristotle's Hellenic love of symmetry in thought led him to bridge gaps in evidence and induction by verbal propositions. His works presented a fictitious completeness which imposed upon students for ages. Mere comment and expansion gave place to original work only when Bacon, Galileo, and others like them, taught that the way to know Nature was to observe, experiment, and generalize. When the methods of Aristotle and Ptolemy as observers were imitated, and when their results ceased to be echoed, was science born again, to achieve wonderful victories; then the goose-step of the schoolmen became the onward march of exploration.

The revolt against the predominance of classical education in favor of that of science is a noteworthy sign of the times. Greek and Latin literatures used to be held to furnish a mental training obtainable by no other studies. Now the dominion of words is passing away. In technical schools and colleges students are brought into direct contact with the facts of Nature, and are taught how to interpret these facts into principles. It is becoming more and more widely held that the ancient literatures only provided a gymnasium for the mind, exercise wherein can be profitably superseded and included by that afforded in the tasks of the laboratory, the workshops or the botanic field. Instead of repeating Greek prose and verse, the student of science is taught skill in the use of his senses and reasoning powers, it being intended that he shall so acquire knowledge as to be able to add to knowledge.

As in the history of science and education, so in that of the state, has authority declined before the spread of the love of freedom. The history of European and American civilization is the history of the gradual recognition of the individual's rights, as against the claims of monarchy and aristocracy, of privileged persons, families, and classes. And, however imperfectly democracy may fulfill the expectations of its advocates, through freedom having often come before education in responsibility, one thing is clear, its idea is better than those which it has displaced—the idea that, as each individual man has duties to the state, he has correlative rights which entitle him to a voice in appointing those who make the laws and execute them.

In its advance from authority to freedom, the history of Christian theology supplies a parallel to that of science and that of the state. Christianity, based on the claim of its founder to be the Lord and Saviour of men, finds its strongest and most consistent exponent in the Roman Catholic Church. That Church presents its dogmas with absolute claims to truth and infallibility, and demands the complete submission of mind and will, as the representative on earth of the Divine Saviour. The yoke of this Church, though firmly fixed about the necks of its followers, grew so burdensome at last that the Reformation arose, and belief was transferred by millions of men from the infallible Church to an infallible book, which book, however, was to be interpreted in the light of private judgment. While the ecclesiastical government of Rome was discarded, much of its creed was retained; and to this day Protestantism, in its ritualistic and more authoritative forms, is scarcely to be distinguished from its parent. Dissatisfied with the Bible as an infallible standard of faith and morals, the Liberal Churches have discarded it from its place of supreme authority and accept Christ as spiritual Lord and teacher. The Liberal fold in turn has developed a school of much influence, which, unable to bow to any external guide, looks within and finds in intuition direction sufficient for spiritual life. The history of Christianity, from the time of the apostles to that of Theodore Parker, manifests first the gradual evolution of authority, and then tells us how by abusing its power and becoming corrupt and arbitrary it incited the rebellion of bold and free men, who point by point have taken the citadels of assertion and dogma. Theology proves on examination to be no more than the views of Nature entertained by observers in the remote past. These views, formulated into creeds and crystallized into institutions, have established churches, ruled not less by the love of power than by the desire to do good.

The church-makers, in a very different spirit from that of men of science, have not dealt directly with facts, but with opinions about facts, and on examination it would appear that they have proceeded on some erroneous lines. In refusing competency to the intellect in its attempt at dealing with the problems of life, the theologians have on another hand overrated the powers of this same intellect.

While affirming the supreme mystery which infolds the universe, they have inconsistently given verbal explanations of that mystery. In the same page which speaks of the untrustworthiness and weakness of the human mind, we may find a full account of the origin and destiny of all things, and an analysis of the Divine nature and intention. The depreciation of human ability and the need of modesty in attacking the great questions of life and death are stated very forcibly, and thereupon solutions are offered us of all that a little before was declared inscrutable. In endeavoring to rise from Nature to a conception of a creating and ruling spirit, different in character from what observation of Nature would lead us to imagine that spirit to be, theology has become involved in endless contradictions. The Christian idea of the Deity would seem to have been developed in the light of the sympathies which have arisen in the domestic and social life of man. These sympathies with their allied sentiments have been unwarrantably projected out beyond their proper sphere, that of human affairs, into an idea of the Divine—it being forgotten in the process that Nature in the broad view is the fullest manifestation of divine power we know, and that from Nature herself in her manifold operations should we try to integrate a conception of its informing Spirit. Hence the discrepancy between the conception of the theological Deity and the facts of the universe. Do the processes of Nature exhibit sympathy, mercy, or love? Or do we not rather observe in them the uniformity of a power manifested through an infinite mechanism which neither excuses ignorance nor spares weakness? Yet so widely and in our view so unjustifiably have the ideas of God and Nature diverged, that we find Tennyson asking, as he depicts the agony of the struggle for existence and the profuse waste of organic life, "Are God and Nature then, at strife?" Any theory of the universe which endeavors to be comprehensive must subdue the impulses of sentiment and emotion and face all the facts of experience. The natural order shows us redundant life as necessary for the competition whereby the fittest individuals and species may survive and advance. The fittest may not from the human stand-point always be the best or the highest, for the parasite, protected from contest in the stomach of a man or horse, may degenerate and assume a type lower than that in which its existence began. The system of prey, the thousands of species of parasites which make the days of so many nobler types of life miserable and short—all this does the natural order include, no less than the culminations of human consciousness, genius, and conscience which thrill us with their power as if we stood in the very presence of the Divine. Nature presents to our view and study a mechanism of infinite complexity. Its rules of action we may know in part, and, when we obey that knowledge, happiness can be ours; but, however diligent we may be in study or willing in our obedience, all its laws we can never discern, and its wheels may seize us and painfully mar or quench our lives at any moment—the lurking germs of disease by inheritance within us, or floating in the air around us, the incalculable forces of earthquake or tornado; the liabilities incidental to modern locomotion, and many of the processes of modern industry. These, together with the willful exertion of human malignity, all beset us as subtractions from joy in life. Our sympathies, baffled in their endeavor to find scope beyond the limits of human relations, return thither to their source, as perhaps to the sole legitimate sphere for their exercise. Humanity remains, though the supreme cause continue undefined. In the spirit of much of what the theologians say, we find ourselves acknowledging our inability to rise from phenomena to ultimate cause or essence.

Declining to attempt solutions of the origin and destiny of the universe, we would endeavor to attack undone work for mankind near at hand, neglecting in the mean time all discussion of the remote and impossible.

Not only in their overrating the powers of the intellect did our forefathers err, but also as seriously in their views of knowable truth did they exhibit immaturity of thought. Truth may be defined as the reality of things underlying our partial knowledge of them. Except in the limited area of axiom, our knowledge is imperfect and incomplete. On examination, it proves to consist largely of mere signs and symbols. We can state the law whereby gravitation acts, but the force itself eludes our scrutiny. We can formulate its rate and measure its quantity, but why bodies tend toward each other throughout universal Nature is as little known to our acutest physicists as to the least informed savages. All analogy requires us to think that a medium is necessary for the conveyance of the attraction, yet, if there be a medium, how does it do its work, and that too across the diameter of the visible universe with practical instantaneity? So too with the properties of substances which are surely among the simplest things we can consider. What is the essential difference between iron and lead, and why does water always freeze in six-petaled crystals? Such questions, which lie at the very threshold of the temple of inquiry, show us how hard is our task of getting below our labels, our names of things, and pursuing investigation more than a single remove from appearance.

At the risk of being tedious, I shall take an example of the growth of our information about a single substance, to illustrate the indefinitely great extensions of knowledge which are possible to us, in every direction in which we may seek it—this in contrast with the views of knowable truth which were current in the infancy of information. Iron had, doubtless, in very remote times, been observed to be tenacious and malleable; of value, therefore, in making of tools and weapons. Later on its magnetism was noticed, and, at some uncertain date, in China probably, it began to be used in navigation as the mariner's compass. The rusting of the metal must have been observed very long ago; yet it is little more than a century since that common fact was rationally explained, and since the chemical relations of iron began to be studied. Examination has determined its crystalline structure; its capacity as a transmitter of sound, heat, and electricity; and its improved tenacity, when united with carbon, to form steel. The long catalogue of its various properties does not seem to be approaching a limit, but rather the reverse. Within recent years spectrum analysis has determined the peculiar lines, several hundred in number, which enable it to be identified as a fiery vapor, alike in the flame of the laboratory or in the remote orbs of space. The telephone proves that a small disk of the metal conceals within its structure the subtile means of converting sound-waves into electrical tremors, and these back again into audible vibrations, with so much of the individual tone of a speaker as to be readily recognizable. Now, if iron, which is comparatively so simple a thing, presents such a multitude of properties and powers, if it be shown to have relations with all else in Nature, if very important knowledge respecting it has but recently come into our possession, how very cautiously should we proceed when our subject of thought is not a chemical element, but, say, some large question of human nature or public policy! The little gray crystal of iron is eloquent in bidding us have some decent hesitation, when we are considering, say, some proposed legislation which is to affect the complex sentiments, desires, and passions of men. For lack of that decent hesitation, statute-books are filled with laws which are evaded, or work results opposed to those expected from them, all tending to establish in the popular mind an injurious contradiction between law and common sense. And what supreme diffidence should there be when we are endeavoring to arrive at, not some knowledge in a special science, not the best policy in a matter of law or state, but when we approach the highest questions: How best can we interpret Nature so as to form a conception of its informing spirit? If a man die, shall he live again? What are the sanctions and what the standard of right conduct? Which is the higher reverence, that which accepts the dictum of a local and arbitrary authority in response to these questions, or that which considers them patiently in the light of all human experience to the present day, by the aid of the highest faculties we possess? We are often told to bow to authority in the singular, but we are surrounded not by authority but by authorities, many and diverse. Among them all—religious, social, or scientific—we can but lean on such common sense as we possess to aid us in selection and discipleship.

I have defined truth to be the reality of things underlying our partial knowledge of them. Our forefathers thought of truth as a thing which they might grasp as fully and perfectly as a child's hand incloses a pebble; our conception is of something which we may approach, but never possess, save in the restricted field of axiom. We think of truth as of the dim face of a star, discerned through difficulties of distance, distortions of media, and defects of the seeing eye. The old view of finality, completeness, and perfection in knowledge, we discard as utterly disproved by fact. Science knows nothing of the infallibilities it was aforetime thought necessary to assume. The infallible standards of Church, Bible, and intuition have never yielded to inquiry more than the verbal husk of assumed certainty. Science accepts the risks of a fallibility which can not be escaped, but which it reduces to a minimum by the co-operation of many minds. The desire to be certain, which set up the oracles and established the successive infallibilities is, however, an intelligible desire. Doubt and ignorance are not pleasant states of mind to acknowledge, and the process of arriving at fair judgments is both laborious and painful. Instead, however, of assuming certainty because it is desirable, we would endeavor to earn it, by recognizing it as every man's duty and privilege to add to truth, in the justness, completeness, and clearness of his knowledge of it. And, since the scope of the unknown is infinite, the incitement to the fulfillment of this duty is full of hope and promise. Science, unlike dogma, does not point to fields harvested and gleaned long ago, but to continents awaiting their Columbus—to pressing problems of individual, social, and political life demanding solutions by thoughtful men. And, in the fields of scientific investigation, we can see how every newly ascertained fact and law extends the horizon of Nature, adds to the area of unexplored territory, thereby stimulating the student to achievement therein. In researches respecting mind and brain, and their relations, in probing consciousness to its depths, and in the results which may follow the inquiry as to whether the intellect does or does not come into direct contact with external Nature, some of the ablest thinkers of our time place hope of more light on the chief problems of life. Our conception, then, of knowledge leads us back to the early similitude which likened it to a tree. Knowledge does not increase, like a honey-comb, cell simply added to cell, but, like an oak, whose every year of growth implies not addition merely, but vital transformation of structure. Nothing is fixed but the axis from which the branches and boughs spread out, as if they felt they had all the universe for their expansion. A stripling oak of a few seasons' growth is beautiful enough in its way; but would it be wise or useful to uproot it, shelve it in a museum, and declare it to represent a finality as to oak-possibilities?

The idea of knowledge which I have sought to express makes clear the grounds whereon thought and discussion ask for full liberty. As men differing in natural ability, temperament, education, and stand-point, strive to attain views of truth, their results must inevitably vary. "Recognition of difference of view" we would, then, substitute for the offensive term "toleration of dissent," which latter phrase, from one who holds that he possesses finality, simply means the permission of known error, which he may be unwilling or unable to punish. And the differences of view which men of opposite temperaments and tendencies may entertain are often mutually completing, and become indued in a master-mind with stereoscopic relief and unity. Let me cite an example of this: Two schools of thought endeavored to explain conscience on different principles. The one held it to arise from an innate moral sense, the other from the results of experience. The philosophy of evolution includes in its explanation both series of facts from which these two schools argued. It shows how ancestral experiences of right and wrong conduct become organized in the race, and are transmitted as moral tendencies to offspring. These tendencies are advanced in their progress a step by the experience of each individual life.

Having, then, expressed our dissatisfaction with the method of theological authority, from its having attempted problems which as yet are beyond the scope of the human intellect, and because of its erroneous notions as to the knowability of truth, let us endeavor to describe the method of science which we would adopt in the whole sphere of our mental activity. The scientific method is nothing very new or unfamiliar ; it is simply ordinary thinking, corrected by the canons of a more exact and cautious procedure. It is organized common sense coming into contact with fact, and carefully sifting the evidence derived from fact. Business men employ it in importing or manufacturing their wares, in estimating the demands of markets, and ascertaining the standing of their employés and customers. Physicians act according to it in diagnosing their cases, prescribing treatment, or operating in surgery. Lawyers employ it in supporting their pleas and arguments ; and judges use it in rendering their decisions within the limits of the written law and of their precedents. The scientific method ignores no faculty of man or fact in Nature ; it recognizes to the full our emotions, affections, and sentiments, but subordinates all these to the intellect, whose dictum alone is given command over the educated will. Authority relies on inspiration, revelation, the miraculous, and the supernatural ; science relies on brain, on experience, the mastery of facts by accurate and patient thought. The one receives or imagines it receives, the other acquires and has no opinion not subject to revision as new evidence comes in. It entertains no beliefs beyond evidence, and seeks none. It knows nothing of infallible guides without or within, nothing of authorities which may not be doubted and which submit no proof of their assertions. Science endeavors to substitute convictions for mere assent ; and, instead of mechanical adhesion, would give to genuine authority the intelligent concurrence earned by the labor of the individual mind. It is not because science has won its chief victories in the physical world, where the comparative simplicity of its problems has invited attack, that we should therefore have an imperfect idea of its scope. Its scope includes the whole range of human thought and feeling. Science is not limited to fields where clocks and micrometers may be used to measure, or logarithmic tables be employed to compute ; it recognizes human emotions, sentiments, and will. To these it would direct study, no less than to the areas where exact results are attainable.

Applying, then, the method of science to an examination of theology, it appears to consist in an attempt at explaining the facts of Nature, and the sanctions of duty, in distant ages of scant knowledge. Its scriptural revelations come down to us through centuries of untrustworthy custodians, and when they reach us at last they are not revelations to us, but hearsay about revelations, and must be judged by the canons of criticism which we apply to other departments of literature. Every theology, no matter how emphatic its assertion of a supernatural source, bears about it the plain marks of its human origin. The conceptions of God vary with the zones and closely parallel the grades of culture in which they arise. The commandments called divine become more elevated as the civilization of a people advances. The disciples of a prophet or apostle direct the noble impulses he has implanted in their hearts to broaden his teachings and correct his errors. Contrast the almost human tribal God of Abraham, Isaac, and Jacob with the lofty idea of the Deity entertained by Isaiah. Compare this latter, again, with the universal Father whom Jesus taught his followers to worship. Mark the cumbrous legality and ritualism of the Old Testament and its silence respecting the future life ; how different this from the teaching of Jesus, who exalted the spirit above the letter, valued love more than sacrifice, and assured his hearers of an immortality which made this world but a temporary scene of trial and probation! Note how the high-minded Paul saw nothing reprehensible in slavery, and compare that with the humanity of an age which gives even dumb animals rights against their owners. The evolution of thought in general is fully exemplified by thought in theology, notwithstanding its assertion of a sacred fixity. John Wesley, sensible man that he was, said that, if he were to give up his faith in witchcraft, he would give up the Bible. Yet his followers have dropped the witchcraft, and kept the Bible.

No study of human history would be valuable or just which did not recognize as a prime fact the profound religious instincts of our race. The awe inspired by the sublimity of the starry heavens, and the terrible and resistless forces of Nature—those of the volcano, the tempest, the pestilence so mysterious in its origin and spread, and the famines so devastating in the childhood of races—all these, not less than the kindly succession of the seasons, and the enjoyments of health and home, have suggested an infinite Power, the immanent sustaining spirit of universal life. The baffled hopes and aspirations of the soul, the anguish of bereaved affection, the enigmas and tragedies of life, have joined together to implant a faith in another life which shall be complement and compensation for this. As a record of man's perception of his helplessness in the combat with Nature, as a pathetic registration of his hope, fear, and remorse, the religious sentiment is entitled to our profound respect. Every sentiment, however, of the human heart, while compelling our respect or reverence in itself, awakens some less lofty feeling by its expression in institutions. The Sanhedrims and Councils of the churches, which have arisen by virtue of the religious sentiments of our race, do not appear to have been lifted above the passions and partialities of our Congresses and Parliaments. The inner heart of humility and reverence in religion we highly respect, but the churches not so highly. The inevitable loss which attends the translation of sentiment into organization may perhaps be exemplified in the case of our instinct for justice. That instinct, one with the love of truth, in its expression as a means of self-protection against wrong, has given rise to law and the courts. Are the results of their processes such as to awaken the reverence which the sentiment of justice compels? The discrepancy between religious feeling and ecclesiasticism; the love of right and law, as practically enacted and executed, suggests the parallel gap which philosophers and poets have so often mourned—the gulf between thought and language, which leaves music to suggest much that in speech must remain inarticulate. The great artists of the world, whose masterpieces fill the generations with wonder, have lamented how far execution has lagged behind conception. The supreme dramatist does not seem to have thought his work sufficiently valuable to take any special care to hand it down to posterity.

Religious feeling by its arrival at the theistic idea has done mankind incalculable service. How potent the thought that the universe is one, and represents one uncontradicted will! How influential for good the thought that a Supreme Mind, too great to be deceived, and absolutely righteous, knows every thought and act! "Thou God seest me," has, I think, restrained evil in the mind of conscientious theists, with a directness which might have been denied to reflections as to consequence. It is not because some of us may be dissatisfied with theology that we fail to recognize its value in the past and present. Associated with moral codes, it has impressed them on minds unfit by immaturity for the responsibilities of freedom, and by dogmatic force has doubtless given stability to order. Not because the Gods of the sects seem crude and imperfect conceptions are we to expect that the religious feeling which gave rise to all these will die out in man. It will, I believe, from age to age, go on endeavoring to form a theory which shall explain the facts of human life and universal Nature, which shall impress the imagination and influence the will.

One result of science will be profoundly influential here—its arrival at the idea of Law, its perception of uniformity and constancy in Nature; the proof which, in large part, it now possesses, that the history of the universe, from nebular mist to man, illustrates causation and continuity. This idea, excluding as it does the miraculous and the supernatural, leads us to regard the history of the universe as an unbroken and consistent unfolding. In this view, every item of knowledge we attain is secure from any interference from break in the natural order. We are incited to explore relations which are unchangeable. The sense of supreme mystery will grow as the margin of the known expands and touches larger and larger circles of the unknown; but any territory we may win we will feel sure of retaining. And, although our knowledge may not be either wide or deep, still much of it will doubtless be regarded as valuable and important throughout the future of our race. The laws of gravitation and evolution may be included by the coming man in wider generalizations, but we can scarcely conceive their being ever regarded as other than immovable and fundamental portions of truth. We are not of those who say that human knowledge is only relative to the individual consciousness, and therefore shadowy and invalid. With reverence be it said, we hold that such knowledge as we have of water or iron, to be a part, however infinitesimal, of the divine knowledge of these things.

The instituted religions have not only given us the theistic idea, but have also laid us under weighty obligations by establishing the only means of formal instruction in morals known to our race. And here let us note the damage caused by the accidental association of a moral code with a cosmogony developed in early stages of knowledge. It is not because Genesis gives an unsatisfactory account of the world's beginning, that the decalogue does not validly register the dictates of human experience, taking form in the brain of a great lawgiver. The Mosaic and all other authoritative codes of conduct, as currently held to-day, are supported by appeals to experience ; then it becomes the mission of competent thinkers to revise these codes in the light of all that men have thought and done to date. It becomes the duty of science to investigate the conditions of happiness, which we must morally fulfill if we want happiness ; no other standard of conduct do we know than this.

For the essence of religion, the faith that the right will win, and that we should help it to win, we are indebted to Christianity in its rationalized forms, and for that faith we thank it.

But the churches have done more than preach theism and teach morality—they have endeavored to imitate their Founder in his care for the desolate and oppressed. Countless kind and tender spirits have found in the noble philanthropies of Christianity scope for their charity and mercy. Here, as elsewhere, we do not propose, in our independence, to disinherit ourselves of anything of value which Christianity can give. The scientific conceptions of duty at which we seek to arrive are to be broadened and deepened by the sympathies which yield the highest satisfactions of man. The necessity for the greater recognition of this element in conduct was never so urgent as now. The masses of mankind born into a world abounding with pain and evil have hitherto been disposed to consider their burdens as all equally providential. They are, however, now beginning to distinguish among the ills which beset them. Some they regard as inevitable, to be borne with manly courage ; others, again, as infractions of justice, preventable or remediable by proper means. There is no prevalent recoil from the disciplines of home and business life, but there is wide-spread and growing discontent at the extreme inequalities of fortune—inequalities held to be the result of bad laws, unwise customs, and downright dishonesty. The enormous sale of Mr. Henry George's books is not, I take it, due to any popular faith that the remedy he proposes—the public confiscation of land—will right the wrongs of poverty. The consciences of the people are shocked at the immorality of the proposal. Mr. George's vast audience is attentive because he states very forcibly the anxieties and dangers which beset bread-winners amid the contingencies of the modern industrial world. When, from beyond the sea, we hear of nihilistic vengeance, socialistic uprising, and dynamite plotting, it would seem that the safeguards of civilization against a relapse into barbarism are less secure than is commonly imagined. Do not all these dangers spring from lack of sympathy between plenty and want? Not simply between plenty and want in matters of goods and chattels, but in the better things of culture and refinement. The generous man who will correct with kindness the faulty arguments of a neighbor less endowed than himself, who will cultivate in the youth of his acquaintance love of literature, of art, and of the natural sciences, is doing as much to strengthen the bonds of society as when he shares his income with the destitute and forsaken.

When I was in Ireland, four years ago, I heard many causes assigned for the prevailing discontent. My informants averred that, not less than the injustice of the landlords, had the arrogant and unsympathetic manners of many of them, and of many of their agents, served to alienate the people. In the development and satisfaction of the sympathies, let me repeat, lies the chief hope of establishing a true brotherhood among men.

Seeking happiness as our aim, we declare knowledge, and obedience to that knowledge, to be its means, and freedom its condition. The cultivation of the heart must receive our attention, not less than the improvement and equipment of the brain, if our lives are to be worthy, useful, and happy.

A SCIENTIFIC VIEW OF THE COAL QUESTION.

By G. GORE.

IT is well known that our stock of coal is not an infinite quantity, and can not last an infinite period of time. Different authorities, and those who have investigated the subject, including a royal commission, have assigned different lengths of time during which our supply is likely to last; and, according to the most reliable authorities, it can not be much less than one hundred nor much more than two hundred and fifty years.

Our abundant store of coal and its application to industrial purposes have been among the largest causes of our wealth and progress. The value of coal for those purposes depends essentially upon the fact that it is combustible and evolves a large amount of heat in burning, and that this heat can be set free at any time and be readily converted into mechanical, chemical, electrical, and other forms of power. As an illustration of the great amount of energy contained in coal, it is well known to scientific men that each piece of it contains sufficient stored-up power to lift its own weight twenty-three hundred miles in height, or twenty-three hundred times its own weight a mile high. The only other common natural substances to be compared with it in this respect are wood and petroleum, and our stores of these are very small. It is by the expenditure of the energy contained in coal that comparatively valueless iron-ore is converted into valuable iron.

It has not been by the mere existence of large quantities of coal in this country, nor entirely by the sale of coal to foreign nations, that so much of our wealth has been obtained, but largely by the circumstance that we were the first nation to apply coal to industrial purposes on a large scale and in a great variety of ways. Other nations also possessing coal, perceiving the great success of this method, followed our example, have overtaken us, and have now rendered it increasingly difficult year by year for us to maintain our position as manufacturers.

As also large quantities of coal, petroleum, and inflammable gas are continually being discovered and utilized in other countries, and it is known that the United States of America alone contain nearly forty times as much coal as our entire stock, the time can not be very far distant when our chances of maintaining even our present position among nations by means of our coal will be considerably less than at present. It would be wise, therefore, boldly to face this serious prospect, and consider by what means our national prosperity can be maintained as our coal diminishes in quantity and increases in price, especially as our population is continually increasing and has to purchase greater supplies of foreign food.

There does exist another and inexhaustible source of wealth and progress, viz., new knowledge obtainable by means of scientific research. It is upon such knowledge, gained by experiments made to examine natural forces and substances, that we must sooner or later depend as a fundamental source of national prosperity. As fast as this knowledge is evolved by discoverers, it is applied in more immediately practical forms by numerous inventors, and then manufacturers and men of business use those practical realities in the production of wealth. This has been the order of events in the past and will be in the future ; this was the way in which we got wealth out of coal. Persons of narrow views on the subject will consider the above proposition vague and unpractical ; but this order of things is a great fact and unavoidable. We are the servants of Nature, and have no choice in the matter ; we might as well hope to live without food as expect to advance in civilization without the aid of new knowledge.

The practical value of new scientific knowledge as a source of wealth and progress is incomparably greater than that of all the coal-deposits, petroleum-springs, and gold-fields of the earth. This great truth, though familiar to scientific investigators, is but little perceived or appreciated by our rulers or by the mass of their electors; and the chief reason for this is the fact that they possess insufficient knowledge of science. Even governments can only appreciate that which they understand, and can only act as circumstances and public opinion allow them, and when fettered by an ignorant population are powerless to preserve a nation from decay.

There can not be a more complete error than to suppose that new knowledge discovered by means of scientific research is not practical. Its immense practical value has been abundantly proved in a multitude of cases. It was largely by means of such knowledge respecting coal, its properties, constituents, and products gained by means of experiments, that coal was applied to so many uses. One of the most recent proofs of the practical value of such knowledge is the conversion of the heat of coal into electric current and light in the dynamo-electric machine and electric lamp; the entire existence of these instruments arose from new knowledge discovered in purely scientific researches by Davy and Faraday. It is not necessary to describe here the exact beginnings of gas-lighting, phosphorus-matches, photography, the voltaic battery, electro-plating, aniline dyes, telegraphy, the telephone, etc. These, and a multitude of other utilities in common use, had their earliest origin more or less completely, not in the labors of the inventor or of the more directly practical man, but in those of philosophical investigators whose experiments were made with the far more widely practical object—the discovery of new scientific knowledge.

It is not the mere possession of good things, but making the best and earliest use of them that most conduces to success. Our great stock of coal lay comparatively useless as a source of national wealth until philosophical investigators discovered its constituents and properties, and inventors applied these to useful purposes. Other nations also possessed coal, and our greater success than theirs was largely and essentially due to the fact that we were the earliest in applying it to important and varied uses. We must not wait, therefore, for those nations to discover for us new knowledge respecting natural forces and substances, but discover it ourselves, in order that we may have the first chance of applying those forces and substances to practical uses, and of offering the useful products for sale or in exchange for food and other commodities.

It is well known that a man who has no faith in medicine will not apply to a physician until death stares him in the face. Similarly the average politician and the ordinary elector, having but little knowledge of philosophical experiments or faith in them, will probably not believe in their great practical value until national distress and panic legislation ensue. The love of money also, and the desire of acquiring it quickly without commensurate sacrifice, fostered by our having so easily obtained it by means of our coal and science, are so strong in this nation, that probably nothing but the actual loss of wealth in the form of diminished value of properties will induce capitalists and landowners to perceive and examine the scientific basis of their incomes. When, however, the stern reality of gradually increasing scarcity of coal, and consequent inability to pay for our great supplies of foreign food by means of that coal, and of articles produced by its aid, comes upon us, perhaps the statesmen and wealthy classes of this country will see the indispensable necessity of new scientific knowledge, and be more ready to promote experimental research, with a conviction that its practical results are vast, though not always direct or immediate.—*Nature.*

THE NERVOUS SYSTEM AND CONSCIOUSNESS.

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II.

MY former paper gave an outline account of the structure of the cerebro-spinal nervous system. The functions of this system were examined as far as to the cerebral hemispheres. It was said that we lacked evidence for the appearance of consciousness in connection with the activities of the spinal cord, the medulla oblongata, the pons Varolii, and the cerebellum. It was also affirmed that, if consciousness be associated with the activities of any organs below the cerebrum, this consciousness is of a general and vague kind, not the intelligence of clear perception.

The present paper is to state the functions of the cerebral hemispheres, as far as these functions are thought to be established by recent experiment and pathology.

We shall need to refresh our minds by a general view of the cerebrum. Looking at this organ from the side, we readily distinguish its so-called lobes or divisions. These are made by the fissures or furrows which dip down from the surface, penetrating, more or less deeply, the entire mass.

The prominent fissures are the fissure of Sylvius (S, Fig. 1) and the fissure of Rolando (R, Fig. 1). The fissure of Sylvius separates, in part, the temporo-sphenoidal lobe from the lobes above, and has two branches, a longer, horizontal branch (*s*), and a shorter, perpendicular branch (*s′*). If we push apart the brain-mass at the horizontal branch, we will see the nerve-matter called the Island of Reil. This is simply an additional fold of cell and fiber substance lying over the corpus striatum. The fissure of Rolando separates the frontal lobe, F, from the rest of the brain. It begins at the great longitudinal division between the hemispheres, and pursues an uninterrupted course to within a short distance of the horizontal branch of the Sylvian fissure. Back of the fissure of Rolando is the external perpendicular fissure (E) ; it

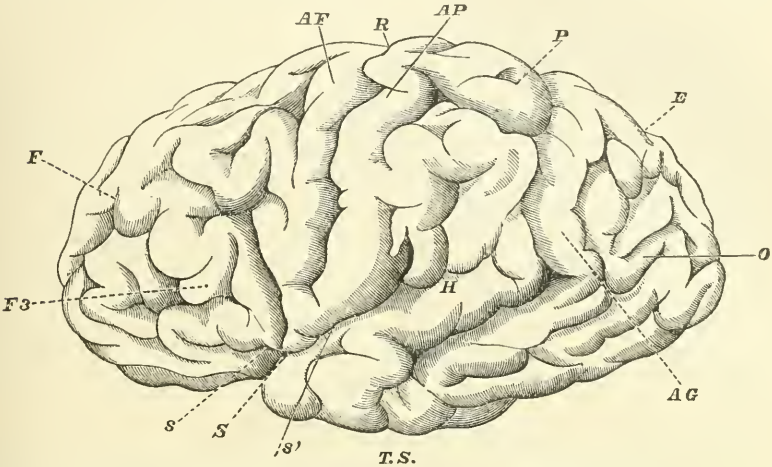


FIG. 1.—FISSURES AND CONVOLUTIONS OF THE HUMAN BRAIN. (Wundt.) Left side. *S*, Sylvian fissure—*s*, perpendicular, *s'*, horizontal, branches of this fissure; *R*, fissure of Rolando; *E*, external perpendicular fissure ; F_3, third frontal convolution or convolution of Broca ; *AF*, ascending frontal convolution ; *AP*, ascending parietal convolution ; *AG*, angular gyrus or pli courbe ; *F*, frontal lobe ; *P*, parietal lobe ; *T.S*, temporo-sphenoidal lobe ; *O*, occipital lobe.

appears as a simple notch on the upper edge of the hemisphere. It is a prolongation, on the convex or lateral surface of the brain, of the deep fissure of the internal zone. This fissure marks the rear limit of the parietal lobe (P), which therefore lies between the fissure of Rolando and this furrow. Back of the parietal lobe is the occipital lobe (O). This region is less exactly defined ; an ideal prolongation of the external perpendicular fissure would determine its anterior and inferior limits. The temporo-sphenoidal lobe (T) has already been noticed as lying below the fissure of Sylvius. Among the various convolutions formed by these fissures there are three or four which must be named, because it is with them that the experiments in brain-functions are chiefly concerned. In the frontal lobe there are two of these convolutions (F 3), the third frontal convolution, or the convolution of Broca, and (A F) the fourth frontal convolution or ascending frontal fold. Broca's convolution has somewhat the shape of a horseshoe, and is formed around the ascending branch of the Sylvian fissure. The ascending frontal fold lies directly to the left of the fissure of Rolando, which it follows throughout. In the parietal lobe we notice (A P) the ascending parietal convolution immediately to the right of the fissure of Rolando, and (A G) the angular gyrus or *pli courbe*. This latter convolution is very complex in man.

It was believed for a long time that the cerebral hemispheres were insensible and inexcitable to direct stimulation. The Germans Fritsch and Hitzig discovered, however, that parts of the cerebrum would respond to a very gentle current of electricity. This beginning has been carefully followed up by Ferrier, Munk, Goltz, and many others, until we now have, amid much disagreement and uncertainty, some results that are interesting, to say the least.

All experiments on the cerebrum are of two kinds (stimulation of the surface and destruction of the surface), and are necessarily made on the lower animals. Dupuy offered an objection to experiment by electrical stimulation, which, if well founded, would destroy the entire value of the undertaking. He claimed that the effects produced by electricity at the surface of the hemispheres were due wholly to conduction of the current through the mass to the corpora striata below and so to the muscles. Dupuy proved that conduction *did* take place through the cell-mass of the hemispheres. He placed the leg of a frog in contact with the rear of a brain, and by application of electricity to the front of this brain produced strong movements in the limb. Ferrier's answers to Dupuy are a sufficient refutation of the objection.

If the effects observed under electrical stimulation are due to conduction, we could not have (as is the case) strikingly different results from application of the electrodes to very closely adjacent areas. Further, when the striata themselves are stimulated, there is always a *general* contraction of muscles on the *entire* opposite side of the body. There is no limitation of the movements to special groups of muscles, as always happens when particular centers on the brain-surface are stimulated. Again, there are many portions of the brain which give *no response* to electrical stimulus. How can this be so if such movements as are produced result from conduction, especially since many of these silent regions of the brain are no more remote from the striata than the responsive ones?

Experiment and pathology, despite all the contradictions, seem to point to the existence of a motor zone on the surface of the hemispheres. This means that certain parts of the brain are directly concerned with the movements of particular muscles and groups of muscles; also, that these parts can not be shown to be connected with sensations. The natural, primary occasions of their activity may be the states of consciousness which we call volitions; they are not, so far as evidence goes, the states of consciousness we call sensations.

It is of interest to observe that these motor regions are situated in the anterior portions of the hemispheres, and occupy here a relatively small space. They lie above the Sylvian fissure, and are mostly on the fourth frontal and ascending parietal convolutions.

The experiments have been performed on a great variety of animals, and repeated a large number of times. The monkey is, of course, the most interesting of these animals to us, from the striking resemblance between his brain and the human brain.

Hitzig's investigations, published in Berlin in 1874, give all the results gained up to that time by the stimulation experiments. Ferrier's book, "The Functions of the Brain," London, 1876, better known to English readers, has special merit in two respects. It displays a very intelligent comprehension of the consequences of electrical stimulation, and seems to give a juster account of the motor regions in the monkey's brain than was furnished by Hitzig.

Figs. 2 and 3 will show the character and results of these experiments in sufficient detail.

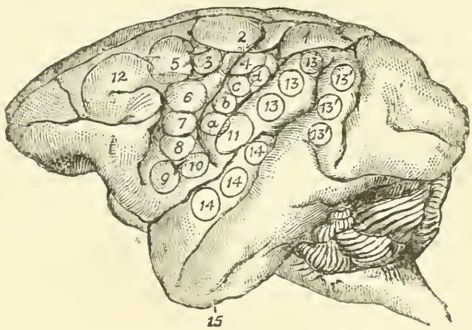


FIG. 2.—LATERAL ASPECT OF MONKEY'S BRAIN, showing the relative positions of the so-called "Motor Centers" in the left Cerebral Hemisphere. (Ferrier.)

When center No. 1 is stimulated, the hind-limb on the opposite side of the body advances as in the act of walking; when No. 5 is stimulated, the opposite arm and hand reach forward as if to touch something. These movements go together and are essentially the same. Centers 2 and 3 work together; when 2 is stimulated, there are combined movements of the opposite thigh, leg, and foot, and the foot is brought to the middle line of the body as in scratching that part, or in seizing something with the foot; 3 gives movements of the tail. An interesting fact should be noted at this point. There is no center No. 2 in the brain of cat, dog, or jackal, while No. 3 is present in each. These animals do not grasp with the foot, and the monkey alone uses the rear foot for seizing. That No. 2 should be present, and of great size, in the monkey's brain, while absent elsewhere, is confirmatory of the accuracy of the experiments. The centers marked *a*, *b*, *c*, *d*, are on the ascending parietal convolution. When stimulus is applied there, the fingers and wrist move with separate and combined movements

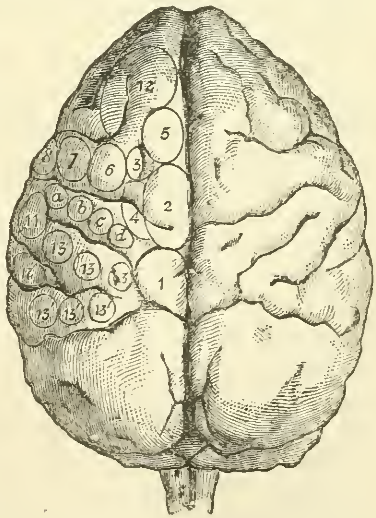


FIG. 3.—UPPER ASPECT OF MONKEY'S BRAIN, showing the relative positions of some of the so-called "Motor Centers" in the left Cerebral Hemisphere. (Ferrier.)

that end in closing the fist; in connection with these centers we may note Nos. 4 and 5; they produce movements of the opposite arm and hand. It is plain that 4 and 5, and *a*, *b*, *c*, *d*, are closely related to one another.

According to the theory of localization of functions, we should expect the centers, *a*, *b*, *c*, *d*, to be extensive in the monkey's brain, and to be wanting in the brains of lower animals. As matter of fact, they are absent in cat, dog, and jackal, except that *a* is found in the brain of the cat. This animal uses the front-paw for seizing and holding. Upon stimulating center No. 6, the fore-arm bends, and the hand lifts to the mouth. This movement is constant with the monkey. There is no corresponding center in the brain of the dog or cat. The centers marked 7, 8, 9, 10, 11, are all concerned with movements of the mouth — such as elevating the angle of the mouth, depressing the lower lip, thrusting out and withdrawing the tongue. No. 12 lies quite to the front of the brain; when it is stimulated, the eyes open widely, the pupils dilate, head and eyes turn toward the opposite side.

These are the centers in the brain which, by some authorities, are thought to have a purely motor significance. The centers marked 13, 13′, 14, and 15, give movements—the former of the eyes, the latter of the nostrils—but they are believed to be primarily connected with sensations.

Aside from the centers enumerated, no other parts of the brain respond to stimulation.

I have purposely stated the results of Ferrier's earlier experiments on the so-called motor zone. These experiments have been, in general, confirmed by other investigators. That is to say, the movements above described have been found by many to follow stimulation. It is, however, a part of the present confusion and contradiction which prevails respecting cerebral localization that the interpretation of these movements is disputed.

Munk appears ("Transactions of the Physiological Society of Berlin," 1876–1878) with a series of experiments which, as he thinks, prove that the motor zone is primarily a zone of *feeling*. He therefore divides this portion of the brain into spheres of feeling—one for the forward limbs, one for the head, one for the eyes, one for the ears, etc. Munk believes that the animal's movements are affected by destruction of these centers, because four distinct kinds of feeling are destroyed. For example, loss of the center concerned with movements of the fore-limb would, according to Munk, cause a loss—1. Of the consciousness of pressure on the limb; 2. Of the consciousness of the position of the limb; 3. Of the consciousness of the motions belonging to the limb; and, 4. Of the consciousness of touch in the limb. Whereas Ferrier and others find sensibility, both general and special, *intact* after destruction of these motor regions, Munk finds a loss of sensibility so well defined and persistent as to justify the fourfold division above stated.

We have now to inquire as to the testimony of pathology respecting these motor areas in the brain. Charcot and Pitres, in "Revue Mensuelle," November, 1878, and February, 1879, cite fifty-six cases of brain-dieases bearing on this subject. Twenty-one of these cases show lesions in the brain outside the motor zone, and unaccompanied by motor trouble. Charcot's deductions from these cases are that "there exist in the cortex of the cerebrum tracts which are independent of voluntary motion, and when lesions occur in these tracts there are no permanent affections of the motor functions." The remaining cases cited by Charcot show lesions in the motor zone, and are accompanied by varied degrees of paralysis in keeping with the situation and extent of the lesion. Dr. Bechstrew, in the "Medicinische Wochenschrift," St. Petersburg, details a number of cases which confirm the recent views on the motor functions of the areas about the middle convolutions. Other confirmatory cases have been cited by Burdon and Maragliano, by Dr. Henry Obersteiner, and many more. It is well known, however, that a number of opposing instances are on record—that is, of lesions in the so-called motor zone without paralysis, and of paralysis unaccompanied by lesions in these portions of the brain. There is a fundamental objection to this kind of evidence: it is *selected* evidence, chosen to make for or against a theory. What we really need is a collection of *all* cases of injuries to parts of the hemispheres, and a *full* statement of consequences without regard to the bearing of the example.

This is the proper place to mention a brain disorder more or less commonly known under the name of aphasia. Aphasia is a disturbance of the power of speech. It appears in two distinct forms, viz., amnesic and ataxic aphasia. The person suffering from amnesic aphasia forgets *substantives* and *names*, other parts of speech being properly used; or he forgets a language which he once knew, or he misapplies terms, "using pamphlet for camphor, horse for man," etc. In ataxic aphasia the power of *articulation* is completely lost. The person understands fully the word to be used, and makes vigorous effort to use it, but is unable to do so. Sometimes articulation is half destroyed, so that the first part of the word can be spoken, but not the other. Sometimes automatic phrases can be uttered, such as yes and no, while it is perfectly clear that these exclamations do not satisfy the person. Another form of this general trouble is agraphia, or the inability to express ideas in writing; this is frequently complete, and all attempts at writing end in a scrawl. It is noticeable that aphasia is sometimes, though seldom, unaccompanied by insanity. As early as 1861 Broca, in Paris, expressed the opinion that aphasia was connected with disease in the third frontal convolution. While a large number of cases have been cited for and against this conclusion, many pathologists are disposed to regard it as substantially correct. It would seem just, then, to connect these central functions which are concerned in speech with the peculiarly developed region of the human brain that lies on the anterior and lower limit of the Sylvian fissure; Wundt adds that perhaps the Island of Reil should be joined to this territory.

We are now brought to consider directly the relation of portions of the brain to specific states of consciousness. I shall state the location of the senses as formerly made by Ferrier and by Munk, and will give a specimen experiment from each investigator. Sight is located by Ferrier in the angular gyrus (A, Fig. 1), by Munk in the occipital lobe (O, Fig. 1); hearing, by both, in the temporo-sphenoidal lobe (H, Fig. 1). Ferrier places smell and taste in the lower and inner aspect of the temporo-sphenoidal lobe (U, Fig. 4). These centers are not distinguished by Munk. Ferrier names also a tactile center (H, Fig. 4). This he locates in what is known as the hippocampal region. If we separate the hemispheres from one another by cutting through the corpus callosum, we shall obtain a view of the median aspect of the hemispheres (see Fig. 4).

Attention has been called to the fact that Munk disagrees with all

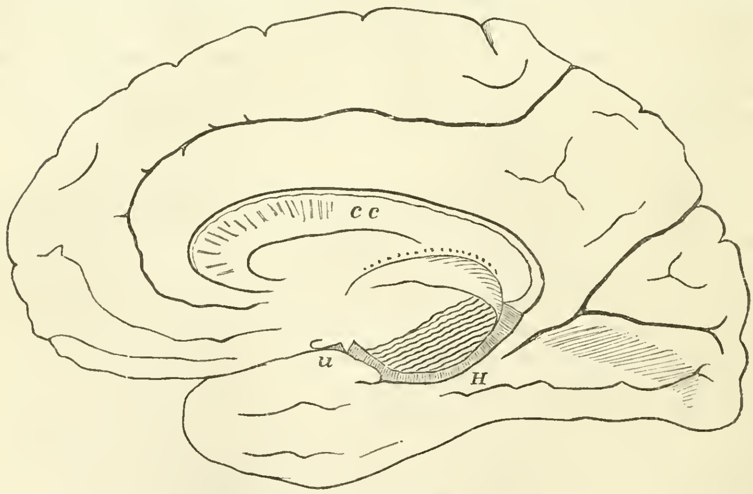


Fig 4.—Median View of Right Hemisphere of Human Brain. (Ecker.) *c c*, Corpus callosum, connecting band between the hemispheres, longitudinally divided; *u*, lower and inner portion of temporo-sphenoidal lobe, center of smell, according to Ferrier; *H*, hippocampal fold, touch.

the authorities, except Schiff, in maintaining that a destruction of the motor centers destroys sensibility. Munk, therefore, does not indicate a special tactile center, but finds centers of feeling for head, neck, and back.

Ferrier's experiment with regard to vision was as follows: He chloroformed the animal, a monkey, and destroyed the angular gyrus on the left hemisphere. He bandaged the left eye, and allowed the animal to recover from the chloroform. "Upon recovery it began to grope about a little *in loco*, perfectly alert, but would not move from its position; hearing and the other senses were not affected, for there was always a prompt reply to stimulation of these senses." The animal remained in this position for an hour. The bandage was then removed from the left eye. "It instantly looked around, ran quickly to the cage and joined its companions. When brought to the light, as before, it flinched and turned away its head." Ferrier describes the change in the animal's manner, after removal of the bandage, as most complete and remarkable. On the following day the left eye was again bandaged, but "the animal gave plain signs of vision, it ran swiftly and accurately to the bars of the cage, thrust its head between them, and began to drink from a cup of water." In his next experiment Ferrier destroyed the angular gyrus on both hemispheres. He found great difficulty in forming a right test for vision, one which should discriminate between sight as a state of consciousness and simple reflex reaction to visual stimulation.

The animal sat perfectly still and would not move from its position. "The pupils contracted to light, and light flashed in the eyes caused the animal to wince." It was utterly unwilling to move from its place; nothing else showed lack of vision. Ferrier's test was a cup of tea, which the animal liked very much. Ferrier placed the tea to the monkey's lips; it began at once to drink eagerly. The cup was then removed, but barely removed, from contact with the lips. "The monkey seemed intensely anxious to drink, but could not find the tea, though both eyes were looking straight at it." As soon as contact was established, the monkey buried his head in the cup and followed it around the room, as the cup was slowly lowered.

Munk's experiments on vision led him to different results. He removed the entire angular gyrus from the left hemisphere; he then raised the lids of the *left* eye with his fingers and touched parts of the eye softly; immediately there were blinking and vigorous movement of the head and muscles of the eye. The animal made every effort to draw back its head, and almost always accompanied these efforts by striking with the left front-limb. With the *right* eye, however, the case was entirely different. This eye could be pressed and pinched constantly, and the animal remained perfectly quiet.

If the finger or hand was brought suddenly up close to the left eye there was blinking; if to the right eye, no blinking at all resulted, unless the lids were actually touched. Munk removed the center, marked O, Fig. 1, from the occipital lobe in both hemispheres. He says: "In from three to five days after the operation there was nothing abnormal in the hearing, smell, taste, movements, or *sensations* of the animal, only in the territory of sight was there any peculiar disturbance. The animal moved about the room or garden with perfect freedom, he did not strike against any object, and if things were put in his way he uniformly avoided them. There was, however, a striking difference. He regarded very coldly those men whom he used to greet most affectionately. He was indifferent to the dogs he always played with before. However hungry and thirsty he was, he did not go to the corner of the room where his food was, as formerly; and, if food and water were placed directly in his path, he would go round and round them without noticing them at all. The sight of the whip, which used to drive him into the corner, did not now produce the slightest effect. He used to raise his paw when your hand was moved before his eyes; now he will not lift it, however much the hand is moved."

From these and similar facts, Munk draws a conclusion which, to say the least, seems a trifle broader than the premises. He says: "There can be no doubt about the meaning of these observations. By the extirpation of this portion of the brain, the dog has become *soul-blind.* He has lost the sight-perceptions which he once possessed; his *recollection-images* of things seen before are gone, so that he can not recognize what he sees—*still he sees;* sensations of sight come to his consciousness, so that he receives a knowledge of the existence, form, and position of external objects, but he does not know what these mean—*this* knowledge must be learned anew. The dog has been set back to his earliest years, to the time when he first opened his eyes; he must learn to see."

As removal of this part of the occipital lobe causes soul-blindness, so a removal of a portion of the temporo-sphenoidal lobe causes soul-deafness.

Until lately the defenders of localization seemed to be justified in believing that something had been established as to a motor area of the brain; they might well feel, also, that a beginning had been made toward connecting certain parts of the cortex with specific sensations and might hope that further experiment would remove, in considerable degree, the present disagreements. The doctrine of localization, both as a whole and in detail, has, however, received a severe blow at the hands of Professor Goltz, of Strasburg. In 1876 this distinguished experimenter began the publication of a series of papers in "Pflüger's Archiv für die gesammte Physiologie." In September, 1881, this series was finished and published by itself. Professor Goltz fearlessly declares that he has overthrown *all* the conclusions about division of the brain into motor and sensory areas, and brought back our knowledge of brain-function to the old view of Flourens, viz., that the cerebrum is one organ, having one function throughout. Professor Goltz's experiments were confined entirely to dogs, and their chief significance is due to the fact that he was able to keep the animal alive after removal of larger masses of the cerebrum than any other experimenter. These experiments seem to have been abundant and thorough. As a result of them, Professor Goltz concludes that the degree of the disturbance of function from destruction of brain-substance depends upon the *quantity* removed, not upon the location of the lesion. He says, most positively, that "no extirpation of the motor centers, or of any other portion of gray matter, could cause permanent paralysis to any muscle in the body." His emphasis is upon the word permanent. Very many of the effects insisted on by advocates of localization did follow these brain-lesions, but the effects were not lasting, and they did not depend upon removal of specific portions of the substance. Blindness follows destruction of the angular gyrus, but it is temporary; the animal will see again in time. Professor Goltz admits a compensation of brain-functions, so that remaining portions of the organ may take up the work of a part destroyed; but this is not at all the compensation talked of by the supporters of localization. Their compensation requires that the additional work shall be done by the corresponding part in the other hemisphere. Professor Goltz destroys the angular gyrus on *both* sides and still his dog sees. Professor Goltz believes, however, that there are some permanent disturbances resulting from brain-lesions, such as "a certain dullness in the sensation of touch, a diminished power of vision, everything appearing cloudy to the eye, and some awkwardness in the movements." It will disturb the opponents of vivisection to know that Professor Goltz sacrificed fifty-one dogs in attempting to determine the effects of lesion in *both* hemispheres. He found that what happened only to one side of the body, and that the opposite, if one hemisphere was dealt with, happened on both sides of the body if both cerebral masses were affected. *In all these cases mental weakness increased with the increasing quantity of matter removed.* When considerable portions were taken away on both sides, the dog presented a demented appearance, very plain to be recognized. He could walk, run, see, hear, smell, and taste, but he was imbecile in all these activities.

It was not to be supposed that so fierce an attack upon localization would go unchallenged. Professor Goltz certainly did not shrink from the demand to make good his assertions. He took up basket and dog and journeyed from Strasburg to London. Here, in 1881, he came before the physiological section of the International Medical Congress, opened his basket, and, taking out the dog, placed him over against the almost equally celebrated monkey of Professor Ferrier. The dog walked, ran, saw, heard, tasted, and smelt; this was as his master desired, yet he should not have behaved so, for he had lost almost all the centers for these respective functions. Large territories in both hemispheres were gone. He was clearly weak-minded, but, on the whole, he was not the kind of dog believed in by the advocates of localization. Professor Yeo even went so far as to say before the section, "I candidly admit that, should the entire of the so-called motor centers prove to be destroyed in this case, Professor Goltz has succeeded in completely changing my views on cerebral localization."

After the dog there was the monkey. Professor Ferrier introduced him. He had lost the motor zone in the left hemisphere seven months previously. Of him Professor Ferrier said: "As to any independent volitional action of the right arm and leg we have not seen a single indication since the operation was made. The animal is, in every other respect, perfectly well, and as to its tactile sensibility there is not the slightest sign of impairment." It is pleasing to know that, as the dog had been faithful to his master, so the monkey was true to his friend; he displayed the proper amount of paralysis on the opposite side of the body. In this connection Dr. Ireland's words are suggested. He says, "It is to be hoped, in the interest of the martyrs of cerebral physiology, that definite results will be attained as quickly and with as little suffering as possible."

Whatever may or may not be accomplished in finding definite centers of the brain for special movements and sensations, one thing stands fast—the cerebral hemispheres are the sole organs of the higher intellectual manifestations. From the time of Flourens, experiment has again and again shown that complete removal of the hemispheres is followed by stupor. All that resembles intellect disappears—spontaneous volition is gone. The animal remains buried in the profoundest repose. He originates no action. A low form of sensation and a low form of volition may remain. The animal when pinched gives evidence of pain; when set in motion, continues the motion till stopped by external hindrances. A frog deprived of the cerebrum and thrown into the water will swim until land is reached; a pigeon thrown into the air will fly until stopped by an obstacle or by exhaustion. It is to be particularly observed that the motions of these animals are strictly *normal*, i. e., pure motions; they are no longer connected with the higher power that once controlled them. They continue because they must continue.

A writer in the "Journal of Anatomy," of Paris, 1870–'71, gives a clear account of this matter. He says: "As a summary, alike in the inferior and superior animals, the removal of the hemispheres does not cause to disappear any of the movements that previously existed, but these movements assume certain peculiar characters. They are *regular*, for no psychical influence intervenes to modify them. They take place inevitably after excitation. The physiologist can, at will, in an animal deprived of the brain, determine such and such an act, limit it, arrest it. He can predict all the movements that will take place as certainly as a chemist knows in advance the reaction he will obtain from mixing certain bodies.

Pathology confirms our conclusion respecting these higher functions of the cerebrum. Loss of cerebral substance, in man, is followed by a weakening of the intellectual powers. They make a very childish mistake who attempt to deal with the physiological materialism of our day by citing the American crow-bar case, or any number of cases of brain-loss unaccompanied by marked intellectual enfeeblement. It is equally puerile to cite instances of small brains with great intellectual power. In the first place, these small brains may be of superior quality, as small muscles often are; or, in the second place, the boasted greatness of mind may be anything and everything but greatness of mind. Learning of a very extensive kind may coexist with small mental caliber. A monkey is shrewd and quick, and cunning and smart—a parrot is learned, up in a variety of languages, speaking, as many human parrots do, some French, some Italian, some Spanish: there is no great-mindedness here.

Proof from size of the brain is, on the whole, reliable. There is, in general, a remarkable decrease in weight corresponding to the intellectual enfeeblement. Many idiots between the ages of sixteen, forty, and fifty years, have shown brains weighing $19\frac{3}{4}$, $25\frac{3}{4}$, and $22\frac{1}{2}$ ounces. There is on record the case of a deaf-mute idiot, forty-three years old, who showed an idiocy of the lowest kind, yet his brain weighed over forty-eight ounces. Such cases are not to overthrow an induction based upon a large majority of opposing instances.

It remains for the succeeding paper to consider the question propounded by the physiology of to-day, respecting the *kind* of relation which holds between the brain and consciousness. If we were to accept the judgment of the younger leading physicians, we should believe that modern Physiology had answered her own question. A distinguished physician of my city says, in his published "Lectures on Physiology": "The *so-called* voluntary movements are only the *final* responses to impressions made upon the special senses at the time or in the past. The highest expressions of the intellect of man may be resolved into the more perfect transmutations of outside forces, by machinery made more perfect by original constitution or by labor."

Without believing that such a correlation between brain and consciousness as is here asserted can be rationally accepted, there are, as I think, two general conclusions which may be drawn with certainty:

A constant relation obtains between nerve-matter and those manifestations which are usually said to belong to the soul. This relation is so important, so constant, as to determine in large measure the intellectual and moral well-being of every individual.

The origination of our states of consciousness, their character and conduct, are conditioned by physical processes antecedently occurring in the brain.

ARCTIC EXPLORATION AND ITS OBJECT.

By Dr. FRANZ BOAS.

THE severe sufferings of the last Arctic expeditions, and the losses of life and property they occasioned, have depressed the public mind in regard to Arctic explorations. Great hopes have given way to the conviction of the impossibility of penetrating the ice-bound seas and accomplishing the task which formerly seemed easy. The effect of these failures is even more profound than we could anticipate; for scientists themselves, and other men of intelligence and influence, now doubt if Arctic expeditions could be of any use either for mankind or for science. And the public mind to-day is so thoroughly imbued with these ideas, that it is necessary for every geographer to combat them with all his power.

We may be allowed to pass by the objections of men who measure the advantage of every study and of every enterprise by their influence on commercial welfare. The scientist's objections are those we wish to refute. Many do not consider the discovery of new lands and new seas a task worthy a life's work, as they do not consider it a benefit for science—for *their* science, which is the deduction of laws from facts. They do not regard the composition of the wonderful picture of the world, as Humboldt tried to delineate in his "Cosmos" a science equal in its worth to the one which abstracts physical laws that govern matter in the worlds as well as in the atoms. However, cosmography, the study of the world and its development, is not at all inferior to physics, the study of its laws.

Geography is one of the branches of science which represent the world as we see it to-day, and as it is developed into its present state. In its method and subject it is related to astronomy and history. Its domain is the study of the surface of our planet, as it has been developed by the physical action of land, atmosphere, and water, as well as by the relations between land and the organisms which live on it. Regarding geography thus in its proper place in the system of sciences, we can not be allowed to consider any one of its objects as of no consequence and not worthy of being pursued with the same perseverance as those of physics, of astronomy, or natural history. In every branch of science the connection between the phenomena and processes, and the reasons for their distribution in space and time, can only be understood by the most thorough and detailed investigation.

If it be granted that every fact added to our knowledge is of value for science, not by itself, but by connecting other facts already known, there is no reason for excluding geographical researches from this principle, or to consider discoveries of unknown regions as trifling.

For the scientist it is not the benefit of commerce which makes the importance of geographical exploration, it is the new material added to our stock of knowledge which enables us to make new comparisons and to reach a more thorough understanding of the world. If we intend to prove the necessity of new polar explorations, we do not need to dwell upon the many observations which are connected with Arctic research. If we should enter more closely into the meteorological and hydrographical or the magnetical problems which may be understood better by researches in regions near the pole; if we should try to demonstrate the immense importance of those questions for the meteorology of our own regions, and for the hydrography of the navigable ocean, or for the closer investigation of terrestrial magnetism which is necessary for the purposes of navigation, we should leave the stand-point we try to maintain here—the principle that we are not allowed to judge the value of scientific work by its immediate importance for science and life, but by its value for science itself.

The effort has often been made to prove the necessity of continued polar exploration after the failure of so many attempts and the loss of so many brave lives, but the reasons brought forth were always those referring to the probable utility of new undertakings. It is not the proper way to defend a scientific work to point out the direct advantages which may be gained by it. Science itself has the right to ask any devotion of man for its purposes. A dangerous enterprise made in behalf of science does not need any proof of its usefulness, if it is possible to show that the results will indeed be a gain to the stock of our knowledge.

If we agree that cosmography be equal in value to physics, or even if we only understand that progress in physics can not be made except by exploring the phenomena in the most minute and detailed way, we have to concede that new explorations in the Arctic regions are of value for science, and that, therefore, they are undoubtedly necessary and must be demanded.

At the same time let us ask, What is the object of polar expeditions? It is the thorough exploration of the Arctic region and of all its phenomena, a great task which will give scientists work for years to come. The problems will not be solved by pushing north and gaining the pole. There are many more objects of study left besides, and it is not necessary at all to work with all our might for the achievement of this single aim. The desires of humanity and the wants of science both direct us the same way. The phenomena of the highest latitudes are not of a kind which requires the promptest attention. Though the reaching of the pole may be desirable, it is not so urgent as to demand the sacrifice of noble lives in hazardous and adventurous enterprises which might be accomplished with relative safety at a later time. If the problems awaiting their solution in the Arctic were as pressing as those of ethnography, any attempt to reach the pole would be justified. Physical phenomena, however, are not so subject to change as those of ethnography. Unknown tribes may be extinguished, or affected by the direct or indirect influence of civilization. The outlines of lands, the state of the weather and the sea, will not undergo alterations in the course of a few years.

Therefore we can not see any reason why polar expeditions should be sent out only in order to reach the pole. The history of former expeditions proves that the most successful results were obtained by making ample use of the experience gained in former voyages, and that most of the failures were due to ignorance of previous observations, or to the careless neglect of previous experiences. If new expeditions should be organized—and they will be organized—we shall always plead for a slow but sure progress toward the pole. From the experience gained hitherto, we are able to start at a point far north, and by studying the distribution of the land and the state of the ice yet farther north, we can conquer step by step the region hitherto unknown with comparative safety. The exploration of the pole is not a work for the bold and daring adventurer; it is the task of the careful scientist, who knows thoroughly what science will profit by every mile gained, by the study of all the phenomena of regions often passed by ships or never visited by man.

The results of a single expedition, however lucky it may be, will always be trifling as compared with the number of problems which have to be solved in the Arctic. It is quite possible that by favorable circumstances an expedition might succeed in getting far north, or discovering large areas of the unknown regions, as has happened in former years. However, the risk which the adventurers run can not be compared with the probable results. By deliberate perseverance, though the progress may be slower, the exploration of the Arctic will be accomplished in greater safety and with far greater results for science.

We wish to establish here the principle that, in the present state of affairs, daring and adventurous explorations have to be excluded from a plan of Arctic researches which is founded on scientific principles. This is not the place to determine the course which new expeditions have to take, as the discussion of this subject is not the affair of the public but of experts, who know thoroughly the phenomena of the Arctic seas and are conversant with the whole of Arctic literature. Whatever the new plans may be, the public and men of science must ask that the plan be not confined to a single expedition. The best results will be gained by considering the exploration of the polar regions as one continuous task, and fitting every new expedition into the far-seeing scheme of a thorough investigation of all the problems subject to Arctic researches. In this way we have the strong conviction that important results will be gained quicker than by spasmodic efforts now in Greenland, now in Behring Strait, now in Franz-Josef

Land. There can be no doubt that such a plan will be expensive, and not so apt to produce stirring results as any other ; however, it is not the purpose of the outgoing explorers to become sufferers and enduring heroes, but to bring home results which are important for their science. The meteorological stations which were established in 1882–'83 were the first step to the organization of an enterprise like that we demand, and their results will show the utility of well-founded plans.

Hitherto I have only referred to the exploration of the unknown region never visited by men. There is more work left, however, which has to be included in a comprehensive plan of research. The southern parts of the Arctic regions—for example, the east shore of Greenland, many of the immense fjords of its west shore, Baffin Land, and the central parts of the north shore of America—are barely delineated. If we look at the charts, we might be induced to believe that most of these lands are sufficiently known, while, indeed, every new journey discloses the deficiency of our knowledge. These countries, which may be reached without serious difficulties, are the proper place for investigations of great importance, and the exploration of these parts of the Arctic is even more urgent than that of the far north, as the study of the numerous tribes which live on the shore of the Arctic Ocean has to be accomplished very soon ; else the rapid diminution of those peoples and the influence of European civilization will deprive the ethnographer of anything to study but their moldering remains.

It is easily understood why, after the northwest passage was found, no new researches in this part of the world were made. Many of the explorers, or those who planned the expeditions, were often more anxious to find sensational results than to further science. Polar exploration is now mostly considered merely the ambitious struggle of expeditions to get a few miles farther north than all the former explorers. We have tried to prove, in our remarks, that its aim is much nobler, and worth all the sacrifices which are brought to it.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

L.—THE VEGETARIAN QUESTION.

IN my introductory paper I said, "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 to be as easily assimilated as the prepared grass which we call beef and mutton."

This has brought me in communication with a very earnest body of men and women, who at considerable social inconvenience are abstaining from flesh-food, and doing it purely on principle. Some people sneer at them, call them, "crotchety," "faddy," etc., but for my own part I have a great respect for crotchety people, having learned long ago that every first great step that has ever been taken in the path of human progress was denounced as a crotchet by those it was leaving behind. This respect is quite apart from the consideration of whether I agree or disagree with the crotchets themselves.

I therefore willingly respond to the request that I should devote one short paper of this series to the subject. The fact that there are now in London nine exclusively vegetarian restaurants, and all of them flourishing, shows that it is one of wide interest.

At the outset it is necessary to brush aside certain false issues that are commonly raised in discussing this subject. The question is not whether we are herbivorous or carnivorous animals. It is perfectly certain that we are neither. The carnivora feed on flesh *alone*, and eat that flesh raw. Nobody proposes that we should do this. The herbivora eat raw grass. Nobody suggests that we should follow *their* example.

It is perfectly clear that man can not be classed either with the carnivorous animals nor the herbivorous animals, nor with the graminivorous animals. His teeth are not constructed for munching and grinding raw grain, nor his digestive organs for assimilating such grain in this condition.

He is not even to be classed with the omnivorous animals. He stands apart from all as The Cooking Animal.

It is true that there was a time when our ancestors ate raw flesh, including that of each other.

In the limestone caverns of this and other European countries we find human bones gnawed by human teeth, and split open by flint implements for the evident purpose of extracting the marrow, according to the domestic economy of the period.

The shell-mounds that these prehistoric bipeds have left behind show that mussels, oysters, and other mollusca were also eaten raw, and they doubtless varied the *menu* with snails, slugs, and worms, as the remaining Australian savages still do. Besides these they probably included roots, succulent plants, nuts, and such fruit as then existed.

There are many among us who are very proud of their ancient lineage, and who think it honorable to go back as far as possible, and to maintain the customs of their forefathers; but they all seem to draw a line somewhere, none desiring to go as far back as to their interglacial trogloditic ancestors, and therefore I need not discuss the desirability of restoring their dietary.

All human beings became cooks as soon as they learned how to make a fire, and have all continued to be cooks ever since.

We should, therefore, look at this vegetarian question from the point of view of prepared food, which excludes nearly all comparison with the food of the brute creation. I say "nearly all," because there is one case in which all the animals that approach the nearest to ourselves—the mammalia—are provided naturally with a specially prepared food, viz., the mother's milk. The composition of this preparation appears to me to throw more light than anything else upon this vegetarian controversy, and yet it seems to have been entirely overlooked.

The milk prepared for the young of the different animals in the laboratory or kitchen of Nature is surely adapted to their structure as regards natural food requirements. Without assuming that the human dietetic requirements are identical with either of the other mammals, we may learn something concerning our approximation to one class or another by comparing the composition of human milk with that of the animals in question.

I find ready to hand in Dr. Miller's "Chemistry," Vol. III., a comparative statement of the mean of several analyses of the milk of woman, cow, goat, ass, sheep, and bitch. The latter is a moderately carnivorous animal, nearly approaching the omnivorous character commonly ascribed to man. The following is the statement :

	Woman.	Cow.	Goat.	Ass.	Sheep.	Bitch.
Water	88·6	87·4	82·0	90·5	85·6	66·3
Fat	2·6	4·0	4·5	1·4	4·5	14·8
Sugar and soluble salts	4·9	5·0	4·5	6·4	4·2	2·9
Nitrogenous compounds and insoluble salts	3·9	3·6	9·0	1·7	5·7	16·0

According to this it is quite evident that Nature regards our food requirements as approaching much nearer to the herbivora than to the carnivora, and has provided for us accordingly.

If we are to begin the building-up of our bodies on a food more nearly resembling the herbivora than the carnivora, it is only reasonable to assume that we should continue on the same principle.

The particulars of the difference are instructive. The food which Nature provides for the human infant differs from that provided for the young carnivorous animal, just in the same way as flesh-food differs from the cultivated and cooked vegetables and fruit within easy reach of man.

These contain less fat, less nitrogenous matter, more water, and more sugar (or starch, which becomes sugar during digestion) than animal food.

Those who advocate the use of flesh-food usually do so on the ground that it it is more nutritious, contains more nitrogenous material and more fat than vegetable food. So much the worse for the human being, says Nature, when *she* prepares food.

But as a matter of practical fact there are no flesh-eaters among us, none who avail themselves of this higher proportion of albuminoids and fat. We all practically admit every day, in eating our ordinary English dinner, that this excess of nitrogenous matter and fat is bad; we do so by mixing the meat with that particular vegetable which contains an excess of the carbo-hydrates (starch) with the smallest available quantity of albuminoids and fat. The slice of meat, diluted with the lump of potato, brings the whole down to about the average composition of a fairly-arranged vegetarian repast. When I speak of a vegetarian repast, I do not mean mere cabbages and potatoes, but properly selected, well-cooked, nutritious vegetable food. As an example, I will take Count Rumford's No. 1 soup, already described, without the bread, and in like manner take beef and potatoes without bread. Taking original weights, and assuming that the lump of potato weighed the same as the slice of meat, we get the following composition, according to the table given by Pavy, page 410:

	Water.	Albumen.	Starch.	Sugar.	Fat.	Salts.
Lean beef	72·00	19·30	....	....	3·60	5·10
Potatoes	75·00	2·10	18·80	3·20	0·20	0·70
	147·00	21·40	18·80	3·20	3·80	5·80
Mean composition of mixture	73·50	10·70	9·40	1·60	1·90	2·90

Rumford's soup (without the bread afterward added) was composed of equal measures of peas and pearl-barley, or barley-meal, and nearly equal weights. Their percentage composition as stated in above-named table is as follows:

	Water.	Albumen.	Starch.	Sugar.	Fat.	Salts.
Peas	15·00	23·00	55·40	2·00	2·10	2·50
Barley-meal	15·00	6·30	69·40	4·90	2·40	2·00
	30·00	29·30	134·80	6·90	4·50	4·50
Mean composition of mixture	15·00	14·65	62·40	3·45	2·25	2·25

Here, then, in one hundred parts of the material of Rumford's halfpenny dinner, as compared with the "mixed diet," we have forty per cent more of nitrogenous food, more than six and a half times as much carbo-hydrate in the form of starch, more than double the quantity of sugar, about seventeen per cent more of fat, and only a little less of salts (supplied by the salt which Rumford added). Thus the John Bull materials fall short of all the costly constituents, and only excel by their abundance of very cheap water.

This analysis supplies the explanation of what has puzzled many inquirers, and encouraged some sneerers at this work of the great scientific philanthropist, viz., that he found that less than five ounces of solids was sufficient for each man's dinner. He was supplying far more nutritious material than beef and potatoes, and therefore his five ounces was more satisfactory than a pound of beef and potatoes, three fourths of which is water, for which water John Bull pays a shilling or more per pound when he buys his prime steak.

Rumford added the water at pump-cost, and, by long boiling, caused some of it to unite with the solid materials (by the hydration I have described), and then served the combination in the form of porridge, raising each portion to nineteen and three quarters ounces.

I might multiply such examples to prove the fallacy of the prevailing notions concerning the nutritive value of the "mixed diet," a fallacy which is merely an inherited epidemic, a baseless physical superstition.

I will, however, just add one more example for comparison—viz., the Highlander's porridge. The following is the composition of oatmeal—also from Pavy's table :

Water	15·00	Sugar	5·40
Albumen	12·60	Fat	5·60
Starch	58·40	Salts	3·00

Compare this with the beef and potatoes above, and it will be seen that it is *superior in every item excepting the water.* This deficiency is readily supplied in the cookery.

These figures explain a puzzle that may have suggested itself to some of my thoughtful readers—viz., the smallness of the quantity of dry oatmeal that is used in making a large portion of porridge. If we could, in like manner, see our portion of beef or mutton and potatoes reduced to dryness, the smallness of the quantity of actually solid food required for a meal would be similarly manifest. An alderman's banquet in this condition would barely fill a breakfast-cup.

I can not at all agree with those of my vegetarian friends who denounce flesh-meat as a prolific source of disease, as inflaming the passions, and generally demoralizing. Neither am I at all disposed to make a religion of either eating or drinking, or abstaining. There are certain albuminoids, certain carbo-hydrates, certain hydrocarbons, and certain salts demanded for our sustenance. Excepting in fruit, these are not supplied by Nature in a fit condition for *our* use. They must be prepared. Whether we do *all* the preparation in the kitchen by bringing the produce of the earth directly there, or whether, on account of our ignorance and incapacity as cooks, we pass our food through the stomach, intestines, blood-vessels, etc., of sheep and oxen, as a substitute for the first stages of scientific cookery, the result is about the same as regards the dietetic result. Flesh-feeding is a nasty practice, but I see no grounds for denouncing it as physiologically injurious.

In my youthful days I was on friendly terms with a sheep that belonged to a butcher in Jermyn Street. This animal, for some reason, had been spared in its lambhood, and was reared as the butcher's pet. It was well known in St. James's by following the butcher's men through the streets like a dog. I have seen this sheep steal mutton-chops and devour them raw. It preferred beef or mutton to grass. It enjoyed robust health, and was by no means ferocious.

It was merely a disgusting animal, with excessively perverted appetite; a perversion that supplies very suggestive material for human meditation.

My own experiments on myself, and the multitude of other experiments that I am daily witnessing among men of all occupations who have cast aside flesh-food after many years of mixed diet, prove incontestably that flesh-food is quite unnecessary; and also that men and women who emulate the aforesaid sheep to the mild extent of consuming daily about two ounces of animal tissue combined with six ounces of water, and dilute this with such weak vegetable food as the potato, are not measurably altered thereby so far as physical health is concerned.

On economical grounds, however, the difference is enormous. If all Englishmen were vegetarians, the whole aspect of the country would be changed. It would be a land of gardens and orchards, instead of gradually reverting to prairie grazing-ground as at present. The unemployed miserables of our great towns, the inhabitants of our union workhouses, and all our rogues and vagabonds, would find ample and suitable employment in agriculture. Every acre of land would require three or four times as much labor as at present, and feed five or six times as many people.

No sentimental exaggeration is demanded for the recommendation of such a reform as this.

I must apologize for this digression, as it has prevented me from closing this series with this paper, as I intended. In my next, which really will conclude, I shall describe some experiments I have recently made on the preparation of vegetable food.—*Knowledge.*

PASTEUR'S RESEARCHES IN GERM-LIFE.*

By Professor JOHN TYNDALL.

THE weightiest events of life sometimes turn upon small hinges; and we now come to the incident which caused M. Pasteur to quit a line of research the abandonment of which he still regrets. A German manufacturer of chemicals had noticed that the impure com-

* From the Introduction to "Louis Pasteur, his Life and Labors." By his Son-in-Law. New York: D. Appleton & Co., 1885.

mercial tartrate of lime, sullied with organic matters of various kinds, fermented on being dissolved in water and exposed to summer heat. Thus prompted, Pasteur prepared some pure, right-handed tartrate of ammonia, mixed with it albuminous matter, and found that the mixture fermented. His solution, limpid at first, became turbid, and the turbidity he found to be due to the multiplication of a microscopic organism, which found in the liquid its proper aliment. Pasteur recognized in this little organism a *living ferment.* This bold conclusion was doubtless strengthened, if not prompted, by the previous discovery of the yeast-plant—the alcoholic ferment—by Cagniard-Latour and Schwann.

Pasteur next permitted his little organism to take the carbon necessary for its growth from the pure paratartrate of ammonia. Owing to the opposition of its two classes of crystals, a solution of this salt, it will be remembered, does not turn the plane of polarized light either to the right or to the left. Soon after fermentation had set in, a rotation to the left was noticed, proving that the equilibrium previously existing between the two classes of crystals had ceased. The rotation reached a maximum, after which it was found that all the right-handed tartrate had disappeared from the liquid. The organism thus proved itself competent to select its own food. It found, as it were, one of the tartrates more digestible than the other, and appropriated it, to the neglect of the other. No difference of chemical constitution determined its choice ; for the elements, and the proportions of the elements, in the two tartrates were identical. But the peculiarity of structure which enabled the substance to rotate the plane of polarization to the right also rendered it a fit aliment for the organism. This most remarkable experiment was successfully made with the seeds of our common mold (*Penicillium glaucum*).

Here we find Pasteur unexpectedly landed amid the phenomena of fermentation. With true scientific instinct he closed with the conception that ferments are, in all cases, living things, and that the substances formerly regarded as ferments are in reality the food of the ferments. Touched by this wand, difficulties fell rapidly before him. He proved the ferment of lactic acid to be an organism of a certain kind. The ferment of butyric acid he proved to be an organism of a different kind. He was soon led to the fundamental conclusion that the capacity of an organism to act as a ferment depended on its power to live without air. The fermentation of beer was sufficient to suggest this idea. The yeast-plant, like many others, can live either with or without free air. It flourishes best in contact with free air, for it is then spared the labor of wresting from the malt the oxygen required for its sustenance. Supplied with free air, however, it practically ceases to be a ferment ; while in the brewing-vat, where the work of fermentation is active, the budding *torula* is completely cut off by the sides of the vessel, and by a deep layer of carbonic-acid gas, from all contact with air. The butyric ferment not only lives without air, but Pasteur showed that air is fatal to it. He finally divided microscopic organisms into two great classes, which he named respectively *ærobies* and *anærobies*, the former requiring free oxygen to maintain life, the latter capable of living without free oxygen, but able to wrest this element from its combinations with other elements. This destruction of pre-existing compounds and formation of new ones, caused by the increase and multiplication of the organism, constitute the process of fermentation.

Under this head are also rightly ranked the phenomena of putrefaction. As M. Radot well expresses it, the fermentation of sugar may be described as the putrefaction of sugar. In this particular field M. Pasteur, whose contributions to the subject are of the highest value, was preceded by Schwann, a man of great merit, of whom the world has heard too little.* Schwann placed decoctions of meat in flasks, sterilized the decoctions by boiling, and then supplied them with calcined air, the power of which to support life he showed to be unimpaired. Under these circumstances putrefaction never set in. Hence the conclusion of Schwann, that putrefaction was not due to the contact of air, as affirmed by Gay-Lussac, but to something suspended in the air which heat was able to destroy. This something consists of living organisms which nourish themselves at the expense of the organic substance, and cause its putrefaction.

The grasp of Pasteur on this class of subjects was embracing. He studied acetic fermentation, and found it to be the work of a minute fungus, the *mycoderma aceti*, which, requiring free oxygen for its nutrition, overspreads the surface of the fermenting liquid. By the alcoholic ferment the sugar of the grape-juice is transformed into carbonic-acid gas and alcohol, the former exhaling, the latter remaining in the wine. By the *mycoderma aceti*, the wine is, in its turn, converted into vinegar. Of the experiments made in connection with this subject one deserves especial mention. It is that in which Pasteur suppressed all albuminous matters, and carried on the fermentation with purely crystallizable substances. He studied the deterioration of vinegar, revealed its cause, and the means of preventing it. He defined the part played by the little eel-like organisms which sometimes swarm in vinegar-casks, and ended by introducing important ameliorations and improvements in the manufacture of vinegar. The discussion with Liebig and other minor discussions of a similar nature, which M. Radot has somewhat strongly emphasized, I will not here dwell upon.

It was impossible for an inquirer like Pasteur to evade the question, Whence come these minute organisms which are demonstrably capable of producing effects on which vast industries are built and on which whole populations depend for occupation and sustenance? He thus found himself face to face with the question of spontaneous genera-

* It was late in the day when the Royal Society made him a foreign member.

tion, to which the researches of Pouchet had just given fresh interest. Trained as Pasteur was in the experimental sciences, he had an immense advantage over Pouchet, whose culture was derived from the sciences of observation. One by one the statements and experiments of Pouchet were explained or overthrown, and the doctrine of spontaneous generation remained discredited until it was revived with ardor, ability, and, for a time, with success, by Dr. Bastian.

A remark of M. Radot's on page 103 needs some qualification. "The great interest of Pasteur's method consists," he says, "in its proving unanswerably that the origin of life in infusions which have been heated to the boiling-point is solely due to the solid particles suspended in the air." This means that living germs can not exist *in the liquid* when once raised to a temperature of 212° Fahr. No doubt a great number of organisms collapse at this temperature; some, indeed, as M. Pasteur has shown, are destroyed at a temperature 90° below the boiling-point. But this is by no means universally the case. The spores of the hay-bacillus, for example, have in numerous instances successfully resisted the boiling temperature for one, two, three, four hours; while in one instance *eight hours'* continuous boiling failed to sterilize an infusion of desiccated hay. The knowledge of this fact caused me a little anxiety some years ago when a meeting was projected between M. Pasteur and Dr. Bastian. For though, in regard to the main question, I knew that the upholder of spontaneous generation could not win, on the particular issue touching the death temperature he might have come off victor.

The manufacture and maladies of wine next occupied Pasteur's attention. He had, in fact, got the key to this whole series of problems, and he knew how to use it. Each of the disorders of wine was traced to its specific organism, which, acting as a ferment, produced substances the reverse of agreeable to the palate. By the simplest of devices, Pasteur, at a stroke, abolished the causes of wine-disease. Fortunately the foreign organisms which, if unchecked, destroy the best red wines, are extremely sensitive to heat. A temperature of 50° C. (122° Fahr.) suffices to kill them. Bottled wines once raised to this temperature, for a single minute, are secured from subsequent deterioration. The wines suffer in no degree from exposure to this temperature. The manner in which Pasteur proved this, by invoking the judgment of the wine-tasters of Paris, is as amusing as it is interesting.

Moved by the entreaty of his master, the illustrious Dumas, Pasteur took up the investigation of the diseases of silk-worms at a time when the silk-husbandry of France was in a state of ruin. In doing so he did not, as might appear, entirely forsake his former line of research. Previous investigators had got so far as to discover vibratory corpuscles in the blood of the diseased worms, and with such corpuscles Pasteur had already made himself intimately acquainted. He was, therefore, to some extent at home in this new investigation. The calamity was appalling, all the efforts made to stay the plague having proved futile. In June, 1865, Pasteur betook himself to the scene of the epidemic, and at once commenced his observations. On the evening of his arrival he had already discovered the corpuscles, and shown them to others. Acquainted as he was with the work of living ferments, his mind was prepared to see in the corpuscles the cause of the epidemic. He followed them through all the phases of the insect's life—through the eggs, through the worm, through the chrysalis, through the moth. He proved that the germ of the malady might be present in the eggs and escape detection. In the worm, also, it might elude microscopic examination. But in the moth it reached a development so distinct as to render its recognition immediate. From healthy moths, healthy eggs were sure to spring; from healthy eggs, healthy worms; from healthy worms, fine cocoons; so that the problem of the restoration to France of its silk-husbandry reduced itself to the separation of the healthy from the unhealthy moths, the rejection of the latter, and the exclusive employment of the eggs of the former. M. Radot describes how this is now done on the largest scale, with the most satisfactory results.

The bearing of this investigation on the parasitic theory of communicable diseases was thus illustrated: Worms were infected by permitting them to feed for a single meal on leaves over which corpusculous matter had been spread; they were infected by inoculation, and it was shown how they infected each other by the wounds and scratches of their own claws. By the association of healthy with diseased worms, the infection was communicated to the former. Infection at a distance was also produced by the wafting of the corpuscles through the air. The various modes in which communicable diseases are diffused among human populations were illustrated by Pasteur's treatmedt of the silk-worms. "It was no hypothetical infected medium—no problematical pythogenic gas—that killed the worms. It was a definite organism."* The disease thus far described is that called *pébrine*, which was the principal scourge at the time. Another formidable malady was also prevalent, called *flacherie*, the cause of which and the mode of dealing with it were also pointed out by Pasteur.

Overstrained by years of labor in this field, Pasteur was smitten with paralysis in October, 1868. But this calamity did not prevent him from making a journey to Alais in January, 1869, for the express purpose of combating the criticisms to which his labors had been subjected. Pasteur is combustible, and contradiction readily stirs him into flame. No scientific man now living has fought so many battles as he. To enable him to render his experiments decisive, the French emperor placed a villa at his disposal near Trieste, where silk-worm

* These words were uttered at a time when the pythogenic theory was more in favor than it is now.

culture had been carried on for some time at a loss. The success here is described as marvelous ; the sale of cocoons giving to the villa a net profit of twenty-six millions of francs.* From the imperial villa M. Pasteur addressed to me a letter, a portion of which I have already published. It may perhaps prove usefully suggestive to our Indian or colonial authorities if I reproduce it here :

"Permettez-moi de terminer ces quelques lignes que je dois dicter, vaincu que je suis par la maladie, en vous faisant observer que vous rendriez service aux colonies de la Grande-Bretagne en répandant la connaissance de ce livre, et des principes que j'établis touchant la maladie des vers à soie. Beaucoup de ces colonies pourraient cultiver le mûrier avec succès, et, en jetant les yeux sur mon ouvrage, vous vous convaincrez aisément qu'il est facile aujourd'hui, nonseulement d'éloigner la maladie régnante, mais en outre de donner aux récoltes de la soie une prospérité qu'elles n'ont jamais eue."

The studies on wine prepare us for the "Studies on Beer," which followed the investigation of silk-worm diseases. The sourness, putridity, and other maladies of beer Pasteur traced to special "ferments of disease," of a totally different form, and therefore easily distinguished from the true *torula* or yeast-plant. Many mysteries of our breweries were cleared up by this inquiry. Without knowing the cause, the brewer not unfrequently incurred heavy losses through the use of bad yeast. Five minutes' examination with the microscope would have revealed to him the cause of the badness, and prevented him from using the yeast. He would have seen the true *torula* overpowered by foreign intruders. The microscope is, I believe, now everywhere in use. At Burton-on-Trent its aid was very soon invoked. At the conclusion of his studies on beer M. Pasteur came to London, where I had the pleasure of conversing with him. Crippled by paralysis, bowed down by the sufferings of France, and anxious about his family at a troubled and an uncertain time, he appeared low in health and depressed in spirits. His robust appearance when he visited London, on the occasion of the Edinburgh Anniversary, was in marked and pleasing contrast with my memory of his aspect at the time to which I have referred.

While these researches were going on, the germ theory of infectious disease was noised abroad. The researches of Pasteur were frequently referred to as bearing upon the subject, though Pasteur himself kept clear for a long time of this special field of inquiry. He was not a physician, and he did not feel called upon to trench upon the physician's domain. And now I would, beg of him to correct me if, at this point of the introduction, I should be betrayed into any statement that is not strictly correct.

In 1876 the eminent microscopist, Professor Cohn, of Breslau, was in London, and he then handed me a number of his "Beiträge," con-

* The work on "Diseases of Silk-worms" was dedicated to the Empress of the French.

taining a memoir by Dr. Koch on splenic fever (*Milzbrand*, *Charbon*, malignant pustule), which seemed to me to mark an epoch in the history of this formidable disease. With admirable patience, skill, and penetration, Koch followed up the life-history of *bacillus anthracis*, the contagium of this fever. At the time here referred to he was a young physician, holding a small appointment in the neighborhood of Breslau, and it was easy to predict, as I predicted at the time, that he would soon find himself in a higher position. When I next heard of him he was head of the Imperial Sanitary Institute of Berlin. Koch's recent history is pretty well known in England, while his appreciation by the German Government is shown by the rewards and honors lately conferred upon him.

Koch was not the discoverer of the parasite of splenic fever. Davaine and Rayer, in 1850, had observed the little microscopic rods in the blood of animals which had died of splenic fever. But they were quite unconscious of the significance of their observation, and for thirteen years, as M. Radot informs us, strangely let the matter drop. In 1863 Davaine's attention was again directed to the subject by the researches of Pasteur, and he then pronounced the parasite to be the cause of the fever. He was opposed by some of his fellow-countrymen ; long discussions followed, and a second period of thirteen years, ending with the publication of Koch's paper, elapsed, before M. Pasteur took up the question. I always, indeed, assumed that from the paper of the learned German came the impulse toward a line of inquiry in which M. Pasteur has achieved such splendid results. Things presenting themselves thus to my mind, M. Radot will, I trust, forgive me if say that it was with very great regret that I perused the disparaging references to Dr. Koch which occur in the chapter on splenic fever.

After Koch's investigation, no doubt could be entertained of the parasitic origin of this disease. It completely cleared up the perplexity previously existing as to the two forms—the one fugitive, the other permanent—in which the contagion presented itself. I may say that it was on the conversion of the permanent hardy form into the fugitive and sensitive one, in the case of *bacillus subtilis* and other organisms, that the method of sterilizing by "discontinuous heating" introduced by me in February, 1877, was founded. The difference between an organism and its spores, in point of durability, had not escaped the penetration of Pasteur. This difference Koch showed to be of paramount inportance in splenic fever. He, moreover, proved that while mice and Guinea-pigs were infallibly killed by the parasite, birds were able to defy it.

And here we come upon what may be called a hand-specimen of the genius of Pasteur, which strikingly illustrates its quality. Why should birds enjoy the immunity established by the experiments of Koch? Here is the answer. The temperature which prohibits the multiplication of *bacillus anthracis* in infusions is 44° C. (111° Fahr.). The temperature of the blood of birds is from 41° to 42° Fahr. It is therefore close to the prohibitory temperature. But then the blood-globules of a living fowl are sure to offer a certain resistance to any attempt to deprive them of their oxygen—a resistance not experienced in an infusion. May not this resistance, added to the high temperature of the fowl, suffice to place it beyond the power of the parasite? Experiment alone could answer this question, and Pasteur made the experiment. By placing its feet in cold water he lowered the temperature of a fowl to 37° or 38° Fahr. He inoculated the fowl, thus chilled, with the splenic-fever parasite, and in twenty-four hours it was dead. The argument was clinched by inoculating a chilled fowl, permitting the fever to come to a head, and then removing the fowl, wrapped in cotton-wool, to a chamber with a temperature of 35° Fahr. The strength of the patient returned as the career of the parasite was brought to an end, and in a few hours health was restored. The sharpness of the reasoning here is only equaled by the conclusiveness of the experiment, which is full of suggestiveness as regards the treatment of fevers in man.

Pasteur had little difficulty in establishing the parasitic origin of fowl-cholera; indeed, the parasite had been observed by others before him. But, by his successive cultivations, he rendered the solution sure. His next step will remain forever memorable in the history of medicine. I allude to what he calls "virus attenuation." And here it may be well to throw out a few remarks in advance. When a tree, or a bundle of wheat or barley straw, is burned, a certain amount of mineral matter remains in the ashes—extremely small in comparison with the bulk of the tree or of the straw, but absolutely essential to its growth. In a soil lacking, or exhausted of, the necessary mineral constituents, the tree can not live, the crop can not grow. Now, contagia are living things, which demand certain elements of life just as inexorably as trees, or wheat, or barley; and it is not difficult to see that a crop of a given parasite may so far use up a constituent existing in small quantities in the body, but essential to the growth of the parasite, as to render the body unfit for the production of a second crop. The soil is exhausted, and, until the lost constituent is restored, the body is protected from any further attack of the same disorder. Such an explanation of non-recurrent diseases naturally presents itself to a thorough believer in the germ theory, and such was the solution which, in reply to a question, I ventured to offer nearly fifteen years ago to an eminent London physician. To exhaust a soil, however, a parasite less vigorous and destructive than the really virulent one may suffice; and, if, after having by means of a feebler organism exhausted the soil, without fatal result, the most highly virulent parasite be introduced into the system, it will prove powerless. This, in the language of the germ theory, is the whole secret of vaccination.

The general problem, of which Jenner's discovery was a particular case, has been grasped by Pasteur, in a manner, and with results, which five short years ago were simply unimaginable. How much "accident" had to do with shaping the course of his inquiries I know not. A mind like his resembles a photographic plate, which is ready to accept and develop luminous impressions, sought and unsought. In the chapter on fowl-cholera is described how Pasteur first obtained his attenuated virus. By successive cultivations of the parasite he showed that, after it had been a hundred times reproduced, it continued to be as virulent as at first. One necessary condition was, however, to be observed. It was essential that the cultures should rapidly succeed each other—that the organism, before its transference to a fresh cultivating liquid, should not be left long in contact with air. When exposed to air for a considerable time the virus becomes so enfeebled that when fowls are inoculated with it, though they sicken for a time, they do not die. But this "attenuated" virus, which M. Radot justly calls "benign," constitutes a sure protection against the virulent virus. It so exhausts the soil that the really fatal contagium fails to find there the elements necessary to its reproduction and multiplication.

Pasteur affirms that it is the oxygen of the air which, by lengthened contact, weakens the virus and converts it into a true vaccine. He has also weakened it by transmission through various animals. It was this form of attenuation that was brought into play in the case of Jenner.

The secret of attenuation had thus become an open one to Pasteur. He laid hold of the murderous virus of splenic fever, and succeeded in rendering it, not only harmless to life, but a sure protection against the virus in its most concentrated form. No man, in my opinion, can work at these subjects so rapidly as Pasteur without falling into errors of detail. But this may occur while his main position remains impregnable. Such a result, for example, as that obtained in presence of so many witnesses at Melun must surely remain an ever-memorable conquest of science. Having prepared his attenuated virus, and proved, by laboratory experiments, its efficacy as a protective vaccine, Pasteur accepted an invitation, from the President of the Society of Agriculture at Melun, to make a public experiment on what might be called an agricultural scale. This act of Pasteur's is, perhaps, the boldest thing recorded in this book. It naturally caused anxiety among his colleagues of the Academy, who feared that he had been rash in closing with the proposal of the president.

But the experiment was made. A flock of sheep was divided into two groups, the members of one group being all vaccinated with the attenuated virus, while those of the other group were left unvaccinated. A number of cows were also subjected to a precisely similar treatment. Fourteen days afterward all the sheep and all the cows, vaccinated and unvaccinated, were inoculated with a very virulent virus ; and three days subsequently more than two hundred persons assembled to witness the result. The "shout of admiration," mentioned by M. Radot, was a natural outburst under the circumstances. Of twenty-five sheep which had not been protected by vaccination, twenty-one were already dead, and the remaining ones were dying. The twenty-five vaccinated sheep, on the contrary, were "in full health and gayety." In the unvaccinated cows intense fever was produced, while the prostration was so great that they were unable to eat. Tumors were also formed at the points of inoculation. In the vaccinated cows no tumors were formed ; they exhibited no fever, nor even an elevation of temperature, while their power of feeding was unimpaired. No wonder that "breeders of cattle overwhelmed Pasteur with applications for vaccine." At the end of 1881 close upon thirty-four thousand animals had been vaccinated, while the number rose in 1883 to nearly five hundred thousand.

M. Pasteur is now exactly sixty-two years of age ; but his energy is unabated. At the end of this volume we are informed that he has already taken up and examined with success, as far as his experiments have reached, the terrible and mysterious disease of rabies or hydrophobia. Those who hold all communicable diseases to be of parasitic origin, include, of course, rabies among the number of those produced and propagated by a living contagium. From his first contact with the disease Pasteur showed his accustomed penetration. If we see a man mad, we at once refer his madness to the state of his brain. It is somewhat singular that in the face of this fact the virus of a mad dog should be referred to the animal's saliva. The saliva is, no doubt, infected, but Pasteur soon proved the real seat and empire of the disorder to be the nervous system.

The parasite of rabies had not been securely isolated when M. Radot finished his task. But last May, at the instance of M. Pasteur, a commission was appointed, by the Minister of Public Instruction in France, to examine and report upon the results which he had up to that time obtained. A preliminary report, issued to appease public impatience, reached me before I quitted Switzerland this year. It inspires the sure and certain hope that, as regards the attenuation of the rabic virus, and the rendering of an animal, by inoculation, proof against attack, the success of M. Pasteur is assured. The commission, though hitherto extremely active, is far from the end of its labors ; but the results obtained so far may be thus summed up :

Of six dogs unprotected by vaccination, three succumbed to the bites of a dog in a furious state of madness.

Of eight unvaccinated dogs, six succumbed to the intravenous inoculation of rabic matter.

Of five unvaccinated dogs, all succumbed to inoculation, by trepanning, of the brain.

Finally, of three-and-twenty vaccinated dogs, not one was attacked with the disease subsequent to inoculation with the most potent virus.

Surely results such as those recorded in this book are calculated, not only to arouse public interest, but public hope and wonder. Never before, during the long period of its history, did a day like the present dawn upon the science and art of medicine. Indeed, previous to the discoveries of recent times, medicine was not a science, but a collection of empirical rules dependent for their interpretation and application upon the sagacity of the physician. How does England stand in relation to the great work now going on around her? She is, and must be, behindhand. Scientific chauvinism is not beautiful in my eyes. Still, one can hardly see, without deprecation and protest, the English investigator handicapped in so great a race by short-sighted and mischievous legislation.

A great scientific theory has never been accepted without opposition. The theory of gravitation, the theory of undulation, the theory of evolution, the dynamical theory of heat—all had to push their way through conflict to victory. And so it has been with the germ theory of communicable diseases. Some outlying members of the medical profession dispute it still. I am told they even dispute the communicability of cholera. Such must always be the course of things, as long as men are endowed with different degrees of insight. Where the mind of genius discerns the distant truth, which it pursues, the mind not so gifted often discerns nothing but the extravagance, which it avoids. Names, not yet forgotten, could be given to illustrate these two classes of minds. As representative of the first class, I would name a man whom I have often named before, who, basing himself in great part on the researches of Pasteur, fought, in England, the battle of the germ theory with persistent valor, but whose labors broke him down before he saw the triumph which he *fore*saw completed. Many of my medical friends will understand that I allude here to the late Dr. William Budd, of Bristol.

The task expected of me is now accomplished, and the reader is here presented with a record in which the verities of science are endowed with the interest of romance.

TRAINING IN ETHICAL SCIENCE.

By H. H. CURTIS.

THE importance of education in the duties of life is recognized in a greater or less degree by all. People differ widely as to absolute standards of right and wrong, and as to the foundation or source of such standards, but all concede by daily acts, as well as by avowed opinions, the necessity of some kind of moral training. Every parent who restrains his child from the commission of a wrongful act, or approves its conduct when praiseworthy, does so in recognition of the importance of moral education. Every individual who uses his influence to keep others from evil associations, or who commends a noble or kindly act, thus manifests his appreciation of the necessity of moral or ethical culture. However undefined may be the limits, however imperfectly understood may be the sources of the laws of duty, it is continually forced upon the attention of every thoughtful person that a proper observance of these laws is of vast importance to mankind. The happiness of man—the great legitimate end of human effort—depends so largely upon the recognition and adoption of high standards of duty, that nothing can exceed in importance the cultivation of the science of duty and the spirit of right action.

The human race is still far from a condition of ideal perfection; man has not as yet reached his highest estate. In the words of Tennyson:

> "A monstrous eft was of old the Lord and Master of Earth;
> For him did his high sun shine, and his river billowing ran,
> And he felt himself in his force to be Nature's crowning race.
> As nine months go to the shaping an infant ripe for its birth,
> So many a million of ages have gone to the making of man;
> He now is first, but is he the last? is he not too base?"

The world is full of want and misery; the strong trample upon the rights of the weak, the cunning take advantage of the unwary, the impulsive and the irresolute are lured on to lives of vice and crime. From every quarter there arise appeals for help, for strength to overcome temptation, for power to resist oppression, for succor in distress. Beyond all these things, as we ascend in the scale of ethical development, there exists a demand for that recognition of the rights of others, that spirit of fellowship and true manhood which shall abridge and overcome the passion of grasping selfishness. How prevalent is the desire for that ostentatious splendor and luxurious ease which too often represent the fruits of many a hard and narrow life of penury and ill-requited toil!

We live in an age of observation, of investigation, of a study of Nature's laws and methods. Nor is the advance of the physical sciences more marked than that of the useful arts. Do not the problems of *life* also demand attention? Is a knowledge of the laws of the physical universe so all-important that no time shall be spared, no thought devoted to acquiring further knowledge of the laws of duty? Every thoughtful observer must admit that *the great governing factor in the problem of the advancement of human happiness is the conduct of man toward his fellow-man.* Immeasurable in importance is the fostering of a spirit of true devotion to duty. There is no loftier ambition, no nobler work, no higher ideal of life, than the promotion of the virtue, goodness, and happiness of mankind.

What are the means by which these ends shall be accomplished? Shall we rely solely upon our supposed consciousness of what is right and what is wrong, and let moral teaching consist simply of appeals for obedience to the dictates of conscience? That which is termed conscience is, in a large degree at least, a matter of inherited tendencies, education, and intellectual development, and varies with the individual, his surroundings, and the age in which he lives.

That which seems right to the mind of one man often seems wrong when presented to the intelligent judgment of other men. The conscience of the average member of a civilized community differs widely from the conscience of the average member of a savage tribe. To the American Indian, revenge is a virtue; to the Quaker, revenge is a crime. To Gautama, to Jesus of Nazareth, and to their ascetic disciples, the total rejection of personal interest or advancement—absolute unselfishness and self-abnegation, unlimited benevolence, and an entire absence of the desire or habit of self-protection—were the greatest virtues and most obligatory duties.

On the other hand, the constitutions of all civilized governments, whether written or unwritten, the principles of the civil as well as those of the common law, and the teachings of wise men of ancient and of modern times, recognize as a duty the protection of individual or selfish interests. They recognize as just and necessary the restraint and punishment of wrong-doers, and the protection of the rights and interests of the individual in person and property. Educated to look upon these and kindred principles as embodying correct rules of conduct, we view with approval the resistance of oppression and injustice, and even the spirit which resents and punishes insult.

There can be no doubt that these are conflicting views of duty, but both extremes have been honestly maintained, and still are in some degree. It hardly admits of a doubt that men of pure motives and good intentions have committed acts of cruelty and inhumanity in the belief that they were simply discharging duties—perchance religious duties.

All these things point to the fallibility of human judgment regarding standards of duty, and the imperfect development of ideas of right and wrong. They furnish no excuse, however, for drifting through life without an attempt to investigate or discover the principles of the science of duty, or for neglecting to govern our actions by those principles, so far as we may be able to recognize them.

With the waning and crumbling of a faith in any books or records as containing absolute or inspired standards of duty, the study of the science and data of ethics should, it would seem, become one of greater interest and attention than ever before.

Whether we regard the ability to distinguish between right and wrong conduct as in a great degree inherent in the human mind, or as having arisen in the course of the evolution of the race, as a sense of that which is conducive to the happiness of man, it is certainly a faculty or sense which is largely developed by educational training and example. Without this, it surely can not be relied upon as an unerring guide in all the problems of life. Man does not possess a power to distinguish between right and wrong action which rises superior to the need of cultivation. For such culture teachers are required, and the great necessity of united action is apparent. If associated action in the shape of schools of moral or ethical training, and agencies for charitable work—the fruit of such training—are demanded, we are confronted with the question of what their nature should be, and how far the want is already supplied. If the means now provided for these purposes are as good as any that can be devised, and if they are suited to the needs and uses of all, it were idle to supply other agencies.

Foremost, perhaps, among the agencies now existing, are the churches. According to the theories adopted and taught by the various religious organizations which are collectively known as Christian, the cultivation of ethical truths, or, in other words, the recognition and adoption of high standards of duty, is regarded as but a part of a religious system founded upon the revealed will of a Divine Being.

To those who accept so-called revelation as infallible truth, the rules of conduct or systems of ethics recognized in their Scriptures furnish, in theory, and so far as they can be harmonized, final and absolute standards of human duty. To them, theoretically at least, right or wrong action is such simply by reason of its adherence to or departure from certain standards of duty recognized in their sacred writings.

To the individual who looks upon the sacred books of Jew and Christian, of Mohammedan and Buddhist, as alike the works of men—men of varying degrees of mental and moral development—the idea of accepting their conclusions as *final* upon the great problems of the duty of man seems narrow and illogical. To him the absolute acceptance of these standards as final, however high he may concede some of them to be, is to place a limit upon moral development and to deny that

> "The thoughts of men are widened with the process of the suns."

But it does not follow, even from the point of view of the agnostic, that there is nothing of value in the ethical teachings of the orthodox Christian churches. Most if not all religions have recognized, and in some sense demanded, the adoption of certain exalted standards of duty, and in this particular the Christian religion stands deservedly high among the great religions of the world. Charity, kindness, and love, are not less beautiful because recognized as such by the churches. A true statement of the duty of man to his fellow-man does not become false because attributed to a Divine Being, or declared to be inspired. It does not become *false* even when the observance of the duty is sought to be enforced by an appeal to selfish interests—by the promise of reward or the threat of punishment in a life of which we know not.

Nor is the value of the *moral* teaching of the churches to be ignored merely because they insist that it is the duty of all to accept and adopt their *theological* teachings—their conception of the infinite and unknown, with its attendant dogmas and "cramping bounds of creed."

The crude and sometimes wholly indefensible theories of right and wrong which are recognized and treated as of divine authority in portions of the Scriptures do not furnish a sufficient reason for an unqualified condemnation of the ethical teachings of the churches. It is in general only in some strained theory—rarely in a practical application to the duties of life—that the most extreme and ultra standards of duty recognized in the writings which are collectively known as the Bible are inculcated, or even defended, inside the churches. Even those men whose mistaken zeal and religious bias lead them to attempt a defense of all the varying and inconsistent standards of duty recognized or promulgated by the many authors of the writings which make up our Bible, do so rather in theory than in fact. In their daily life, or practical advice to others, they adopt neither the standard of implacable and indiscriminating revenge and cruelty on the one hand, nor that of absolute self-abasement and meek submission to insult and injury on the other, which are alternately represented as attributes of the Divine character by the respective authors of these so-called sacred writings.

Without stopping here to discuss the objectionable features of a system of ethical training or education which has its nominal foundation in the supposed fiat of a Divine Intelligence, and which in theory necessarily precludes the possibility of the development of higher standards, it may be conceded that such education in morals is better than none. The value of such education is not wholly counterbalanced by the evil of its constant appeal to the selfish interests by promises of personal reward or threats of punishment, rather than to the nobler sentiments of the mind. Conceding the moral education of the churches to be imperfect in theory, in the manner in which it is imparted, and the means by which it is sought to be enforced, it nevertheless contains elements of good to those who can receive it.

The believer of course finds in the ethical teachings of his church a deeper and fuller moral education than they impart to others. He can at least give due weight to their real merits, and they are to him authoritative in a greater or less degree—the degree being dependent upon his faith in their divine origin. From long association of ideas and the influence of early education, the attendant *theological* teachings do not suggest to him that sense of incongruity and inconsistency which they present to others.

But how far is the moral education furnished by the Church suited to the needs of those who are compelled to reject its theological dogmas concerning the unknown, and to regard its standards of duty as those of fallible men only? Does it furnish to the earnest and fearless seeker for moral truth an undeviating path to the object of his search? Is he not constantly invited to depart from his course on journeys through the pathless wastes of theological speculation, where each man thinks his diverging creed marks the true highway to heaven?

There are various reasons why the earnest seeker for truth who is without religious belief can not feel content with the Church as a teacher of moral duty. The energy, the time, the money which should be devoted to building up character, to a recognition of the duties of man to his fellow-man, to the relief of the afflicted, to an intelligent dealing with the great problems of this life—he sees devoted largely to building up, promulgating, or seeking excuse for dogmas and theories from which his intelligence revolts. With want and suffering appealing for relief, with ignorance demanding enlightenment, with a thousand duties at our doors which scarcely receive a passing notice, we are asked to follow these blind teachers of the blind away from the things of this world, and to enjoy with them their irrational conception of what is to us the unknown—perhaps the unknowable.

Of what value is a sermon on the duty and efficacy of prayer, to one who looks upon the question of the existence of a Divine Being as an insoluble problem? Of what use or benefit to him is a discourse on the nature of the Trinity, or the theory of the atonement?

The rationalist is compelled to look upon the books which make up the Bible as simply the work of fallible men, of varying degrees of intelligence, and representing the thought of widely differing periods of human development. To him, what is there of interest in attempts to reconcile their contradictions and inconsistencies—attempts to establish the untenable theory that they embody and set forth the plan and design of an all-wise Author of the universe?

If the rationalist would support and uphold the *ethical* school of the Church, he is in a measure also supporting and upholding *theological* ideas which are to him in the last degree unreasonable and improbable. His money pays misguided men for teaching the ignorant of earth that the all-foreseeing and merciful Author of all things would doom his creatures to suffer untold agony throughout eternity for the sins and mistakes of a short life, or for using the reason with which he has endowed them! Where one dollar goes to relieve want, or build up character, two go to build up church or creed. The relief of the widow and the fatherless is thought a matter of less importance than acquainting the heathen with the theological dogmas of the Christian Church.

Of course the church-going and church-supporting rationalist must expect to be continually reminded of the culpability of his unbelief, which, so far as he can judge, arises simply from an exercise of his reasoning faculties, and not from any wrongful intention. He becomes wearied and disheartened by the want of consideration shown for the duties of this life, and the undue prominence given to a supposed preparation for an alleged future life, of which he has no evidence and can form no conception.

But though the Church fails to furnish adequate ethical training to those who can not accept its theological teachings, some kind of moral education is necessary if we would have true moral development. While much can be done in the home circle in teaching the rudiments of the science of duty—the beauty of love and charity and other attributes of noble character—this is not alone sufficient to meet the demand which should exist for true ethical culture. Teachers are needed. The complicated interests which surround most of the great social and moral problems demand the most careful and patient study, and only he who has brought to these tasks the forces of a well-trained mind can suggest the true means of relief from conditions which all may recognize as deplorable. The value of association with a broad and generous mind—a mind filled with high and pure conceptions of duty—a mind which ever presents and holds before us high and noble ideals, can not well be overestimated.

The time may come when the Church will so far outgrow the myths, the dogmas, and the beliefs with which it now struggles that there will be room within it for all who would earnestly unite in efforts to better the condition of man, and to diffuse a knowledge of those principles which lie at the foundation of human happiness. There is, indeed, a progress of thought in the Church far broader and deeper than any actual modifications of written creeds would indicate. We will not pause to inquire as to what class of thinkers is chiefly entitled to the credit for this progress. This rapid development in the direction of individual freedom of thought may give us at length a church—by whatever name it may be designated—where the only creed held binding will be the creed of love, the only devotion essential to true fellowship a devotion to truth and duty.

Meanwhile, though there are signs of progress, and noble exceptions in the few societies for ethical culture now existing, and in similar organizations, it is evident that the demand for ethical progress outside the Church has not as yet culminated in any general constructive effort either in the direction of improving the condition of the weak, the needy, and the suffering, or in the cultivation of the science of duty.

It is in one sense an unfortunate circumstance that most rationalists are persons of very independent habits of thought. Their work in the past has been necessarily and perhaps almost too largely one of iconoclasm. The exposure of shams, the demolition of creed and dogma, the unveiling of myth and traditional faith based upon foundations which have slowly crumbled away in the light of increasing intelligence, have thus far largely occupied the attention of the rationalist. The men who have done this work are not of a nature which bids them cling together for mutual support and sympathy, and as a whole they have hardly the characteristics which would qualify them for united constructive effort. Nevertheless, association is needed. A comparison of views, each individual reaping the benefit of the thought of his co-workers, is of the highest value. Without associated action but little enthusiasm can be expected, and enthusiasm is all-important in carrying forward any good work. The employment of earnest and competent teachers and leaders in thought is practicable only through united action. For charitable work—the relief of want, the alleviation of suffering, the furnishing of employment, the assistance which helps others to help themselves—associated and united effort is well-nigh indispensable. And in earnest exertions to improve the condition and add to the happiness of our fellows, may be found the best and highest ethical culture, giving to those who engage in the work a new conception as it were of the higher duties and nobler life of man.

A VERY OLD MASTER.

THE work of art which lies before me is old, unquestionably old; a good deal older, in fact, than Archbishop Usher (who invented all out of his own archiepiscopal head the date commonly assigned for the creation of the world) would by any means have been ready to admit. It is a bas-relief by an old master, considerably more antique in origin than the most archaic gem or intaglio in the Museo Borbonico at Naples, the mildly decorous Louvre in Paris, or the eminently respectable British Museum, which is the glory of our own smoky London in the spectacled eyes of German professors, all put together. When Assyrian sculptors carved in fresh white alabaster the flowing curls of Sennacherib's hair, just like a modern coachman's wig, this work of primæval art was already hoary with the rime of ages. When Memphian artists were busy in the morning twilight of time with the towering coiffure of Rameses or Sesostris, this far more ancient relic of plastic handicraft was lying, already fossil and forgotten, beneath the concreted floor of a cave in the Dordogne. If we were to divide the period for which we possess authentic records of man's abode upon this oblate spheroid into ten epochs—an epoch being a good, high-sounding word which doesn't commit one to any definite chronology in particular—then it is probable that all known art, from the Egyptian onward, would fall into the tenth of the epochs thus loosely demarkated, while my old French bas-relief would fall into the first. To put the date quite succinctly, I should say it was most likely about 244,000 years before the creation of Adam according to Usher.

The work of the old master is lightly incised on reindeer-horn, and represents two horses, of a very early and heavy type, following one another, with heads stretched forward, as if sniffing the air suspiciously in search of enemies. The horses would certainly excite unfavorable comment at Newmarket. Their "points" are undoubtedly coarse and clumsy: their heads are big, thick, stupid, and ungainly; their manes are bushy and ill-defined; their legs are distinctly feeble and spindle-shaped; their tails more closely resemble the tail of the domestic pig than that of the noble animal beloved with a love passing the love of women by the English aristocracy. Nevertheless, there is little (if any) reason to doubt that my very old master did, on the whole, accurately represent the ancestral steed of his own exceedingly remote period. There were once horses even as is the horse of the prehistoric Dordonian artist. Such clumsy, big-headed brutes, dun in hue and striped down the back like modern donkeys, did actually once roam over the low plains where Paris now stands, and browse off lush grass and tall water-plants around the quays of Bordeaux and Lyons. Not only do the bones of the contemporary horses, dug up in caves, prove this, but quite recently the Russian traveler Prjevalsky (whose name is so much easier to spell than to pronounce) has discovered a similar living horse, which drags on an obscure existence somewhere in the high table-lands of Central Asia. Prjevalsky's horse (you see, as I have only to write the word, without uttering it, I don't mind how often or how intrepidly I use it) is so singularly like the clumsy brutes that sat, or rather stood, for their portraits to my old master, that we can't do better than begin by describing him *in propria persona*.

The horse family of the present day is divided, like most other families, into two factions, which may be described for variety's sake as those of the true horses and the donkeys, these latter including also the zebras, quaggas, and various other unfamiliar creatures whose names, in very choice Latin, are only known to the more diligent visitors at the Sunday Zoo. Now everybody must have noticed that the chief broad distinction between these two great groups consists in the feathering of the tail. The domestic donkey, with his near congeners, the zebra and co., have smooth, short-haired tails, ending in a single bunch or fly-whisk of long hairs collected together in a tufted bundle at the extreme tip. The horse, on the other hand, besides having horny patches or callosities on both fore and hind legs, while the donkeys have them on the fore-legs only, has a hairy tail, in which the long hairs are almost equally distributed from top to bottom, thus giving it its peculiarly bushy and brushy appearance. But Prjevalsky's horse, as one would naturally expect from an early intermediate form, stands half-way in this respect between the two groups, and acts the thankless part of a family mediator; for it has most of its long tail-hairs collected in a final flourish, like the donkey, but several of them spring from the middle distance, as in the genuine Arab, though never from the very top, thus showing an approach to the true horsey habit without actually attaining that final pinnacle of equine glory. So far as one can make out from the somewhat rude handicraft of my prehistoric Phidias, the horse of the quaternary epoch had much the same caudal peculiarity ; his tail was bushy, but only in the lower half. He was still in the intermediate stage between horse and donkey, a natural mule still struggling up aspiringly toward perfect horsehood. In all other matters the two creatures—the cave-man's horse and Prjevalsky's—closely agree. Both display large heads, thick necks, coarse manes, and a general disregard of "points" which would strike disgust and dismay into the stout breasts of Messrs. Tattersall. In fact, over a T. Y. C. it may be confidently asserted, in the pure Saxon of the sporting papers, that Prjevalsky's and the cave-man's lot wouldn't be in it. Nevertheless, a candid critic would be forced to admit that, in spite of clumsiness, they both mean staying.

So much for the two sitters ; now let us turn to the artist who sketched them. Who was he, and when did he live ? Well, his name, like that of many other old masters, is quite unknown to us ; but what does that matter, so long as his work itself lives and survives ? Like the Comtists he has managed to obtain objective immortality. The work, after all, is for the most part all we ever have to go upon. "I have my own theory about the authorship of the Iliad and Odyssey," said Lewis Carroll (of "Alice in Wonderland") once in Christ Church common-room ; "it is that they weren't really written by Homer, but by another person of the same name." There you have the Iliad in a nutshell as regards the authenticity of great works. All we know about the supposed Homer (if anything) is that he was the reputed author of the two unapproachable Greek epics ; and all we know directly about my old master, viewed personally, is that he once carved with a rude flint flake on a fragment of reindeer-horn these two clumsy prehistoric horses. Yet by putting two and two together we can make, not four, as might be naturally expected, but a fairly connected history of the old master himself and what Mr. Herbert Spencer would no doubt playfully term his "environment."

The work of art was dug up from under the firm concreted floor of a cave in the Dordogne. That cave was once inhabited by the nameless artist himself, his wife, and family. It had been previously tenanted by various other early families, as well as by bears who seem to lived there in the intervals between the different human occupiers. Probably the bears ejected the men, and the men in turn ejected the bears, by the summary process of eating one another up. In any case the freehold of the cave was at last settled upon our early French artist. But the date of his occupancy is by no means recent ; for since he lived there the long cold spell known as the Great Ice Age, or Glacial Epoch, has swept over the whole of Northern Europe, and swept before it the shivering descendants of my poor prehistoric old master. Now, how long ago was the Great Ice Age ? As a rule, if you ask a geologist for a definite date, you will find him very chary of giving you a distinct answer. He knows that the chalk is older than the London clay, and the oölite than the chalk, and the red marl than the oölite; and he knows also that each of them took a very long time indeed to lay down, but exactly how long he has no notion. If you say to him, "Is it a million years since the chalk was deposited?" he will answer, like the old lady of Prague, whose ideas were excessively vague, "Perhaps." If you suggest five millions, he will answer oracularly once more, "Perhaps"; and if, you go on to twenty millions, "Perhaps," with a broad smile, is still the only confession of faith that torture will wring out of him. But in the matter of the Glacial Epoch, a comparatively late and almost historical event, geologists have broken through their usual reserve on this chronological question, and condescended to give us a numerical determination. And here is how Dr. Croll gets at it.

Every now and again, geological evidence goes to show us, a long cold spell occurs in the northern or southern hemisphere. During these long cold spells the ice-cap at the poles increases largely, till it spreads over a great part of what are now the temperate regions of the globe, and makes ice a mere drug in the market as far south as Covent Garden or the Halles at Paris. During the greatest extension of this ice-sheet in the last glacial epoch, in fact, all England except a small southwestern corner (about Torquay and Bournemouth) was completely covered by one enormous mass of glaciers, as is still the case with almost the whole of Greenland. The ice-sheet, grinding slowly over the hills and rocks, smoothed, and polished, and striated their surfaces in many places till they resembled the *roches moutonnées* similarly ground down in our own day by the moving ice-rivers of Chamouni and Grindelwald. Now, since these great glaciations have occurred at various intervals in the world's past history, they must depend upon some frequently recurring cause. Such a cause, therefore, Dr. Croll began ingeniously to hunt about for.

He found it at last in the eccentricity of the earth's orbit. This world of ours, though usually steady enough in its movements, is at times decidedly eccentric. Not that I mean to impute to our old and exceedingly respectable planet any occasional aberrations of intellect, or still less of morals (such as might be expected from Mars and Venus); the word is here to be accepted strictly in its scientific or Pickwickian sense as implying merely an irregularity of movement, a slight wobbling out of the established path, a deviation from exact circularity. Owing to a combination of astronomical revolutions, the precession of the equinoxes and the motion of the aphelion (I am not going to explain them here; the names alone will be quite sufficient for most people; they will take the rest on trust)—owing to the combination of these profoundly interesting causes, I say, there occur certain periods in the world's life when for a very long time together (10,500 years, to be quite precise) the northern hemisphere is warmer than the southern, or *vice versa*. Now, Dr. Croll has calculated that about 250,000 years ago this eccentricity of the earth's orbit was at its highest, so that a cycle of recurring cold and warm epochs in either hemisphere alternately then set in ; and such cold spells it was that produced the Great Ice Age in Northern Europe. They went on till about 80,000 years ago, when they stopped short for the present, leaving the climate of Britain and the neighboring continent with its existing inconvenient Laodicean temperature. And, as there are good reasons for believing that my old master and his contemporaries lived just before the greatest cold of the Glacial Epoch, and that his immediate descendants, with the animals on which they feasted, were driven out of Europe, or out of existence, by the slow approach of the enormous ice-sheet, we may, I think, fairly conclude that his date was somewhere about B. C. 248,000. In any case we must at least admit, with Mr. Andrew Lang, the laureate of the twenty-five thousandth century, that

"He lived in the long, long agoes;
'Twas the manner of primitive man."

The old master, then, carved his bas-relief in pre-glacial Europe, just at the moment before the temporary extinction of his race in France by the coming on of the Great Ice Age. We can infer this fact from the character of the fauna by which he was surrounded, a fauna in which species of cold and warm climates are at times quite capriciously intermingled. We get the reindeer and the mammoth side by side with the hippopotamus and the hyena ; we find the chilly cave-bear and the Norway lemming, the musk-sheep and the Arctic fox in the same deposits with the lion and the lynx, the leopard and the rhinoceros. The fact is, as Mr. Alfred Russel Wallace has pointed out, we live to-day in a zoölogically impoverished world, from which all the largest, fiercest, and most remarkable animals have lately been weeded out. And it was in all probability the coming on of the Ice Age that did the weeding. Our Zoo can boast no mammoth and no mastodon. The saber-toothed lion has gone the way of all flesh ; the deinotherium and the colossal ruminants of the Pliocene Age no longer browse beside the banks of Seine. But our old master saw the last of some at least among those gigantic quadrupeds ; it was his hand, or that of one among his fellows, that scratched the famous mammoth etching on the ivory of La Madelaine, and carved the figure of the extinct cave-bear on the reindeer-horn ornaments of Laugerie Basse. Probably, therefore, he lived in the period immediately preceding the Great Ice Age, or else perhaps in one of the warm interglacial spells with which the long secular winter of the northern hemisphere was then from time to time agreeably diversified.

And what did the old master himself look like ? Well, painters have always been fond of reproducing their own lineaments. Have we not the familiar young Raphael painted by himself, and the Rembrandt, and the Titian, and the Rubens, and a hundred other self-drawn portraits, all flattering and all famous? Even so primitive man has drawn himself many times over, not indeed on this particular piece of reindeer-horn, but on several other media to be seen elsewhere, in the original or in good copies. One of the best portraits is that discovered in the old cave at Laugerie Basse by M. Élie Massénat, where a very early pre-glacial man is represented in the act of hunting an aurochs, at which he is casting a flint-tipped javelin. In this as in all other pictures of the same epoch I regret to say that the ancient hunter is represented in the costume of Adam before the fall. Our old master's studies, in fact, are all in the nude. Primitive man was evidently unacquainted as yet with the use of clothing, though primitive woman, while still unclad, had already learned how to heighten her natural charms by the simple addition of a necklace and bracelets. Indeed, though dresses were still wholly unknown, rouge was even then extremely fashionable among French ladies, and lumps of the ruddle with which primitive woman made herself beautiful forever are now to be discovered in the corner of the cave where she had her little prehistoric boudoir. To return to our hunter, however, who for aught we know to the contrary may be our old master himself in person, he is a rather crouching and semi-erect savage, with an arched back, recalling somewhat that of the gorilla, a round head, long neck, pointed beard, and weak, shambling, ill-developed legs. I fear we must admit that pre-glacial man cut, on the whole, a very sorry and awkward figure.

Was he black? That we don't certainly know; but all analogy would lead one to answer positively, Yes. White men seem, on the whole, to be a very recent and novel improvement on the original evolutionary pattern. At any rate he was distinctly hairy, like the Ainos, or aborigines of Japan, in our own day, of whom Miss Isabella Bird has drawn so startling and sensational a picture. Several of the pre-glacial sketches show us lank and gawky savages with the body covered with long scratches, answering exactly to the scratches which represent the hanging hair of the mammoth, and suggesting that man then still retained his old original hairy covering. The few skulls and other fragments of skeletons now preserved to us also indicate that our old master and his contemporaries much resembled in shape and build the Australian black fellows, though their foreheads were lower and more receding, while their front teeth still projected in huge fangs, faintly recalling the immense canines of the male gorilla. Quite apart from any theoretical considerations as to our probable descent (or ascent) from Mr. Darwin's hypothetical "hairy arboreal quadrumanous ancestor," whose existence may or may not be really true, there can be no doubt that the actual historical remains set before us pre-glacial man as evidently approaching in several important respects the higher monkeys.

It is interesting to note, too, that while the Men of the Time still retained (to be frankly evolutionary) many traces of the old monkey-like progenitor, the horses which our old master has so cleverly delineated for us on his scrap of horn similarly retained many traces of the earlier united horse-and-donkey ancestor. Professor Huxley has admirably reconstructed for us the pedigree of the horse, beginning with a little creature from the Eocene beds of New Mexico, with five toes to each hind-foot, and ending with the modern horse, whose hoof is now practically reduced to a single and solid-nailed toe. Intermediate stages show us an Upper Eocene animal as big as a fox, with four toes on his front feet and three behind ; a Miocene kind as big as a sheep, with only three toes on the front-foot, the two outer of which are smaller than the big middle one ; and, finally, a Pliocene form, as big as a donkey, with one stout middle toe, the real hoof, flanked by two smaller ones, too short by far to reach the ground. In our own horse these lateral toes have become reduced to what are known by veterinaries as splint-bones, combined with the canon in a single solidly mortised piece. But in the pre-Glacial horses the splint-bones still generally remained quite distinct, thus pointing back to the still earlier period when they existed as two separate and independent side-toes in the ancestral quadruped. In a few cave specimens, however, the splints are found united with the canons in a single piece, while conversely horses are sometimes, though very rarely, born at the present day with three-toed feet exactly resembling those of their half-forgotten ancestor, the Pliocene hipparion.

The reason why we know so much about the horses of the cave period is, I am bound to admit, simply and solely because the man of the period ate them. Hippophagy has always been popular in France ; it was practiced by pre-Glacial man in the caves of Périgord, and revived with immense enthusiasm by the gourmets of the Boulevards after the siege of Paris and the hunger of the Commune. The cave-men hunted and killed the wild horse of their own times, and one of the best of their remaining works of art represents a naked hunter attacking two horses, while a huge snake winds itself unperceived behind close to his heel. In this rough prehistoric sketch one seems to catch some faint antique foreshadowing of the rude humor of the "Petit Journal pour Rire." Some archæologists even believe that the horse was domesticated by the cave-men as a source of food, and argue that the familiarity with its form shown in the drawings could only have been acquired by people who knew the animal in its domesticated state ; they declare that the cave-man was obviously horsey. But all the indications seem to me to show that tame animals were quite unknown in the age of the cave-men. The mammoth certainly was never domesticated ; yet there is a famous sketch of the huge beast upon a piece of his own ivory, discovered in the cave of La Madelaine by Messrs. Lartet and Christy, and engraved a hundred times in works on archæology, which forms one of the finest existing relics of pre-

Glacial art. In another sketch, less well known, but not unworthy of admiration, the early artist has given us with a few rapid but admirable strokes his own reminiscence of the effect produced upon him by the sudden onslaught of the hairy brute, tusks erect and mouth wide open, a perfect glimpse of elephantine fury. It forms a capital example of early impressionism, respectfully recommended to the favorable attention of Mr. J. M. Whistler.

The reindeer, however, formed the favorite food and favorite model of the pre-Glacial artists. Perhaps it was a better sitter than the mammoth ; certainly it is much more frequently represented on these early prehistoric bas-reliefs. The high-water mark of palæolithic art is undoubtedly to be found in the reindeer of the cave of Thayngen, in Switzerland, a capital and spirited representation of a buck grazing, in which the perspective of the two horns is better managed than a Chinese artist would manage it at the present day. Another drawing of two reindeer fighting, scratched on a fragment of schistose rock and unearthed in one of the caves of Périgord, though far inferior to the Swiss specimen in spirit and execution, is yet not without real merit. The perspective, however, displays one marked infantile trait, for the head and legs of one deer are seen distinctly through the body of another. Cave-bears, fish, musk-sheep, foxes, and many other extinct or existing animals, are also found among the archaic sculptures. Probably all these creatures were used as food ; and it is even doubtful whether the artistic troglodytes were not also confirmed cannibals. To quote Mr. Andrew Lang once more on primitive man, "he lived in a cave by the seas ; he lived upon oysters and foes." The oysters are quite undoubted, and the foes may be inferred with considerable certainty.

I have spoken of our old master more than once under this rather question-begging style and title of primitive man. In reality, however, the very facts which I have here been detailing serve themselves to show how extremely far our hero was from being truly primitive, You can't speak of a distinguished artist, who draws the portraits of extinct animals with grace and accuracy, as in any proper sense primordial. Grant that our good troglodytes were indeed light-hearted cannibals ; nevertheless, they could design far better than the modern Esquimaux or Polynesians, and carve far better than the civilized being who is now calmly discoursing about their personal peculiarities in his own study. Between the cave-men of the pre-Glacial age and the hypothetical hairy quadrumanous ancestor aforesaid there must have intervened innumerable generations of gradually improving intermediate forms. The old master, when he first makes his bow to us, naked and not ashamed, in his Swiss or French grotto, flint scalpel in hand and necklet of bear's teeth dropping loosely on his hairy bosom, is nevertheless in all essentials a completely evolved human being, with a whole past of slowly acquired culture lying dimly and mysteriously behind him. Already he has invented the bow with its flint-tipped arrow, the neatly chipped javelin-head, the bone harpoon, the barbed fish-hook, the axe, the lance, the dagger, and the needle. Already he had learned how to decorate his implements with artistic skill, and to carve the handles of his knives with the figures of animals. I have no doubt that he even knew how to brew and to distill; and he was probably acquainted with the noble art of cookery as applied to the persons of his human fellow-creatures. Such a personage can not reasonably be called primitive; cannibalism, as somebody has rightly remarked, is the first step on the road to civilization.

No, if we want to get at genuine, unadulterated primitive man, we must go much further back in time than the mere trifle of 250,000 years, with which Dr. Croll and the cosmic astronomers so generously provide us, for pre-Glacial humanity. We must turn away to the immeasurably earlier fire-split flints which the Abbé Bourgeois—undaunted mortal!—ventured to discover among the Miocene strata of the *calcaire de Beauce.* Those flints, if of human origin at all, were fashioned by some naked and still more hairy creature, who might fairly claim to be considered as genuinely primitive. So rude are they that, though evidently artificial, one distinguished archæologist will not admit they can be in any way human; he will have it that they were really the handiwork of the great European anthropoid ape of that early period. This, however, is nothing more than very delicate hair-splitting; for what does it matter whether you call the animal that fashioned these exceedingly rough and fire-marked implements a man-like ape or an ape-like human being? The fact remains quite unaltered, whichever name you choose to give to it. When you have got to a monkey who can light a fire and proceed to manufacture himself a convenient implement, you may be sure that man, noble man, with all his glorious and admirable faculties—cannibal or otherwise—is lurking somewhere very close, just round the corner. The more we examine the work of our old master, in fact, the more does the conviction force itself upon us, that he was very far indeed from being primitive—that we must push back the early history of our race not for 250,000 winters alone, but perhaps for two or three million years, into the dim past of Tertiary ages.

But if pre-Glacial man is thus separated from the origin of the race by a very long interval indeed, it is none the less true that he is separated from our own time by the intervention of a vast blank space, the space occupied by the coming on and passing away of the Glacial Epoch. A great gap cuts him off from what we may consider as the relatively modern age of the mound-builders, whose grassy barrows still cap the summits of our southern chalk-downs. When the great ice-sheet drove away palæolithic man—the man of the caves and the unwrought flint axes—from Northern Europe, he was still nothing more than a naked savage in the hunting stage, divinely gifted for art indeed, but armed only with roughly-chipped stone implements, and wholly ignorant of taming animals, or of the very rudiments of agriculture. He knew nothing of the use of metals—*aurum irrepertum spernere fortior*—and he had not even learned how to grind and polish his rude stone tomahawks to a finished edge. He couldn't make himself a bowl of sun-baked pottery, and if he had discovered the almost universal art of manufacturing an intoxicating liquor from grain or berries (for, as Byron, with too great anthropological truth, justly remarks, "man, being reasonable, *must* get drunk") he at least drank his aboriginal beer or toddy from the capacious horn of a slaughtered aurochs. That was the kind of human being who alone inhabited France and England during the later pre-Glacial period.

A hundred and seventy thousand years elapse (as the play-bills put it), and then the curtain rises afresh upon neolithic Europe. Man meanwhile, loitering somewhere behind the scenes in Asia or Africa (as yet imperfectly explored from this point of view), had acquired the important arts of sharpening his tomahawks and producing hand-made pottery for his kitchen utensils. When the great ice-sheet cleared away he followed the returning summer into Northern Europe, another man, physically, intellectually, and morally, with all the slow accumulations of nearly two thousand centuries (how easily one writes the words! how hard to realize them!) upon his maturer shoulders. Then comes the age of what older antiquaries used to regard as primitive antiquity—the age of the English barrows, of the Danish kitchen-middens, of the Swiss lake-dwellings. The men who lived in it had domesticated the dog, the cow, the sheep, the goat, and the invaluable pig; they had begun to sow small ancestral wheat and undeveloped barley; they had learned to weave flax and wear decent clothing; in a word, they had passed from the savage hunting condition to the stage of barbaric herdsmen and agriculturists. That is a comparatively modern period, and yet I suppose we must conclude, with Dr. James Geikie, that it isn't to be measured by mere calculations of ten or twenty centuries, but ten or twenty thousand years. The perspective of the past is opening up rapidly before us; what looked quite close yesterday is shown to-day to lie away off somewhere in the dim distance. Like our palæolithic artists, we fail to get the reindeer fairly behind the ox in the foreground, as we ought to do if we saw the whole scene properly foreshortened.

On the table where I write there lie two paper-weights, preserving from the fate of the sibylline leaves the sheets of foolscap to which this article is now being committed. One of them is a very rude flint hatchet, produced by merely chipping off flakes from its side by dexterous blows, and utterly unpolished or unground in any way. It belongs to the age of the very old master (or possibly even to a slightly earlier epoch), and it was sent me from Ightham, in Kent, by that indefatigable unearther of prehistoric memorials, Mr. Benjamin Harrison. That flint, which now serves me in the office of a paper-weight, is far ruder, simpler, and more ineffective than any weapon or implement at present in use among the lowest savages. Yet with it, I doubt not, some naked black fellow, by the banks of the Thames, has hunted the mammoth among unbroken forests two hundred thousand years ago and more ; with it he has faced the angry cave-bear, and the original and only genuine British lion (for everybody knows that the existing mongrel heraldic beast is nothing better than a bastard modification of the leopard of the Plantagenets). Nay, I have very little doubt in my own mind that with it some æsthetic ancestor has brained and cut up for use his next-door neighbor in the nearest cavern, and then carved upon his well-picked bones an interesting sketch of the entire performance. The Du Mauriers of that remote age, in fact, habitually drew their society pictures upon the personal remains of the mammoth or the man whom they wished to caricature in deathless bone-cuts. The other paper-weight is a polished neolithic tomahawk, belonging to the period of the mound-builders, who succeeded the Glacial epoch, and it measures the distance between the two levels of civilization with great accuracy. It is the military weapon of a trained barbaric warrior as opposed to the universal implement and utensil of a rude, solitary, savage hunter. Yet how curious it is that, even in the midst of this "so-called nineteenth century," which perpetually proclaims itself an age of progress, men should still prefer to believe themselves inferior to their original ancestors, instead of being superior to them ! The idea that man has risen is considered base, degrading, and positively wicked ; the idea that he has fallen is considered to be immensely inspiring, ennobling, and beautiful. For myself, I have somehow always preferred the boast of the Homeric Glaucus, that we, indeed, maintain ourselves to be much better men than ever were our fathers.—*Cornhill Magazine.*

SKETCH OF M. PIERRE E. BERTHELOT.

UNTIL a few years ago, investigation in organic chemistry was pursued almost wholly by the road of analysis. As Gerhardt wrote in his treatise : "The chemist did everything in opposition to living Nature. He burned, destroyed, and worked by taking apart, while the vital force operated by synthesis or putting together, to reconstruct the edifice which chemical forces would destroy." The chemist was, in fact, a great destroyer. He could isolate the essence from a flower, and could destroy that essence and determine its chemical composition, but he was powerless to reconstruct the destroyed perfume, and could not even conceive that such a thing was possible. It is the chief title to fame of M. Berthelot that he introduced the synthetic method into organic chemistry, and devised a system of processes by means of which we are able to create organic compounds by the direct combination of their constituent radicals.

Pierre Eugène Marcellin Berthelot was born in Paris, October 25, 1827. He was the son of a physician of some distinction, and while a student in one of the lyceums of Paris showed marked tastes for philosophical studies and chemical research, so that, when the time for the contest came, he easily won the honors in philosophy. Then, following his favorite pursuits, he occupied himself especially with studies of the acids and fatty bodies, and of fermentations. In 1851 he became attached to the Collége de France as preparator in the course of chemistry, in which position he was assistant to Balard. In 1854 he propounded his theory of polyatomic alcohols, and was in the same year made a Doctor in Science. In 1859 he was appointed a Professor in the Superior School of Pharmacy. In 1861 he received the Joecker prize from the Academy of Sciences for his experiments in the artificial production of chemical substances by synthesis. In 1864 he was made a Professor of Organic Chemistry in the Collége de France in a chair which had been created especially for him, in which he was instructed to advance his own ideas, and to treat in his lectures especially of his own discoveries.

M. Berthelot entered upon the researches in synthesis, which give him his strongest title to fame, in 1854. Berzelius had said that, although we may produce with inorganic bodies a few substances having a composition analogous to that of some organic ones, the imitation is too restricted to justify us in hoping that we shall be able to produce organic bodies in the same sense that we have frequently succeeded in confirming the analysis of inorganic bodies by performing the synthesis of them. Yet, when this was said, Wöhler had already performed the synthesis of urea; and a few other syntheses had been made, but they were so isolated, so insignificant, and so barren of fruit, that all attempts to constitute organic bodies by bringing together the elements of which they are composed were, as a rule, regarded as chimerical. The law and the manner of the formation of the organic matters which enter into the composition of the living being were unknown; the question whether those substances were chemical in their character, or depended for their existence and maintenance upon a peculiar vital force, had been started, but the discussion of it had not been seriously entered upon. M. Berthelot began to give his attention to the solution of this problem very early in his scientific career.

One of the first syntheses he performed was that of formic acid, and this was used as the basis of his further researches. Regarding this substance as formed by the union of water and carbonic oxide, he brought about a compound of that character through the intervention of potash, and secured the result he sought. Other syntheses followed this one, conducted, like it, with very simple compounds, till he was finally led to the artificial composition of the carburets of hydrogen. Among his most important experiments in this line was the artificial production of alcohol from olefiant gas. Alcohol once obtained synthetically, he had a station whence he could pursue his investigations in various directions. It was not a long step from this to the composition with the same elements (oxygen, hydrogen, and carbon) of a number of volatile organic substances—such as the oils of garlic, mustard, etc.—and then to the formation of glycerine. With these processes he had built up by synthesis what we might perhaps call the first story of organic chemistry. To complete his work it was necessary to produce the saccharine and albuminous substances which constitute what might be called, repeating our figure, the second story of the edifice—a problem of a more difficult character, because those substances are less stable in their nature, and are more completely decomposed under energetic chemical reactions. On this subject M. Berthelot said, several years ago: "The reconstitution of the saccharine and albuminoid principles is the final object of organic chemistry, the most remote one indeed, but also one of the most important, on account of the essential part which these principles play in our economy. When science attains it, it will be able to realize the synthetic problem in its whole extent—that is, to produce, with the elements and by the play of molecular forces alone, all the definite natural compounds and all the changes which matter undergoes in the bodies of living beings."

"The labors of M. Berthelot in this line," says an enthusiastic French biographer, "constitute one of those events which change the aspect of things, not only by the new processes which they have developed, or by the substances, more or less known, which they have given the means of reproducing, but because they have taken hold bodily of one of the strongest intrenched ideas of mankind and overthrown it. We had been taught that all the complex substances constituting plants and animals were produced wholly under the influence of a special vital force peculiar to organized beings. When it came to verifying the facts in the case, it was found that Nature acts in a more simple way than we had thought, and that she employs those chemical affinities that control the metamorphoses of matter equally in executing those immense earth-convulsions that stir the foundations of countries and overthrow cities, and in perfuming a flower by the distillation, molecule by molecule, of its essential oil."

The fruits of M. Berthelot's investigations in this department of research have been given in a number of publications, among which we may name the "Combinaisons de la glycérine avec les acides, et reproduction des corps gras neutres" ("Combinations of Glycerine with the Acids, and Reproduction of Neutral Fatty Bodies"), 1860; various memoirs in the "Annales de physique et de chimie"; "Chimie organique fondée sur la synthèse" ("Organic Chemistry founded on

Synthesis ") 1860; and "Leçons sur les méthodes générales de synthèse en chimie organique" ("Lessons on the General Methods of Synthesis in Organic Chemistry"), a course of lectures in the Collége de France, 1864.

M. Berthelot has also pursued elaborate researches in specific heat, and in the relations between the heat developed in composition and decomposition, and the force of affinity. On the subject of the relations of specific heat with the composition of bodies he said, in 1873, in a discussion in the French Academy with M. Dumas: "The study of the specific heats established by the most recent researches tends to prove that there is a positive characteristic which, it seems to me, distinguishes the elements of modern chemistry from its compounds, and shows that no known compound body ought to be considered as of the same order as an actually simple one. The importance of such a characteristic can not be doubted, and it becomes greater on account of the mechanical meaning which modern theories attach to specific heat. . . . Nevertheless, exaggerated conclusions must not be drawn from such an opposition between the mechanical and physical characteristics of our simple and compound bodies. If our elements have not as yet been decomposed, and appear not to be decomposable by the forces which are at present at the command of the chemist, nothing compels us to assert that they are not decomposable in another way than our compounds are; as, for instance, as Mr. Lockyer asserts, by means of the forces acting in cosmical space. Nor does anything prevent that such a discovery as that of voltaic electricity would enable the chemists of the future to overpass the limits which are imposed upon us. The possible fundamental identity of the matter constituting our elements, and the possibility of transmuting into one another the so-called elements, can, moreover, be admitted into the category of more or less plausible hypotheses without it necessarily resulting that there is a single really existing matter of which our actual elements represent unequal states of condensation. In fact, nothing compels us to conceive the existence of a final decomposition which shall tend necessarily to reduce our elements either to more simple bodies, from the addition of which they arise, or to multiples of a single elementary ponderable unit."

M. Berthelot's views of the relations between chemical affinity and the intensity of chemical action were presented in his "Essai de mécanique chimique fondée sur la thermo-chimie" ("Essay on Chemical Dynamics based on Thermo-Chemistry"), 1880, of which Mr. M. M. Pattison Muir said, in "Nature," that its publication "marks an important point in the advance of modern chemistry." Among the more recent investigations which M. Berthelot has pursued in the light of his thermo-chemical theories are those into the properties of explosives and the laws of the propagation of explosions.

CORRESPONDENCE.

FRUCTIFICATION OF THE FIG.

Messrs. Editors:

DEAR SIRS: Some time ago I wrote to my son, Grant Allen, to say that, in that special portion of his article ("Queer Flowers") which referred to the fructification of the fig, there must, I thought, be some mistake, for I had seen a fig-tree bear a large crop of fruit, and was sure that no such pains had been taken with it as that referred to in the article in question. To this I received yesterday (March 11th) the following reply, which, though intended only for myself, I think I break no confidence in publishing: "The fig-tree question," says he, "puzzled me myself much, long ago, for the *caprifico* doesn't grow in England, and fig-trees bear abundantly. But all the authorities are unanimous, and I can't go against them. There is a vast literature on the subject, caprification as they call it, and Müller in his 'Fertilization of Flowers' gives a list of *ten separate works* dealing with it." So that, if he has erred, he has erred *cum patribus*. So far for my son. Now Müller, who is a specialist on this subject, and the latest and very highest authority, tells us (see "The Mechanisms of Flowers," part iii, page 521) that "*the latest researches* (377, *Ficus carica*, L.) *confirm* the fact, which Linnæus (416 A.) was aware of, that the so-called *caprificus* which bears inedible fruit, and the fig-tree, cultivated for the sake of its fruit from time immemorial, stand in the relation of male and female to one another. Fertilization is effected by a wasp. . . . In most cases, each crop of figs, whether of the fig-tree or the caprificus, brings only flowers of one sex to maturity." Again (p. 522): "While the fruit of the caprificus, whose only use is to supply pollen, remains hard and withers on the tree, or falls off without becoming sweet, the fruit of the fig-tree, when the seeds ripen, becomes sweet and juicy, and so attracts birds which disseminate the seeds. From the most ancient times, as long as the fig-tree has been cultivated, its artificial fertilization by means of the caprificus, or so-called caprification, has been practiced," and so on.

How are we to reconcile all this with the very lucid exposition and array of facts of your able correspondent in the February number of "The Popular Science Monthly." I confess I think your correspondent is in this particular right. Only that I do not wish to venture a guess—never permissible on a question of science, save tentatively—I might make one here as to how these differences might be reconciled, but I forbear.

Though my son is a keen and close observer of Nature, and a good judge of the men to be relied on for such facts as, in his yet short life, he could not have scrutinized himself personally, yet as *his* more especial object is to get at the heart of his facts, to read their hidden meaning, and to show how whole continents of facts, apparently disconnected and unrelated, are yet bound together by the strongest ties of consanguinity or more close or distant relationship, he has very frequently to go to the works of able specialists of repute in order to learn from them what they have observed.

Thus, for example's sake, in a late article of his in the "Cornhill Magazine" ("Go to the Ant") he had, as is obvious, to have recourse to the vast stores of observations accumulated by many able specialists in many parts of the world. Now, it is quite possible that some of these observations may in time come to be questioned by more exact observers; still, in a case like this of the fig-tree, when all practical men and scientific observers have coincided in opinion, and where "all authorities" have for over a century been "*unanimous*," a writer is to be pardoned for thrusting aside a difficulty in his own mind, in deference to the practical judgment of the ages and the decision of all experts in the case.

I sent my son by to-day's post the number of "The Popular Science Monthly" which contained the letter of your correspondent; but I wish it to be borne in mind that the reply here given is mine, not his, save in the few words quoted from a *private* letter and dashed off by him in great haste. His reply, on seeing your correspondent's letter, might be very different.

Yours very truly, J. ANTISELL ALLEN.

March 12, 1885.

Messrs. Editors:

IN the February number of "The Popular Science Monthly," Mr. George Pyburn, of Sacramento, says, "I have yet to see the first seedling fig," and suspects, therefore, that the seeds are generally infertile.

In 1878 I planted the seeds of an imported white Smyrna fig. They germinated abundantly, and, in the fourth year from planting, my seedling fig-tree bore fruit. I shall try this year a similar experiment with a California fig. I anticipate a similar result. The seeds are so small that they require care. They should be planted in a box, covered shallow with fine sand, and regularly watered with a sprinkler.

I think figs generally are self-fertilizing. I had one tree, however, whose fruit uniformly fell when about two thirds grown. I ascribed this to want of fertilization. Possibly the presence of the *caprifico* might have changed results. If so, it would follow that some varieties are self-fertilizing and others not. The "fig-wasp" is unknown here.

The "novel phenomenon" related by Mr. C. G. McMillan may be found duplicated, though not in precisely the same way, in Northern Mississippi. His fossil leaves had retained their color during untold ages. In the other case it was the resin of the pine-tree. Near the village of Iuka was lying, some twenty years ago, and perhaps is still, a petrified pine-log about two feet in diameter, a ten-pound fragment of which lies here in my study. Not only does the stone retain the color and appearance of pine-wood, but the petrified resin has the color, semi-transparency, and general appearance of real resin. The surface-land is eocene.

Isaac Kinley.

Los Angeles, Cal., *March* 11, 1885.

SAMP AND HULLED CORN.

Messrs. Editors:

Mattieu Williams, in article 42 of his "Chemistry of Cookery" ("Popular Science Monthly" for January), says: "Before proceeding further I must fulfill the promise made in No. 39, to report the result of my repetition of the Indian process of preparing *samp*. I soaked some ordinary Indian corn in a solution of carbonate of potash, exceeding the ten or twelve hours specified by Count Rumford. The external coat was not removed even after two days' soaking." He suspects the corn was too old and dry, and that the Indians used new or freshly gathered grain.

In the first place, this is not the way to prepare *samp*. Samp is the Anglicized Indian name for maize parched and pounded. It came afterward to be the name for the new corn, pounded or coarsely ground. This being done before the kernels were fairly dry, it was much prized for mush or hasty-pudding.

The prepared Indian corn he refers to is called in New England *hulled corn*. My grandmother, whose parents were contemporary with and from the same part of the country as Count Rumford, was famous for her hulled corn.

That this method of preparing corn for food was learned from the Indians is uncertain. It was probably a Yankee invention of early date.

Grandmother's way was to put a peck of old, dry maize into a pot filled with water, and with it a bag of hard-wood ashes, say a quart. After soaking a while it was boiled until the skins or hulls came off easily. The corn was then washed in cold water to get rid of the taste of potash, and then boiled until the kernels were soft. Another way was to take the lye from the leaches where potash was made, dilute it, and boil the corn in this until the skin or hull came off. In the experiment tried by Mr. Williams, his solution of carbonate of potash was not of sufficient strength, or, if it was, the maize or corn should have been boiled. It makes a delicious dish, eaten with milk or cream.

In the early days of New England, maize was the principal grain, and was designated *corn*, which is the significance of the name now in all parts of the Union. Ground maize is called in New England "Indian-meal," and mixed with one third of rye-meal, fermented and baked, once constituted the principal bread of the whole country. It was called "rye-and-indian," pronounced *ryningen*. Boston brown bread is an imitation of it. Baked Indian is still a common appellation for a corn-meal pudding that strikes a stranger as a reminiscence of cannibalism.

P. J. F.

Clinton, Iowa, *March* 20, 1885.

EDITOR'S TABLE.

ILLITERACY AS A SOURCE OF NATIONAL DANGER.

A GREAT deal of attention has lately been drawn to this subject, and in certain quarters an attempt has been made to "boom" it in a manner that can hardly be pronounced entirely disinterested. In certain educational journals, for example, teachers are urged to petition the national Legislature for the passing of the "Blair Bill," on the ground that it will improve their own remuneration. One form of petition, which we find printed for the convenience of teachers, states that "ignorance among the masses of the people now exists to such a degree as to threaten the early destruction of the free institutions of the republic," and that therefore a system of free schools "should be in part established and, temporarily at least, supported by contributions from the overflowing Treasury of the United States." The word "temporarily" here will raise a smile on the lips of those who remember how often temporary protection for "our infant industries" has been applied for, and how invariably the protection so accorded has become a permanent thing. Infant industries that are nourished on "protection" never emerge from the infant condition. However they may extend and expand, they never voluntarily forego the leading-strings or the pap-bottle; and so we shrewdly suspect it would be with the schools "temporarily" assisted by the Federal Government. If, in the course of a few years, they demonstrated their ability to dispense with such assistance, they would do what has seldom been done in this world. It is a most unusual thing for any organism to close an easy channel of alimentation, in order to depend exclusively upon one more difficult. Let the Treasury of the United States once begin to overflow in the way of aid to education "on the basis of illiteracy," it may go on overflowing. The "basis" is not likely to contract, but rather to widen out from year to year.

The question, however, deserves careful consideration. Is the stability of our institutions threatened by the ignorance of the electorate? By "illiteracy" is understood the condition of being unable to read or write; and we are asked to believe that our system of government stands in peril on account of the extent to which illiteracy as thus defined prevails. The language used would point to the conclusion that illiteracy is now a more serious evil than at any previous period of our history. The facts, however, do not support any such conclusion. The census of 1870 gave the total number of white males of voting age unable to write as 748,970. From 1870 to 1880 our population increased thirty per cent. Had the number of illiterates remained, therefore, relatively stationary, we should have had in 1880 not less than 973,661 white voters unable to write; instead of that, the census for that year shows the number to be 886,659 only, a decidedly reduced proportion. It is true, on the other hand, that, among the colored population, education is not keeping pace with the natural increase of numbers, but this fact alone does not justify the interference of the Federal Government to supplement the educational work that is now going on.

What has not been shown as yet, so far as we are aware, is that the so-called illiterate classes are a specific source of danger to our institutions. If we review the several crises of our history, we shall probably find that those who have done most to bring on these crises have been, for the most part, men quite able to read and write. The Tilden-Hayes imbroglio could not certainly be traced to the ignorance of the electorate. Maine is a highly educated State, and yet it was precisely there that a few years ago a condition of war almost supervened in connection with the State elections. The false returns which kept this city, and in a less degree the whole Union, in a condition of fever-heat for days together last fall, had nothing to do with illiteracy, quite the contrary. Even the Cincinnati riot was not the work of men who could not read or write, but rather of citizens quite competent in these respects, but who had momentarily lost their heads. The fact is, the citizens who can read and write have everywhere the power in their own hands, and if they are only willing to discharge their duties, private and public, in a proper manner, the non-reading and non-writing element in the population will give them comparatively little trouble.

There is, however, another view to be taken of the matter. If our schools are not as efficient as they should be, and if an undue proportion of the whole population escapes the civilizing influence of education, what is the cause? We do not hesitate to say that the chief cause is one which no Government action, State or Federal, can ever reach—viz., defect of home discipline. The boy who will not attend school, or who, attending school, learns nothing, is the boy accustomed to rebellion at home, or the boy whose parents are themselves too negligent and vicious to care whether he learns anything or not. It is no doubt the case that a certain portion of the population of these States is being brought up in partial or total savagery. Not for want of schools, however, for schools abound. The evil is deep-seated, and can only be reached by the vigorous action of public opinion, and by wise measures of reform in connection with the administration of justice. When we explain why it is that our educational systems fail altogether to reach a certain element in the population, we explain, also, why the work of education is in many cases so shallow, and why it even seems at times to do more harm than good. Everything depends on the spirit with which it is approached. A well-known figure in contemporary fiction—Maud Matchin—well illustrates the work of the high-school or academy on the mind of a vain and vulgar girl, who sets no value upon education, save as it may help her to a position in the world, and the vices of whose character are therefore brought only into stronger relief by her wretched varnish of accomplishments. And here we see the folly of all schemes that would set the Federal Government at work to repair the weak places of education throughout the States and Territories. All that is proposed is that reading and writing should be made universal accomplishments, so as to remove the reproach and danger of technical "illiteracy." But there is absolutely no guarantee that the voter newly instructed to read and write would be any better *man* than he was before. If our high-schools are turning out Maud Matchins by the score and hundred, and if youths by the thousand leave school to pursue a career of "smartness," without one thought of social responsibility, it is evident that the mere extension of educational facilities is a much less pressing need than the moralizing of the whole business of education. Philosophers have told us that it is perfectly possible to educate in an intellectual sense without touching one single moral chord; and daily experience confirms the truth of the statement. Instead, therefore, of engaging the Federal Government to establish more schools, we would engage the whole community to place the schools that now exist upon a higher moral plane, and to render them more effectual in their working by a higher quality of home influence. It is in the home above all that reform is needed; but, unhappily, the school has of late years so dwarfed the home, so interposed between the parent and his natural and proper responsibility toward his child, that to preach "home influence" to-day is almost like raising one's voice in the wilderness. Things are badly complicated; one thing only is certain, and that is, that more State interference will not help to clear up the complications, or to put things on a sound basis.

It is needless, we trust, in concluding these remarks, to say that we yield to none in the importance we attach to education rightly understood. By education, however, we do not understand merely the ability to read and write, and we are not fully persuaded that our institutions would be any safer than they are to day if every child in the country over twelve years old could both read and write. What we know for certain is, that an individual able to do both may be in a condition of very unstable intellectual equilibrium, and so, we believe, might a whole community of such individuals. What we need to improve our intellectual state is not an increase of activity on the part of the Government, but deeper convictions of social duty throughout the community, and, above all, a livelier sense of parental responsibility. Let us have these things, and the republic will be safe, and education will begin to be truly humanizing and truly progressive.

A TEST OF PHILOSOPHY.

There is now a pretty decided agreement among the intelligent and unprejudiced that Herbert Spencer takes rank as the first philosopher of England, and G. H. Lewes many years ago declared him to be the *only* English thinker who has originated a philosophy. How much this may mean is well intimated by the remark of Mr. Lester F. Ward, that, "when we have reached England's greatest in any achievement of mind, we have usually also reached the world's greatest."

But there is still room to regard the compliment as equivocal, for the question remains, What is it to be "the first philosopher"? To be first and alone in a department of thought obviously means little or much, according to the grade of intellectual work involved. Philosophy is a vague term, and, as experience shows, may imply the lowest as well as the highest exercise of the mind. As applied to systems of speculation in pre-scientific ages, it no doubt represented the best mental effort then possible. But as applied in these times to similar speculations, with little reference to the rise of modern knowledge, it is not the highest kind of intellectual performance. True philosophy—the deepest and largest understanding of things—must be so far scientific in spirit and method as to place facts first, and work in subordination to them. The philosophy that is typified by the Concord school, which is most interested in the transcendental, which gives imagination the lead, leaves vulgar facts to the Gradgrinds, and is as jealous of science as theology, is not a very exalted form of mental exertion, and to be first in it is no great compliment. Philosophy, to achieve its highest objects, must now begin with the patient study of long-contemned realities; must discipline the imagination, must work in subordination to established knowledge, and aim to bring out profounder truth for the practical guidance of man in ordering the course of his life.

To be the first philosopher of the foremost nation of the world from this point of view is exalted praise, and this is the position that Mr. Spencer has undoubtedly won. His philosophy is based upon Nature, is limited to Nature, is subordinated to science, and is such a presentation of the laws and order of the world as bears immediately upon questions of human conduct. It is synthesis of the principles which become all-determining rules in the practical sphere of human action. It bears upon religion, upon politics, upon education, and upon social and domestic experience, with the authority of science and the full power of a verified system of natural laws. It was long a reproach to Spencer that he undertook to deal with so many subjects, but it is now perceived that this was but the inevitable consequence of that comprehensive method which the advance of modern knowledge had made possible and imperative.

We have been led to these remarks by a circumstance, not in itself of much importance, but which is yet significant as giving a new attestation of the worth of Spencer's philosophy in its practical bearings. Mr. Spencer has applied his philosophical views to the subject of education, and his little treatise upon the subject has been rendered into all the languages of the civilized world. And now, by an appeal made to the judgment of English teachers, the verdict has been rendered that the first of English philosophers is also the first of English educators. We see, by the London "Journal of Education," that an extra prize was offered for the best list of the seven greatest living educationists classed in the order of importance. A great number of lists were sent in, and the prize was awarded to "X. Y. Z." for the following list: 1, Spencer; 2, Huxley; 3, Wilson; 4, Thring; 5, Miss Buss; 6, Laurie; 7, Quick. Besides this premium list, in which the name of Spencer was first in importance, his name also appeared in seventy-two other lists, while Bain appeared in fifty; Huxley, thirty-eight; Thring, thirty-six; Miss Beale, thirty-four; Miss Buss, thirty-three; R. H. Quick, thirty-two; E. A. Abbott, thirty one; A. J. Mundella and J. G. Fitch, twenty-nine; J. Ruskin and M. Arnold, twenty-eight.

It has been said in deprecation of Spencer that "only the Seven Sages can understand him"; but it seems that practical teachers can sufficiently understand him to be able to form a very appreciative estimate of his position in the field where they are the most competent judges.

LITERARY NOTICES.

American Political Ideas: Viewed from the Stand-point of Universal History. Three Lectures delivered at the Royal Institution of Great Britain, in May, 1880. By John Fiske. New York: Harper & Brothers. Pp. 158. Price, $1.00.

As many will be gratified to learn, Mr. Fiske has at length published the brief course of lectures upon "American Political Ideas" which attracted so much attention at the time of their delivery in England, and subsequently in this country. They afford an excellent popular illustration of the scientific method in politics, and as an original statement of the place of American political institutions in the progress of civilization they will be read with deep interest and patriotic pride by multitudes of our thoughtful citizens. Under the three titles of "The Town-Meeting," "The Federal Union," and "Manifest Destiny," the author gives us a pregnant discussion of the ideas that are at the foundation of true political development, of their historic growth, and the vast consequences to the world of their present success and their future ascendency.

Mr. Fiske takes the "town-meeting," the idea of which is so thoroughly familiar in this country, as the elemental basis of our political system. He devotes his first lecture to the consideration of it as involving the principle of local self-government. The present or absence, in various degrees, of institutions corresponding to this, in different countries, is shown to be intimately connected with the progress of free government, and to have exerted a powerful control over the character and destiny of nations.

Having treated of the corporate units of society, the township, the village, the parish, or whatever grouping becomes the seat and center of local self-control, Mr. Fiske passes in his second lecture to the important problem of their combination or aggregation into coherent extended political organizations. In communities of despotic type this is done by conquest and centralized military power. But wherever and to the degree in which civilization or civil agencies have replaced militancy, the principle of representation arises, and the freer mode of government takes the form of federal union. Mr. Fiske illustrates the progress and vicissitudes of the federal principle very impressively from Greek, Roman, and modern history, and in the United States, where representation and federal unity have received their largest application.

The third lecture, on "Manifest Destiny," is a brilliant and powerful exposition of the vast scale and comprehensive interaction of the political forces that are now so potent in civilization, and that are destined to work out grand results in the future. He shows that civilization is to conquer through peace; that the militant countries will have to disband their armies under the irresistible influence of the industrial competition of nations; and that the pacific federation of great communities is as certain to replace brute force in the politics of the civilized world as civil processes have replaced arbitrary violence in the private relations of men. The real significance of the American civil war is shown to consist in the vindicated strength and supremacy of the great pacific and constructive federative principle which is to dominate in the political future of civilization; and the data are given by which to forecast the stupendous future of the English race, not only on this continent, but throughout the world.

Although written with sobriety, to be submitted to the critical judgment of a cultivated audience, yet these lectures are a good deal stirring and stimulating in their effect upon the reader's mind. This is due both to the charm of the presentation and to the magnitude of the elements of the author's imposing theme. "The stand-point of universal history" affords an exciting outlook, and Mr. Fiske gives his readers a clear command of the position. The author of "Cosmic Philosophy," with whom the conception of universal evolution has become part of his mental constitution, is well prepared to handle historical questions in the fullest breadth of their bearings, and the interest of the present book is chiefly derived from this preparation of its author. It may, in fact, be commended as a specially instructive study in political evolution. This is well explained by Mr. Fiske in the following prefatory passage:

In the three lectures now published I have endeavored to illustrate some of the fundamental ideas of American politics, by setting forth their relations to the general history of mankind. It is impossible thoroughly to grasp the meaning of any group of facts in any department of study until we have duly compared them with allied groups of facts; and the political history of the American people can be rightly understood only when it is studied in connection with that general process of political evolution which has been going on from the earliest times, and of which it is itself one of the most important and remarkable phases. The government of the United States is not the result of special creation, but of evolution. As the town-meetings of New England are lineally descended from the village assemblies of the early Aryans; as our huge Federal Union was long ago foreshadowed in the little leagues of Greek cities and Swiss cantons—so the great political problem which we are (thus far successfully) solving is the very same problem upon which all civilized peoples have been working ever since civilization began. How to insure peaceful concerted action throughout the whole, without infringing upon local and individual freedom in the parts, this has ever been the chief aim of civilization viewed on its political side; and we rate the failure or success of nations politically according to their failure or success in attaining this supreme end. When thus considered in the light of the comparative method, our American history acquires added dignity and interest, and a broad and rational basis is secured for the detailed treatment of political questions.

The Nature and Reality of Religion. A Controversy between Frederic Harrison and Herbert Spencer. With an Introduction, Notes, and an Appendix on the Religious Value of the Unknowable, by Count D'Alviella. New York: D. Appleton & Co. 1885. Pp. 218. Price, cloth, $1; paper, 50 cents.

That there is a "chaos of discordant opinion" in the religious world is a common remark, and, superficially regarded, the remark is true enough. There are divers great religious systems accepted by vast multitudes which exemplify profound diversities of belief; and these systems are broken up into sects innumerable, all marked by divergences of religious opinion. Yet this state of thought is by no means a "chaos"; there are order and law in it. Religious phenomena exhibit their predictable sequences of cause and effect. It may be counted on that people generally will stick to the faith into which they were born, and to the sect in which they were brought up, regardless of any question of the rationality of the creed they hold. Indeed, the tenacity with which, generation after generation, they cling to the accidental tenets they inherit, is an element of order which gives to religious organizations their stability and permanence.

Yet the condition of the religious world is by no means one of absolute immobility and stagnation. To the degree in which the human mind is active, religion shares the result. While many are quiescent, a few are ever inquiring, and, with increasing enlightenment and growing knowledge, the superstitious element in religion gradually diminishes and disappears. This, too, is an orderly change, and goes on in the religious world by the established laws of progress.

Such controversies as those of Spencer and Harrison are, hence, quite in the course of things. With whatever considerations of personality they may be mixed up, they are products of religious advancement, and still further contributions to it. The present discussion, however, is of more than usual significance, as it is not occupied with incidental but with fundamental religious questions. The conception of progress in religion is unquestionably revolutionizing and destructive, and no problem is more profound or momentous than that which seeks to determine the final result of religious evolution. However it is to be commended, or however deplored, the advanced mind of this generation is deeply engaged with the most radical religious questions; and it is fortunate, when, as in the present case, the contestants are men of earnestness, sincerity, and reverence, as well as of fearlessness, brilliancy, and power. To the readers of the "Monthly" nothing need be said in regard to the special merits of this controversy, except that they will find the volume convenient from the completeness of the views it presents.

Land-Laws of Mining Districts. By Charles Howard Shinn. Baltimore: N. Murray. Pp. 83. Price, 50 cents.

Mining-Camps. By Charles Howard Shinn. New York: Charles Scribner's Sons. Pp. 316. Price, $2.

These two works present the results of an investigation into the history of mining-camps, undertaken with a hope of giving the forms of social organization manifest in the early "districts" of the Sierras, Coast Range, and Rocky Mountains, their proper place in the story of institutional development on American soil. The work first named is one of the "Johns Hopkins University Series of Studies in Historical and Political Science"; and the editor of the series introduces it with the intimation that it is a "natural, though unconscious, continuation of Mr. Johnson's study of 'Rudimentary Society among Boys,'" which we have already noticed, "and that it might be called 'Rudimentary Society among Men.'" The second work is of larger scope and more fully wrought out. Mr. Shinn has done a good work in elucidating some peculiar phenomena of social and political development. What his essays teach may be illustrated by quoting one of the passages in "Mining-Camps": "In every important particular the organizations of the typical mining-camps, which we have been considering, offer sharply-outlined contrasts. Camp-law has never been the enemy of time-tried and age-honored judicial system, but its friend and forerunner. Axe of pioneer and pick of miner have leveled the forests, and broken down the ledges of rock, to clear a place for the stately structures of a later civilization. Rude mountain courts, rude justice of miner-camps, truth reached by short cuts, decisions unclouded by the verbiage of legal lexicons, a rough-hewed, sturdy system that protected property, suppressed crime, prevented anarchy—such were the facts; and on these frontier government rests its claims to recognition as other than mob-law, and better than passionate accident."

"The Jukes": A Study in Crime, Pauperism, Disease, and Heredity. By R. L. Dugdale. Fourth edition. New York: G. P. Putnam's Sons. Pp. 121. Price, $1.25.

This book embodies the substance of a famous paper, which, first published in the report of the Prison Association for 1877, has probably done more to promote the investigation of methods for the reform of criminals and the prevention of crime than any other single document of the time. It is, as the editor, Mr. Round, says in the introduction, "known, read, and valued wherever the civilization of the world has advanced far enough to be alarmed at the increase of crime, and to be concerned in reducing the criminal classes." It relates the story of a large family of criminals, prostitutes, and vagrants, which infested a group of counties in New York for two or three generations, all the descendants of a prostitute who was left to go her ways for evil unrestrained by any efforts to reclaim her. A new edition has been demanded in the interest of penal science. The original paper is supplemented with further studies of criminals, and an introduction insisting on the importance of the investigations by Mr. William M. F. Round, Secretary of the National Prison Association.

A Popular Exposition of Electricity. With Sketches of some of its Discoverers. By the Rev. Martin S. Brennan. New York: D. Appleton & Co. Pp. 191. Price, 75 cents.

The object of this book is to make all familiar with the essential principles, at least, of the science of electricity; a purpose which none of the learned and excellent treatises devoted to the subject, "but so illustrated with complex and intricate mechanical diagrams as to frighten away the timid and uninitiated," seem adapted to effect. The author has, therefore, devoted his attention almost entirely to the explanation of principles, to the exclusion of mechanics. He has aimed to exhibit the identity of all the forms of electricity, and has accordingly so arranged the matter of his treatise that each succeeding form shall appear to flow naturally from its predecessor. For the biographical sketches, those men have been selected whose discoveries have added most to the science; and the sketches are so distributed that each one shall be in logical juxtaposition with those branches of the science that have been most conspicuously illustrated by its subject. In the several chapters are given explanations of magnetism; the "Mariner's Compass," statical and atmospheric electricity, galvanism and galvanic batteries, electro-chemical decomposition, electrotyping and gilding, electro-magnetism, the electric telegraph, magneto-electricity and dynamos, the storage of electricity, the telephone, the aurora borealis, and Faraday's observations on table-moving. The subjects of the sketches are Faraday, Franklin, Galvani, Volta, Oersted, Ampère, and Professor Morse.

The Care of Infants: A Manual for Mothers and Nurses. By Sophia Jex-Blake, M. D. London and New York: Macmillan & Co. Pp. 109. Price, 40 cents.

The subject of this primer is a most important one, especially in view of the frightful rate of infant mortality that prevails, largely the result of ignorance and carelessness. The author is a most competent person to discuss it. Her purpose, she says, is "to supply, in the simplest and easiest possible way, the few leading facts respecting infant existence, and to specify, as briefly and clearly as may be, the treatment demanded by Nature and common sense for the preservation of the frail little lives that are perishing by millions for want of it."

Annual and Seasonal Climatic Maps of the United States. By Charles Denison, Denver, Colorado. Chicago: Rand, McNally & Co. Five Maps, in Colors, variously mounted.

These maps are compiled from the returns of the Signal-Service Office, and are designed to show, graphically, by an equable standard and on impartial authority, chiefly, the average amount of cloudiness and precipitation at every place in the United States, for the year and for each season. In addition to this, they give the isothermal lines, the directions of prevailing winds, and of winds that usually and those that do not usually bring rain or snow, elevation above the sea, location of mineral springs, annual, monthly, and daily ranges of temperature, and other information that can be given graphically, or in a table, relating to the climatology of our country. The maps can be had separately, or, as in the case of the set submitted to us for examination, mounted on opposite sides of the same sheet.

Controlling Sex in Generation. By Samuel Hough Terry. New York: Fowler & Wells Company. Pp. 147. Price, $1.

This is an attempt to discover the physical law influencing sex in the embryo of man and brute, and its direction to produce male and female offspring at will. The subject is an important one to breeders, and the author thinks he has discovered its law, claiming that the determination of the sex of offspring in all life lies in the separate physical conditions of the two parents. In his book he shows how he has reached his conclusion, brings forward the evidence by which he believes it is sustained, and makes suggestions respecting its practical bearing.

The National Dispensatory. Containing the Natural History, Chemistry, Pharmacy, Actions, and Uses of Medicines. By Alfred Stillé, M. D., and John M. Maisch, Ph. D. Third edition. Philadelphia: Henry C. Lea's Son & Co. Pp. 1,755, with 311 Illustrations.

The first edition of the "National Dispensatory" was published in 1879. It included descriptions of all crude drugs and chemical and pharmaceutical preparations, officinal in the Pharmacopœias of the United States and Great Britain, together with the more important medicines of the French Codex and German Pharmacopœia which were, to some extent, prescribed here, or which might serve for comparison with similar articles in the English and American standards; also, of drugs not recognized by any pharmacopœia, but often kept in the shops because they were prescribed by physicians, or used in domestic practice, either entered under their own headings, or as "allied drugs" under those of more important substances. With these descriptions was given such information about the botanical character of plants yielding drugs, the external and structural characteristics, and the modes of preparation of drugs, their chemical properties, and their physiological action as determined by experiment, as seemed appropriate to the purposes of the work. The present edition may be regarded as embodying the pharmacopœias of the four chief civilized nations. Those of the United States and Germany appeared at the close of 1882, and formed the basis of the revision. The French Codex was published after the work was prepared for the press, but in time to admit of its incorporation. The British Pharmacopœia has not been revised since 1867. Many of the newer statements have been tested and corrected by special experiments. A large number of extra-pharmacopœial medicines have been added to those in previous editions. Numerous historical notes have been added. The descriptions have been condensed or extended as occasion seemed to require, and microscopical structure has been more fully described and illustrated. While the most recent views of the physiological action, so far as it explains the curative effects of medicines, have been given, all generalizations have been kept subordinate to the practical character of the work. The General Index contains more than 3,700 more references than that of the second edition, and the Index of Therapeutics nearly 1,600 new references. The references to authorities in the therapeutical portion of the work have been extended.

Occult Science in India and among the Ancients, with an Account of their Mystic Initiations, and the History of Spiritism. By Louis Jacolliot. Translated by Willard L. Felt. New York: John W. Lovell Company. Pp. 275.

It may be well to say, in view of the manner in which the title has been used by a certain sect, that this is apparently a real historical study and an account of phenomena which, whatever may be their character, exist and have not been explained. The author is Chief-Justice of Chandernagore, in the French East Indies, and of Tahiti, who has, during long residence in India, given considerable attention to investigations of the subject, and to observations of the practices of those who have been initiated into the sect of the Pitris, or ancestral shades. The book, he declares, is neither a doctrinal one nor a work of criticism. He does not feel himself called upon to decide either for or against the belief in spirits, either meditating or inspiring, which was held by those who had been initiated in the temples of antiquity, and which is the keystone of the philosophical and religious instruction of the Brahmans; therefore he regards himself as the better able to write its history. He assumes to give "the words themselves," and set forth things as they actually were; to interpret and explain the philosophical compendium of the Hindoo spiritists; to tell what he saw with his own eyes, and faithfully record such explanations as he received from the Brahmans. He pays attention to the phenomena which the fakirs produce at will, which are variously regarded, but concerning which he remarks that "the facts which are simply magnetic are indisputable, extraordinary as they may seem. As to the facts which are purely spiritual, we were only able to explain those in which we participated, either as actor or spectator, upon the hypothesis that we were the victims of hallucination, unless we are willing to admit that there was an occult intervention."

The Sanitary Engineer. Conducted by Henry C. Meyer. Volume X. June to November, 1884. 140 William Street, New York. Pp. 612. Price, $4 a year.

The "Sanitary Engineer" is a journal of civil and sanitary engineering and public and private hygiene, and gives particular attention to plumbing and the construction and arrangement of houses, with reference to sanitary conditions. The present volume contains many valuable papers; among them those relating to the International Health Exhibition, to describing and illustrating the plumbing, heating, ventilating and lighting of notable buildings, to steam-fitting and steam-heating, and the reports of various hygienic conventions.

JOHNS HOPKINS UNIVERSITY STUDIES IN HISTORICAL AND POLITICAL SCIENCE.

THE projectors of the "Johns Hopkins University Studies in Historical and Political Science" offer a third series of their monthly monographs, which have proved so valuable and instructive, to be devoted to American institutions and economies. The series will include papers on "Local and Municipal Government," "State and National Institutions," and "American Socialism" and "Economies." The numbers may be obtained separately, or the series as a whole after it is completed, from N. Murray, publication agent, Baltimore.

ONE HUNDRED YEARS OF PUBLISHING, 1785–1885. Philadelphia: Lea Brothers & Co. Pp. 20.

THIS is a memorial volume commemorative of the hundredth year of the publishing house whose imprint it bears. The business of the house was founded by Matthew Carey, an Irish exile, who began a daily paper in 1785, to which he soon added a monthly magazine. He and his successors then published quarto Bibles—the Douay and authorized versions—the Waverley Novels, the works of Fenimore Cooper, Washington Irving, and other early American authors, with some encyclopedic books which evinced considerable boldness of enterprise for their day, and introduced the American public to the genius of Charles Dickens. Gradually the business of the house tended to medical and scientific publications, to which, giving up literary and miscellaneous works, it has of late years been exclusively devoted. No member of the house has died in the business, but each one has in his turn withdrawn in season to enjoy the fruits of his industry.

THE MENTOR. By ALFRED AYRES. New York: Funk & Wagnalls. Pp. 211.

THIS little book, by an author already well known by his "Orthoëpist," "Verbalist," etc., is intended "for the guidance of such men and boys as would appear to advantage in the society of persons of the better sort." As the author well says, not wealth, but moral worth, supplemented with education, and enough money to make one's self presentable, are the passport to the better circles of society In the body of the work are given common-sense principles respecting what constitutes a good personal appearance and good behavior—at the dinner-table, and in public, in conversation, in calls, and at cards, "odds and ends," and "What is a Gentleman?"

THE NEXT STEP OF PROGRESS: A LIMITATION OF WEALTH. By JOHN H. KEYSER, 115 Beekman Street, New York. Pp. 50. Price, 20 cents.

THIS document expounds the principles of a new party which has been formed, or is in the process of formation, of which the author appears as one of the active organizers. It proposes to "level up, not down," and to break monopoly by promoting a limitation of wealth. For this purpose, it would impose a graduated taxation on accumulating and accumulated fortunes, ranging, say, from one half of one per cent on estates of between $10,000 and $20,000, to fifty per cent on estates of $5,000,000 and upward.

SCHOOL-KEEPING. How to do it. By HIRAM ORCUTT. Boston: N. E. Publishing Company. Pp. 244. Price, $1.

THIS volume embodies to a great extent fruits of the author's experience; incidents that have happened during his school-keeping, and the thoughts and principles that have been suggested by them. Its design is to aid and encourage teachers who need and would profit by the experience of others; and to awaken an interest in the subjects treated, and lead to a more extensive reading and study of the works of standard authors on pedagogics, with a more careful preparation for the important duties of their position. It is a pleasant book, and contains good thoughts.

DILUVIUM: OR, THE END OF THE WORLD. By GEORGE S. PIDGEON. St. Louis: Commercial Printing Company. Pp. 175, with Plates.

THE author's purpose in publishing this book is to invite consideration of the possible consequences that may follow the execution of such a project as the French one for turning the waters of the ocean into the Desert of Sahara, and forming a great inland sea there. He apprehends that the sudden transfer of so large a mass of matter from one part of the earth's surface to another will be attended with a disturbance of the center of gravity of the planet, and with convulsions, floods, and great disasters to the continents and what is upon them. Further, "meteorological, electrical, and other phenomena of equal greatness, grandeur, and sublimity, as those of land and water, would follow a paroxysmal movement of the earth." Therefore, it will be well to halt before making real so rash a scheme.

Inglish az She iz Spelt. Perpetrated by Fritz Federheld. New York: G. W. Carleton & Co. Pp. 93. Price, 25 cents.

The compiler of this odd composition evidently regards the accepted English orthography as a fetich to whose sanctity he does not consider himself bound to pay any respect; for he holds it up to ridicule in a very amusing style by parodies, epigrams, comic poems, anecdotes, and witty extracts, the purport of all of which is to stamp the whole system as inconsistent with itself, and particular features of it as absurd. The variety of the sounds which are given to the groups of letters "ough" is humorously set forth in several pieces, the most noteworthy of which is Planché's squib on the pronunciation of the name of Lord Houghton. Other rhymes, drawn from Professor Barnard, Professor Gregory, and others, expose what appear to be monstrosities of spelling, but which are shown to be justified by analogous spellings in other words recognized as orthographic. A series of extracts from standard authors shows what was the condition of English spelling, at intervals of about fifty years, from Chaucer to Samuel Johnson.

Practical Work in the School-Room. Object-Lessons on the Human Body. New York: A. Lovell & Co. Pp. 157.

This volume embraces transcripts of lessons that have been given in the primary department of Grammar-School, No. 49, New York, and which include instructions consonant with the plan, on the subject of physiology and the effects of stimulants and narcotics. The plan of teaching comprises a model lesson, to show how each subject should be developed and taught; a formula, embodying the principal facts presented; questions on the formula; directions for touching, or pointing to the part under description; questions on the lesson; and a blackboard outline.

Alice's Adventures in Wonderland, and Through the Looking-Glass. By Lewis Carrol. New York: Macmillan & Co. Pp. 192 and 224, with 92 Illustrations. Price, paper, 50 cents; cloth, 75 cents.

Two books in one, of pure nonsense and delightful absurdities, which have for several years enjoyed extensive popularity. In the first book, Alice goes down into a rabbit-hole and has stirring adventures with the rabbit and an animated pack of cards. In the second story, she succeeds in getting into the country behind the looking-glass, where she finds everything reversed, and meets the characters of Mother Goose and English folk-lore mythology.

Serapis. By George Ebers. From the German by Clara Bell. New York: William S. Gottsberger. Pp. 387. Price, 90 cents.

This is a story of Alexandria in A. D. 391, under Roman rule; one of those attempts to restore and present to the present age the life of antiquity, with some of the most successful of which the author's name is associated.

The Wane of an Ideal. By La Marchesa Colombi. From the Italian by Clara Bell. New York: W. S. Gottsberger. Pp. 260. Price, 90 cents.

A story, by a popular living Italian novelist, of contemporary village life in the north of Italy, in which "a variety of the social problems which occupy Italian thought are treated in a way which is humorous without being cynical," and having a close "which is melancholy but scarcely tragical."

The Canadian Record of Science. Vol. I, No. 1. Quarterly. Pp. 64. Price, $3 per volume of eight numbers.

This journal takes the place of "The Canadian Naturalist and Geologist," and is under the charge of an editing committee of the Natural History Society of Montreal, which is composed of T. Sterry Hunt, D. P. Penhallow, B. J. Harrington, J. Wanless, and J. T. Donald. The intention of the editors is to present both original and selected articles, more particularly those of especial interest to the Dominion. In the present number we find a history of the journal of which this is a continuation; an account of "The Royal Society of Canada"; a paper by Professor Dawson on "Rhizocarps in the Palæozoic Period;" a description by the Rev. Émile Petitot of "the Athabasca District of the Canadian Northwest Territory"; and shorter papers.

"SHADOWS": Being a Familiar Presentation of Thoughts and Experiences in Spiritual Matters, with Illustrative Narratives. By JOHN WETHERBEE. Boston: Colby & Rich. Pp. 288.

THE author's endeavor has been to give, in a series of chapters, each of which shall be a finished one of itself, the reasons, without particularly saying so, why he is a spiritualist; or to make a familiar presentation of the subject of modern spiritualism to those whom it may concern, both among its exponents, and among that wider world who feel interested in the subject, "and wish it were true," and want the "bottom facts."

MARYLAND'S INFLUENCE UPON LAND CESSIONS TO THE UNITED STATES. With Minor Papers. By HERBERT B. ADAMS, Ph. D. Baltimore: N. Murray. Pp. 102. Price, 75 cents.

THIS essay constitutes the first number of the third series of "Johns Hopkins University Studies in Historical and Political Science"—a series which is to be devoted to American institutions and economics. Among the purposes the author endeavors to serve in publishing it is to "call attention to the territorial foundations of the American Union, and point out the fact that our public lands stand in the same fundamental relation to our national commonwealth as did common lands to the village republics of New England. The great West was the *Folkland* of the United States; it bound them together by economic interests when they would otherwise have fallen apart after the Revolution. To trace out the further constitutional influence of our public lands upon the development of these States, which have increased and multiplied within the national domain, as did New England parishes within the original limits of one town, this would be a contribution indeed to American institutional history." As bearing upon this point, the author outlines a wide and varied field of research, on which it is hoped laborers will soon be engaged, and parts of which are to be exploited in future numbers of this series. The "Minor Papers" include articles on "George Washington's Interest in Western Lands," the "Potomac Company," and a "National University."

EGYPT AND BABYLON, FROM SACRED AND PROFANE SOURCES. By GEORGE RAWLINSON. New York: Charles Scribner's Sons. Pp. 329. Price, $1.50.

THE Bible abounds in references to Egypt and the Mesopotamian empires and their affairs. So long as we had to depend for our knowledge of those countries in ancient times from the statements, generally half informed and often erroneous, of the Greek historians, these references were obscure and difficult to verify. The progress of archæological discovery has put a different face upon matters. Under its light the life and history of these extremely ancient empires have been revealed at many points with remarkable vividness and a precision which we have hardly yet attained concerning some contemporary people, and the references in the Bible have been, to a very large extent, endowed with an exact significance. It is hardly necessary to say that further elucidations on points that are still dark may be anticipated from continued researches. It has been Mr. Rawlinson's task to collect the references, separately for Egypt and for Babylon, in the Bible, taking them nearly in chronological order, and to compare them with the facts, as related in other histories, and as inscribed in contemporary records, on the monuments executed by the rulers and peoples of the empires to which the references are made.

VAN NOSTRAND'S ENGINEERING MAGAZINE. Vol. XXXI, July–December, 1884. New York: D. Van Nostrand. Pp. 524.

THIS publication has a place of its own. It appeals especially to engineers, and to persons who are interested in the construction of works beyond the sphere of ordinary builders, and in extensive applications of machinery; and its papers on subjects of such class, both original and selected from foreign journals, are, as a rule, written by experts, by men who have made special study of the points they are discussing, or have had experience in the application of them. It also pays considerable attention to topics of a more general scientific character, and gives much withal that commends itself to persons who are not specialists or professionally informed, but who have an intelligent interest in the progress of the departments to which it is devoted.

Proposed Plan for a Sewerage System, and for the Disposal of the Sewage of the City of Providence. By Samuel M. Gray, City Engineer. Pp. 146, with Plans and Maps.

City Engineer Gray was deputed by the City Council of Providence, a year ago, to proceed with his assistant to Europe to investigate the various plans in practical operation for the disposition and utilization of sewage, and upon the information thus obtained to report a plan for adoption in that city. The list of cities and works he visited, in England, Wales, Holland, France, and Germany—wherever, in fact, important sewerage-works have been undertaken, or systems for the disposition of sewage have been tried, or are under trial—shows that his inspection was a busy one. In the plan which he has devised, with the aid of these observations, he has had in view the principle which is in reality the Hamlet of the question, but is too often left out, that "no system of sewerage is complete which fails to dispose of the sewage so as to avoid its causing a nuisance." The report embodies a large mass of information, presented with commendable brevity. After an historical review of the subject, the several systems for disposing of sewage are considered as to their general principles and specifically. Among these are the systems of sewage interception, or dry-sewage systems, the pneumatic systems (Liernur, Berlier, and Shone); the water-carriage system; and the systems of disposal by irrigation and precipitation; with a comparison of the different methods of purifying sewage. Although prepared only for a special object, the report might, in the absence of any other comprehensive work, serve as a general manual of the subject.

Tables, Meteorological and Physical. By Arnold Guyot. Fourth edition, revised and enlarged. Edited by William Libbey, Jr. Washington: Smithsonian Institution. Pp. 738.

Professor Guyot's original work, published in 1852, was the first of the series of "Tables of Constants," to which the Smithsonian Institution is gradually making important contributions, and has proved, by the demand which arose for it, to be the one of the series that has met the most general public want. A second revised edition was published in 1857, in which the tables were so enlarged as to extend the volume of the book from two hundred and twelve to more than six hundred pages. A third edition was published in 1879, with further amendments. The author began the revision for this fourth edition in 1879, but was met with delays, and died before completing the work, which was left for his assistant and successor in his college professorship to finish. The contents consist of tables comparing the different thermometrical scales, with reductions from one to another; hygrometrical tables, with tables for the conversion of metrical hygrometric measures into others; barometrical tables; hypsometrical tables; geographical measures, in which means are given for reducing the measures of all countries from one to another; meteorological corrections; and "Miscellaneous Tables useful in Terrestrial Physics and Meteorology." The whole constitute a valuable reference-book.

The Ornithologist and Oölogist, Vol. IX. 1884. Pawtucket, R. I.: Frank B. Webster, publisher. Twelve Numbers. Pp. 152. Price, $1.50 a year; 15 cents a number.

As is implied in its title, this is a magazine devoted to birds, their nests, and eggs. It is beautifully printed, and is sustained by a corps of competent and enthusiastic contributors, who record in it their daily, weekly, monthly, yearly, or occasional observations, on these the most attractive of man's companions on the earth. It is a pity that so many of them consider it an indispensable preliminary to the observations to shoot the birds or steal their eggs. In the present state of science, these things, when they are done, are unnecessary in nine cases out of ten. Except for the encouragement given to this practice, which is reprehensible, except when most sparingly and discriminatingly indulged in, we cordially recommend the "Ornithologist and Oölogist" as a publication that every lover of Nature will do well to have by his side. It also admits to its pages notes and observations on the kindred study of entomology.

Our Bodies; or, How we live. By Albert F. Blaisdell, M. D. Boston: Lee & Shepard; New York: Charles F. Dillingham. Pp. 285. Price, 60 cents.

This is a "Physiology for the Young," intended for an elementary text-book in the common schools. It aims to present clearly, concisely, and in a logical order, the most important facts about the build and health of our bodies. Prominence has been given to such facts of anatomy and physiology as are essential to a proper understanding of the laws of hygiene. Hence, special emphasis has been laid upon the practical bearing of this branch of science upon daily life and personal health. As far as possible, each paragraph is complete in itself, and discusses a definite subject. The instructions of the text are re-enforced by review and analytical chapters, and by a systematic series of practical and suggestive experiments, simple and not requiring expensive apparatus.

Stories by American Authors. IX. New York: Charles Scribner's Sons. Pp. 180. Price, 50 cents.

It was a happy thought to gather up into this series of volumes, convenient to hold in the hand or to put in the pocket, the fugitive short stories that have appeared from time to time in various publications; many of them, perhaps, by authors whose works would never have been otherwise collected. To say nothing of their interest as stories, these works are of value—if we may judge from the present volume—as giving pictures of American character and life in various situations, with bright local coloring. One of the stories pictures a Virginia neighborhood before the war; another gives a piece of the life of a New England seaport village; a third offers a view of a California village, with its political boss; and another is a sailor's yarn, told in his own dialect.

PUBLICATIONS RECEIVED.

Should Experiments on Animals be restricted or abolished? Pp. 15. Methods of studying the Physiological Action of Drugs. Pp. 20. Death. Pp. 5. All by Robert Meade Smith, M. D. Detroit: George H. Davis.

"The Pulpit of To-Day." A monthly magazine of sermons. Alfred E. Rose, Editor, Westfield, N. Y. New York: Fords, Howard & Hulbert. Pp. 58.

The Thermic Phenomena in Contraction of Mammalian Muscles. By Robert Meade Smith, M. D. New York: G. P. Putnam's Sons. Pp. 50.

The Truth-Seeker Annual and Free-Thinkers' Almanac, for 1885. New York: Truth-Seeker Office, 33 Clinton Place. Pp. 120. 25 cents.

A Correction of Certain Statements published in "The Zoöphilist." By H. Newell Martin, M. D., Baltimore. Pp. 11.

The New Departure in College Education. By James McCosh, President of Princeton College. New York: Charles Scribner's Sons. Pp. 23. 15 cents.

U. S. Department of Agriculture. Report of the Entomologist, for 1884. By Charles V. Riley. Washington: Government Printing-Office. Pp. 144, with Ten Plates.

Report on the Waters of the Hudson River. By C. F. Chandler, Ph. D. New York: Trow's Printing and Bookbinding Company. Pp. 35.

"The Journal of Physiology." Edited by Michael Foster, M. D. Vol. V, Nos. 4, 5, 6. Cambridge, England. Baltimore: Professor H. Newell Martin. Pp. 180, with Plates. $5 a volume.

Alabama Weather Service. February, 1885. Auburn, Ala.: Agricultural and Mechanical College. Pp. 15.

Medical Jurisprudence in Divorce. By Carl H. von Klein, M. D., Dayton, Ohio. Pp. 8.

A General Description, etc., of the Cotton-producing States. By Eugene A. Smith, Ph. D. Tuscaloosa, Ala. Pp. 80, with Maps.

Septennial Report of Ligonier Public Schools, Indiana. Pp. 89.

Supplement to the Transactions of the Sei I Kwai, or Society for the Advancement of Medical Science in Japan. "Transactions" Monthly. Tokio. Pp. 16 English—40 Japanese. $2 silver a year.

Ten Days in the Laboratory with Dr. Robert Koch, of Berlin. By George W. Lenois, Jr. Buffalo, N. Y. Pp. 15.

Mind in Nature. Vol. I, No. 1. Monthly. Chicago: Cosmic Publishing Company. Pp. 16. 10 cents a copy; $1 a year.

A Synopsis of the Medical Botany of Illinois. By J. M. G. Carter, M. D., Waukegan. Pp. 45.

The Progress of the Working-Classes in the Last Half-Century. By Robert Griffen. New York: G. P. Putnam's Sons. Pp. 43. 25 cents.

The Osteology of Amia Calva. By R. W. Shufeldt. Pp. 132, with Fourteen Plates.

The Action and Antagonism of some Drugs on the Frog's Ventricle. By Thomas J. Mays, M. D. Philadelphia. Pp. 17.

Sorghum, its Culture and Uses. By Dr. Peter Collier. New York: Chamber of Commerce. Pp. 20.

"The Cornell Review," March, 1885 (Woodford number). Pp. 28.

An Electric Ophthalmoscope. By Louis J. Lautenbach, M. D., of Philadelphia. Pp. 7.

New York State Board of Health. Monthly Bulletin, February, 1885. Pp. 2.

Science and the Supernatural. By Professor A. J. Dubois, New Haven. Pp. 32.

Defective and Corrupt Legislation, The Cause and the Remedy. By Simon Sterne. New York: G. P. Putnam's Sons. Pp. 26. 25 cents.

A Hand-Book on the Teeth of Gears. By George B. Grant. Boston. Pp. 29. $1.

U. S. Bureau of Entomology. Catalogue of New Orleans Exhibit of Economic Entomology. Washington: Judd & Detweiler. Pp. 95.

A Solution of the Mormon Problem. By John Codman. New York: G. P. Putnam's Sons. Pp. 25. 25 cents.

"The Alumni Magazine" (Lincoln University). Philadelphia: 924 Lombard Street. Quarterly. Pp. 24. 30 cents a number, $1 a year.

International Electrical Exhibition, 1884. Reports of Examiners: XIX, Electric Telegraphs, pp. 24. XXIV, Electro-Dental Apparatus, pp. 11. XXVII, Applications of Electricity to Warfare, pp. 8. With Plates. Philadelphia.

New York State Reformatory. Report of the Board of Managers, 1884. Elmira. Pp. 100.

Local Institutions of Virginia. By Edward Ingle. Baltimore: N. Murray. Pp. 127. 75 cents.

International Fisheries Exhibition. Report upon the American Section. By G. Brown Goode. Washington: Government Printing-Office. Pp. 1,279.

Man's Birthright; or, The Higher Law of Property. By Edward H G. Clark. New York: G. P. Putnam's Sons. Pp. 133. 75 cents.

Madam How and Lady Why. By Charles Kingsley. New York: Macmillan & Co. Pp. 321, 50 cents.

Mind-Reading and beyond. By William A. Hovey. Boston: Lee & Shepard. New York: C. T. Dillingham. Pp. 201. $1.25.

Obiter Dicta. New York: Charles Scribner's Sons. Pp. 232. $1.

The History of the Present Tariff, 1860-1883. By F. W. Taussig, Ph. D. New York: G. P. Putnam's Sons. Pp. 111. 75 cents.

Jelly-Fish, Star-Fish, and Sea-Urchins. By G. J. Romanes. New York: D. Appleton & Co. Pp. 3-3. $1.75.

Geology and the Deluge. By the Duke of Argyll. Glasgow: Wilson & McCormick. Pp. 47.

Paradise Found. By William F. Warren, S. T. D. Boston: Houghton, Mifflin & Co. Pp. 504. $2.

The Lenâpé and their Legends. By Daniel G. Brinton. Philadelphia: D. G. Brinton. Pp. 262.

The "Quincy Methods" illustrated. By Lelia E. Partridge. New York: E. L. Kellogg & Co. Pp. 660. $1.50.

The Rescue of Greely. By Commander W. S. Schley and Professor J. R. Soley. New York: Charles Scribner's Sons. Pp. 277, with Maps. $3.

The Ten Laws of Health. By J. R. Black, M. D. Baltimore: J. R. Black, M. D. Pp. 413. $2.50.

The Life of Society. By Edmund Woodward Brown. New York: G. P. Putnam's Sons. Pp. 270. $2.

Contributions to American Ethnology. Vol. V. U. S. Geographical and Geological Survey. Washington: Government Printing-Office. Pp. 237, with Plates.

The Cretaceous and Tertiary Floras of the Territories. By Leo Lesquereux. Washington: Government Printing-Office. Pp. 283, with Fifty-nine Plates.

U. S. Geological Survey. Third Annual Report. J. W. Powell, Director. Washington: Government Printing-Office. Pp. 564, with Plates.

Geology of the Comstock Lode and the Washoe District. By George F. Becker. Washington: Government Printing-Office. Pp. 422. Atlas to accompany the same, 21 sheets and Maps.

The Religion of Philosophy, or the Unification of Knowledge. By Raymond S. Perrin. New York: G. P. Putnam's Sons. Pp. 566. $4.

Dinocerata. A Monograph of an Extinct Order of Gigantic Mammals. By Othniel Charles Marsh. Washington: U. S. Geological Survey. Pp. 237, with Fifty-six Plates.

POPULAR MISCELLANY.

Fifty Years of the Essex Institute.—Professor E. S. Morse has published a review of the condition of zoölogy fifty years ago and to-day, in connection with the growth of the Essex Institute, which has just completed its first half-century. The institute has always kept true to its name. It has been wholly for the benefit and in the interests of the county of Essex, in every corporate town of which but one public meetings have been held, to the number of two hundred in all; while the enthusiasm of its members has often led it beyond the limits of the county and of the State, into, in all, some sixty-eight "out-of-the-way places—little villages, cross-roads, and hamlets by the sea." To these places the society has induced the celebrated naturalists of the country to bring the results of their researches, and the latest and freshest fruits of science. Further evidence of its county character is found in the facts that its members are scattered over the county, and that it has aimed especially at forming a collection of the animals and plants of the county, and has such a collection, which is not excelled by any other of similar character. When the Institute was founded, there was not a single text-book of zoölogy in our schools; now, every high and classical school has its classes in zoölogy and botany, and every college its special professor. Then there was not a single popular periodical devoted to those sciences; now there are a number of illustrated weeklies and monthlies with a large circulation, the earliest of them, the "American Naturalist," having been founded under the auspices of the Institute; and even the newspapers keep pace with the progress of science, and publish special articles on scientific matters of interest. Then, the science of archæology was not born; now it is 'the most vigorous and aggressive of the sciences," and one of the Institute's men, Mr. Putnam, "is, for the first time, teaching the country the proper and only way of exploring the mysterious mounds of the West." The little society of a few men and a library of a hundred volumes has grown to be a powerful body of three hundred and forty members, with a library of thirty-eight thousand volumes.

Why Wool felts.—The cause of the felting properties of wool is generally attributed to serratures on the surface of the fibers, which are supposed, when driven into the closest possible contact, to hook into one another, and so to hold together by what might be called a "beggar's-lice grapple." The validity of this theory was called into question by two gentlemen of Hartford, Captain George R. Case, a microscopist, and Mr. Joseph Dawson, a woolen manufacturer. These gentlemen, obtaining samples of wool of different grades, subjected them to various manipulations, and found: 1. That a single fiber of wool, when manipulated by itself in a lubricant of soap, has no fulling property, but rather a tendency to lengthen the fiber; 2. That a number of fibers placed side by side, just as they grew on the sheep, and with simply tension enough to take out the kinks, when manipulated with a lubricant of soap, have no felting property; 3. That fibers similarly treated, but with the roots and tips alternating, have no fulling or felting property, and no power of adhesion; but, 4. That a number of fibers placed side by side, with the tips all one way or with the roots and tips alternating, without any tension, have fulling properties; and, 5. That fine-carded wool, taken from a second breaker, with the fibers thoroughly mixed, has great fulling properties when properly manipulated. A sample of negro's hair of suitable length, which was found by microscopical examination comparatively free from serratures but slightly spiral in structure, manipulated in the same manner as the wool had been, was formed into a "well-felted sample of cloth." These and other experiments satisfied the authors that the fulling properties of wool or any other fibers were in proportion to the number of waves, curls, or kinks, and their degree of fineness, and that the serratures, *per se*, have little to do with the matter, excepting possibly that which may be due to friction. "To the question, What is the cause of the fulling or felting of wool? the simplest answer possible is, it is the looping and interlooping, locking and interlocking of the fibers until they become inextricably entangled, but by interlooping and interlocking, and not upon the beggar's-lice principle."

Spade-Foot Toads.—Dr. Charles C. Abbott contributes to the "American Naturalist" a study of the hermit spade-foot toad (*Scaphiophis Holbrooki*), a rare animal, whose custom it seems to be to appear unexpectedly in numbers, and, after a few days, suddenly to disappear. Its name is derived from its long, horny index-toe, which may well be characterized as a spade, for it digs with it rapidly into the ground; and its voice, immense for so small an animal, is like a steam-whistle. The spade-foots first visited Dr. Abbott's field of observation in May, 1874, stayed a few days, and were gone. Their next visit, ten years having passed without a single specimen being seen or heard, was April 10, 1884, in the same spot, a sink-hole in a dry upland field near Trenton, N. J. They remained till the 15th, when the weather became cooler and they vanished. Again they came, June 26th, after a rain-storm that flooded the sink-hole, and were found sitting on the grass-tufts and swimming in the pond by the hundred, all uttering their shrill, ear-piercing groans, through the day and night; but on the morning of the 28th all were gone. During this brief visit the frogs spawned, and the eggs were found attached to blades of grass and slender twigs. In about a week, those of them which were not destroyed by the retiring of the water were hatched out into tadpoles very much like other tadpoles. As they grew, about five per cent of the number failed to develop as rapidly as the others. These "retarded" tadpoles were voracious cannibals, preying upon their fellows, now become "hoppers" and miniatures of the adult spade-foots, so extensively that it was necessary to protect them to save any. In due time, the water was removed from the aquarium, and earth put in its place to about an inch in depth. "Upon this the young spade-foots were placed, and in less than one minute many had commenced digging little burrows, into which they disappeared as the excavations deepened. . . . In twenty minutes all but two of forty-four specimens were below the surface." A few individuals remained in the sink-holes as the water dried up into puddles; but Dr. Abbott having neglected them, under the supposition that they would burrow where they were, for ten days, could find no trace of them upon an exhaustive search. He concludes that the animals must wander farther from their breeding-grounds than is supposed, or else must dig far deeper into the earth than to six or eight inches, as stated by Holbrook and De Kay.

Effect of Earthquakes on Buildings.—Mr. John Milne, of Tokio, Japan, has published some observations of the effects of earthquakes on buildings. In regard to the relative security of buildings on low and on high ground there is no universal rule, but each small area in an earthquake-region has its peculiarities. Theory indicates that soft, marshy ground is safer, because it will act as a buffer between the shock and the building; and the Temple of Diana, at Ephesus, was located with reference to this point. But experience at Tokio and Manila has shown repeatedly that there is very little, if anything, in it; and hard, rocky strata, where the amplitude of motion is small, but the period quick as compared with the motion in the inelastic material of the plains, proved the better foundation in Jamaica in 1692, and at Lisbon in 1755. Places to be avoided are the edges of cliffs, scarps, and cuttings. Europeans fasten the foundations of their buildings firmly in the ground, and their houses are much shaken. The Japanese put their structures loosely on top of stones or bowlders, and they escape serious disturbance. Europeans and Americans build iron-bound houses to resist earthquakes, and they resist them, though they get badly shaken, as a steel box would be; but they are very expensive. The Japanese and the people of the west coast of South America build a kind of wicker-basket house—a frame house with a light roof, which lives through the earthquake like "a reed shaken by the wind." The stability of such houses depends upon their not being firmly attached to the earth, and their numerous joints admit considerable yielding, so that the earthquake-wave passes through them before they begin to show its visible effects. A cheap aseismic house would be a low frame building supported by a number of slightly concave surfaces resting on segments of stone or metal spheres in connection with the ground. Chimneys should be given a play-space around them, and not be in contact with the roof; else, since the vibrational periods of the chimney and the roof never correspond, clashes will occur between them, and a shock and overthrow result. The pitch of the roof should not be great, or the tiles or slates will be shot off; and the upper parts of all buildings should be as light as is consistent with strength.

Suggestions in School-keeping.—Mrs. H. F. Wilson, in a paper read before the Educational Association of Alabama, tells how in her school she eschewed the system of marks and statistical reports as pernicious and false, and imposed as the one rule to govern the whole school, "Do right"; and, as the real goal to be reached, excellence in everything. Incorrect sentences heard by any pupil are reported in a blunder-box, to be corrected by the school. Once a week, half an hour is devoted to the recitation of facts, drawn from the public press and other sources. Half of every holiday is given to microscopic, stereoscopic, or other instructive exhibitions. In connection with the teaching of music, information is collected concerning the old masters of music. Physical culture is attended to, and dancing is cultivated as an element of it. In this work the teacher finds infinite variety and enjoyment, and has been "filled with amazement and enthusiasm at the immense amount of work pupils did unbidden, hunting over cyclopædias and books of reference for information when the text-book was obscure or inadequate."

Source of Atmospheric Electricity.—The source of atmospheric electricity has never yet been satisfactorily indicated, although various theories have been suggested to account for it. It has been attributed to aërial friction, to combustion or oxidation, to evaporation, and to condensation, to inductive or conductive effects of the earth's electricity, to convection currents, to electrified corpuscles coming from the sun, to solar radiation, to the friction of aqueous vapor against dry air, to capillary surface-tension of water, to the production of hail, etc. Professor Tait suggests that the mere contact of the particles of vapor with the air may suffice to produce the exceedingly small potential requisite to start the effects. He has not had an opportunity to investigate his hypothesis, but he makes a few statements that illustrate how apparently small this potential may be. "To raise a single pound of water," he says, "in the form of vapor from the sea or from moist ground, requires an amount of work equal to that of a horse for about half an hour. This is given out again, in the form of heat, by the vapor when it condenses; and the pound of water, falling as rain, would cover a square foot of ground to the depth of rather less than one fifth of an inch. Thus, a fifth of an inch of rain represents a horse-power for half an hour on every square foot; or on a square mile, about a million horse-power for fourteen hours. A million horses would barely have standing-room on a square mile. Considerations like this show that we can account for the most violent hurricanes by the energy set free by the mere condensation of vapor required for the concomitant rain. Now, the modern kinetic theory of gases shows that the particles of water-vapor are so small that there are somewhere about three hundred millions of millions of them in a single cubic inch of saturated steam at ordinary atmospheric pressure. This corresponds to $^1/_{1600}$ or so of a cubic inch of water—i. e., to about an average rain-drop. But if each of the vapor particles had been by any cause electrified to one and the same potential, and all could be made to unite, the potential of the rain-drop formed from them would be fifty million million times greater. Thus it appears that if there be any cause which would give each particle of vapor an electric potential, even if that potential were far smaller than any that can be indicated by our most delicate electrometers, the aggregation of those particles into rain-drops would easily explain the charge of the most formidable thunder-cloud."

How an Iron-Ore Bed was formed.—Professor James P. Kimball, of Lehigh University, has published in a single pamphlet two papers on the iron-ores of the Juragua Hills, of the province of Santiago, Cuba, beds of a hematite or specular ore, which appears to be largely the result of the weathering of the highly basic rock which gives the geological character of the formation. These rocks, the eruptive material which gave origin to the iron-ore, consisted of proto-silicates, or silica combined with the protoxide bases, iron, lime, and magnesia, and with alumina. Under its new conditions at and near the surface, with access to oxygen in the atmosphere, circulating waters, etc., the protoxide of iron became rapidly further oxidized into ferric or sesquioxide, which is a comparatively stable product under conditions prevailing at the surface. The oxidation of the ferrous to ferric oxide is attended with more or less complete dismemberment of the eruptive rock, little by little. Silica originally combined with the ferrous oxide is isolated as silica. Silicates of lime, magnesia, and alumina form new aggregates among themselves. Soluble matter as fast as isolated enters into solution in circulating waters, and is thus at hand to assist in the work of weathering. This work of alteration has gone on until a complete change has been wrought not only in the composition but also in the arrangement of the original eruptive rock. By the law of molecular attraction a process of concentration has gone on simultaneously with the process of weathering decay. Homogeneous material, such as ferric oxide, was collected by itself to a degree far greater than the other earthy residues, because, in the process of conversion from ferrous to ferric oxide, it has been in solution, and so in circulation, and has hence become finally deposited under long-prevailing conditions of uniform circulation. The process here briefly followed out has gone on just below the surface, within the range of the circulating waters. The same action immediately at the surface is followed by waste or diffusion of the products of alteration. In the present case, the best of the ore-bodies are mainly, if not indeed wholly, replacements of coralline limestone.

Jules Verne as a Scientific Authority.—The "Revue Scientifique" discusses a curious question in giving its estimate of the value of Jules Verne as a scientific writer. It considers the judgment, which many of us are ready to give, that such science as is inserted into the framework of a romance is worse than no science at all, as too severe.

"Does any one believe seriously that a cannon-ball can be shot from the earth to the moon? But what harm is there in letting a child entertain a fancy of the kind for a few hours? He amuses himself with it, and, while he is amused, he learns, without conscious effort, that the moon revolves around the earth, and the earth around the sun, and that there are forces of gravitation and universal attraction, etc. . . . The false idea does no harm, for nothing is built upon it. . . . I venture to say that it is advantageous to inspire children with the love of hazardous adventures, and the taste for the unknown that they find in all the romances of Jules Verne. They will encounter real difficulties soon enough to be discouraged from them earlier than they need to be. Not to see the difficulties is sometimes a good way to triumph over them. We have all grown timid and hesitating, and it is not a bad thing for us to be roused up to ardor in chimerical enterprises, in which the power of science is exhibited to us in the service of an energetic will. It is, perhaps, on this account, as much as for the amusement they give us, that we avow a strong liking for all of M. Verne's works. We might, if it were worth while, defend M. Verne on other considerations. When an idea enters the mind of a child, what matter is it how it gets there? Whether it be in a romance, or in a lesson, or in a text-book, or in a familiar conversation, makes but little difference, so the result is acquired. To tell a fourteen-year-old boy that the diamond is crystallized carbon, and that fruitless efforts have been made to produce it artificially, is all very well, but will he remember it? Are these abstract facts interesting enough to stay? Possibly; but the contrary is probable. When you interest a child by relating to him the adventures of Cyprian, as he puts earth and charcoal into a crucible, and tries to crystallize it into a diamond, the scientific fact will not be forgotten; and some day Cyprian will retire into the background, while the physical fact will be a permanent acquisition, which he will owe to this new mnemonic agency. It is more than mnemonics. While M. Verne entertains us with adventures, and fastens scientific facts upon us, he also gives us a taste for science. With him it is a goodly personage, smiling, affable, pleasant, greeting all who come."

Crickets and "Hair-Snakes."—The so-called horse-hair snake, as is known to naturalists, is a parasite of the cricket, which only becomes active under water. Dr. H. C. McCook recently read a statement before the Academy of Natural Sciences of Philadelphia which indicates that the crickets are aware of the peculiarity of their parasites, and take advantage of it to get rid of them. A lady having moved into a house which was a harbor for crickets, was troubled by frequently finding the hair-snakes in her water-pails, a short time after the water had been brought into the house. She sat down to watch how they came there. In a short time she saw "a particularly plethoric cricket" mount upon the edge of the pail, and, after some uneasy movements, bring the tip of the abdomen just beneath the water, and, with a few violent throes, expel a black mass, which fell slowly through the water, and, before it reached the bottom, resolved itself into one of the worms. The cricket seemed much exhausted by the operation.

Toxic Effects of Smoking.—Dr. Zulinski, of Warsaw, has made some experiments upon the effects of tobacco-smoke, which he determined to be a distinct poison, even in small doses. Its action on men is very slight when it is not inhaled in large quantities, but it soon becomes powerful in those who contract the habit of "swallowing the smoke." The toxical property is not due exclusively to the nicotine, but the smoke, even when disengaged from nicotine, contains a second toxical principle, called solanine, besides carbonic oxide and hydrocyanic acid. The effects produced by smoking depend upon the nature of the tobacco and the way in which it is smoked. The cigar-smoker absorbs more poison than the cigarette-smoker, and he than the person who smokes a pipe; while the one who uses a medium, by which the smoke is conducted through water, reduces the deleterious effects to a minimum. As a rule, the light-colored tobaccos are supposed to be the mildest, but they are sometimes artificially uncolored by chemicals, the presence of which is dangerous. Tobaccos are also generally adulterated, and, if the adulterating matter be woody, the smoke will be of high temperature, and liable to cause inflammation of the tongue.

Antipathies.—Some strange cases of antipathy are recorded in the lives of eminent men. Erasmus was made feverish by the smell of fish. Ambroise Parr had a patient who would faint at the sight of an eel, and another who was convulsed on seeing a carp. Gardan was disgusted at the sight of eggs. A king of Poland and a secretary of France bled at the nose when offered apples. A huntsman in Hanover, who would attack a wild-boar valiantly, ran away or fainted whenever roast pig was presented to his view. A person is told of who fainted whenever he saw a rose, and similar stories are told of antipathies to lilies and honey. Tycho Brahe abhorred foxes, Henry III. of France cats, mice, spiders, etc., and Marshal d'Albret pigs. There was "once upon a time" a lady who could not endure the sight of silk or satin. The man who would faint whenever he heard a servant sweeping is not so much of a stranger, and the one who was similarly affected by the sound of a bagpipe invites universal sympathy. Boyle was overcome at hearing the splashing of water.

Coinage Alloys.—According to Professor W. Chandler Roberts, of the Royal Mint, the term alloy is usually applied in ordinary language to the mass formed by mixing a base metal with a precious one, while in scientific language it indicates the base metal which is added. Alloys are used in preference to pure precious metals for various reasons, chief among which is the fact that they are harder and more durable. The fact that their substitution for pure gold or silver may be a valuable source of revenue is a less commendable reason, but has not been without force. When a base metal is to be chosen for mixture with a precious one, it should be borne in mind that the resulting alloy must have the qualities of good color, ductility, and freedom from brittleness. Silver forms a very ductile alloy with gold, but lowers the color, while copper forms a durable as well as a ductile alloy and heightens the color. A triple alloy of gold, silver, and copper may be made of delicate tints; but it is difficult to assay and causes complications in the keeping of the accounts, and for those reasons the simple copper alloy is now almost universally used. At the mint, the qualities sought as most desirable in an alloy are: 1. Ductility; 2. Durability; and, 3. Uniformity of composition. The alloy is, besides, expected to be sonorous, or to impart the true "ring" to the coins struck from it, and to possess the degree of viscosity which will enable it to flow under pressure into all the fine lines of an engraved die, while at the same time the metal must be rigid enough to retain its impression when submitted to rough usage. A great variety of alloys have been used for coinage in the world's history, from pure precious metal down to base metal with only a trace of precious metal in it. Those now in use are not very numerous. The fineness of alloys of silver is computed with reference to the troy pound. The computation in the case of gold alloys is based on the singular "carat" system, the name of which is probably derived from the *κεράτιον*, a small Greek weight. This has within two years given way at the British Mint to a decimal system.

Making Champagne.—The making of champagne is a process requiring extreme care and attention at every stage for at least two years. The grapes are picked with especial pains to keep any of them from falling or receiving bruises. Only the juice of the first pressing is made into high-class wine, and the quantity of this that shall be drawn is regulated by weight. Four hundred kilogrammes are allowed for every forty gallons of wine, and when the desired quantity has been obtained the pressing is stopped. The protruding edges of the mass which have escaped the heavier pressure are cut off and subjected to a second pressure, the juice from which is called the first *taille*. A third pressure gives the second *taille*, and a fourth the *redéche*, juices that are considered fit only for the workmen. When the scum has risen in the wine-tubs it is taken off, and the casks are filled and fumigated with sulphur and put away, not quite full, in the cellar, for fermentation.

The wine is racked off into other casks when the fermentation has subsided, and becomes quite clear by the time the December frosts set in. It is then mixed, by bringing together thirty or forty casks of the same growth, and blended. Tannin is added, to neutralize grease and deposits, and as much alcohol as is required. At a later stage a *masque* or deposit forms on the side of the bottle, the removal of which requires much care and skill and manipulation for several weeks. Afterward a sirup of sugar and alcohol is added, in proportions varying according to the country to which the wine is to be sent. Finally, the bottles are corked, wired, and set on end.

Changes in the Color of the Hair.—Cases of changes in the color of hair other than to gray are not uncommon. Workers in cobalt-mines and indigo-works sometimes have their hair turned blue, and workers in copper green, by deposition of coloring-matter upon it. This, however, is only a superficial coloring, and can be washed off. Prentiss records a case of a patient to whom muriate of pilocarpine was administered hypodermically whose hair was changed from light blonde to nearly jet-black, and his eyes from light blue to dark blue. These changes were due to increase of normal pigment. Hauptmann relates a case of a body exhumed twenty years after burial, the hair on which had changed from dark brown to red. Leonard cites a case in which, after death, red hair was changed to gray within thirty hours. Other cases have been mentioned in which the color of the hair has been variously changed in consequence of disease.

Decline of Mussulman Industries.—According to a letter in the "Allgemeine Zeitung," art and industry are in a lower stage in Algeria than in any other Mohammedan country, and their progressive decline is perceptible there from day to day. Persons may be seen walking in the streets of Algiers, dressed in Moorish or Arabian costumes, every piece of which is of European origin. Many branches of industry are extinct, others are nearly so, and all show unmistakable signs of decay. Many articles of European production are much cheaper than Mohammedan fabrics of the same kind, and are preferred for that reason; and many which at the first glance seem to be Mohammedan are in fact European imitations. Most of the really Mohammedan articles which are found, such as carpets, cloths, and table-wares, are not Algerian, but of Moroccan or Syrian manufacture. Arms are not made, for the wearing of them is forbidden by the French Government; but the Kabyles make a kind of iron knife, which can hardly be called a weapon. The only native industry still flourishing in the city of Algiers appears to be shoe-making, and this is because the Algerine men refuse to wear European shoes; but the women wear shoes of the prevailing fashion, with Louis XIV. heels. The cause of the depression of Mohammedan industry is the pressure of European population and influence, which has been attended with a corresponding diminution of the Turkish element.

Aryan Origins.—Professor K. Penka, of Vienna, has recently published a work on "Aryan Origins," in which, according to Professor A. H. Sayce, an eminent linguist, he sets out with "the incontrovertible but hitherto neglected doctrine that language alone will not interpret for us the former history of our race. Without the aid of anthropology, it is not only useless, but misleading. The theories built on the assumption that language and race are interchangeable terms, have introduced nothing but confusion into science, and have even left their scar on the politics of the day. It is only the skull in the hands of the anthropologist which can teach him the relationship of a people; the language they speak, or may have spoken, will of itself tell him but little." Professor O. Schrader has published, at Jena, a work regarding the Indo-Germanic race from the linguistic side, "in which," says Professor Sayce again, "for the first time a thoroughly critical method has been employed in determining the character and condition of primitive Aryan society by means of the records of speech; and the results are very different indeed from the idyllic picture of that civilized community to which Pictet and other writers have accustomed us. The early Aryan comes before us as a coarse and uncivilized nomad, unacquainted with the use of metals, and protecting himself with the skins of wild beasts from the inclemencies of the climate." What his society was like, Professor Schrader thinks may be gathered from the remains left by the "pile-villagers" of the Swiss lakes, whom he regards as Aryans. Both Professor Penka and Professor Schrader express the belief that Europe, and not Asia, was the original home of the Aryan family. Penka considers the starting-point of Aryan emigration to have been Scandinavia, while Schrader suggests the northeastern lands of Europe generally as the most probable locality. The evidence, according to Professor Sayce, is now tending to show that the districts in the neighborhood of the Baltic were those where the race or races who spoke the Aryan languages originally dwelt, and that the Aryan invaders of Northwestern India were only a late and distant offshoot of the primitive stock who were speedily absorbed into the earlier population of the country as they advanced southward.

A Highway in the Himalayas.—One of the native explorers of the Himalayan regions of India lying beyond the British boundary, says Sir J. H. Lefroy, in his British Association address, "describes a portion of his track at the back of Mount Everest as having been carried for a third of a mile along the face of a precipice at the height of fifteen hundred feet above the Bhotia-kosi River upon iron pegs let into the face of the rock, the path being formed by bars of iron and slabs of stone stretching from peg to peg, in no place more than eighteen inches and often not more than nine inches wide. Nevertheless, this path is constantly used by men carrying burdens."

Currency of the Cannibal Islands.—Mr. Walter Coote has described some curious moneys of the New Hebrides and the Solomon Islands. On one of the islands he noticed a neatly-kept house, which he was told was the money-house. Entering it, he found a number of mats hanging from the roof, beneath which a fire was constantly kept up, under the effect of which they became covered with a black, glistening coating and adorned with festoons of soot. It was a man's business to keep the fire always burning, and so low as not to scorch the mats. A well-colored mat is worth about as much as a well-grown, vigorous boar. This is the strangest of all kinds of money, for it must never be taken from the money-house, even when the title in it is transferred from one owner to another. The inhabitants of Santa Cruz Island use for money rope-ends, about an inch thick, and ornamented with scarlet feathers, which are worn about the waist. The traveler could not obtain new coins of this kind, but found them current everywhere. The specimens he bought were already old, and the feathers grown dingy. The money of the Solomon Islands consists of neatly-worked pieces of shell of about the size of our shirt-buttons. They are strung on strings about four yards long, and are distinguished under the names of red and white money. Dog-teeth are of higher value, and comparable to our gold coins. They are usually worn on a string around the neck. Mr. Coote saw a necklace of this kind that was valued at about a hundred dollars. Marble rings are also worn on the breast for ornaments, and as valuable money. The currency-table of these islands would be about as follows:

10 cocoanuts = 1 string of white-money.

10 strings of white-money = 1 string of red-money, or 1 dog-tooth.

10 strings of red-money = 1 isa, or 50 dolphins' teeth.

10 isa = 1 fine woman.

1 bahika, or marble ring = 1 head with the head-antlers, or 1 good hog, or 1 useful young man.

Theory of Lubricants.—In a British Association paper on the theory of lubricants, Professor Osborne Reynolds referred to some experiments by Mr. Tower, which showed that, when the rotating journal with its box was immersed in a bath of the lubricant, the resistance was not more than one tenth of its value in ordinary oiling, and that the journal was less likely to heat at higher than at lower speed; and that if, after running the journal for some time in one direction, a reversal was made, great heating would result. This was to be expected, in the light of an observation made by Professor Reynolds, that there must result a difference of pressure on the two sides of the vertical line through the center of gravity in the thin space between the box and the journal—the maximum being on one side or the other, according as the rotation is one way or the other; for, undoubtedly, the box and journal became adapted to each other for a certain direction of running, and when a reversal was made some time would elapse before a re-adaptation would be completed. This would explain why a new journal and box would always heat on first being run, however perfect they might be.

Deaths by Poisoning.—According to the English Registrar-General's reports, deaths by poisoning occur with alarming frequency in the ordinary course of events. In 1881, 569 deaths were recorded in England alone from this cause; in 1882, 599, or one in every 863 of the total deaths registered. Fully two fifths of the cases in the latter year were classified under the heading "accident and negligence"; the rest, 288, were suicides. Of the deaths through accident or negligence, 85 were occasioned by opium, laudanum, and morphia; 78 by lead compounds; 34 by the four stronger acids—hydrochloric, nitric, sulphuric, and carbolic; 14 by chloral; 11 by phosphorus; nine by arsenic; six by chlorodyne; four by chloroform; and four by soothing-sirup. How came the victims of these poisons to take them accidentally in fatal doses? The medical reports on the subject trace the mistakes to two principal causes—the giving or taking of overdoses of certain remedies containing poisons, and the substitution of one bottle or substance for another, as where bottles of all kinds of things are piled together in the cupboard, and, in the nervousness of haste or in carelessness, the wrong one is taken. The remedies for these dangers ought to be obvious. One is, never to give an infant an opiate or other powerful soothing remedy without first obtaining the sanction of a doctor. Another is, that no patient taking powerful remedies should be permitted, or should permit himself, to measure or repeat the dose himself. A third is, never to place bottles or packets containing poison alongside of or near anything that is to be taken internally. Fourth, never to put any poison into bottles, jugs, or cups which children or any other persons are apt to associate in their minds with substances not in themselves dangerous. The last remedy is sovereign. It is, not to keep strong remedies on hand.

Relation of Color and Flavor in Fruits and Vegetables.—Mr. Emmett S. Goff records in the "American Naturalist" some investigations he has made to determine whether there may not be a law of relation between the color and flavor in fruits and vegetables. He was led to his experiments by the observation that in several fruits and vegetables, such as onions, currants, tomatoes, and raspberries, a white or light-colored flesh is accompanied by a milder and more delicate flavor than exists in other varieties of the same fruit or vegetable having a dark-colored flesh; also that some vegetables are "blanched" to give them a more delicate flavor. The usual aim in improving the qualities of fruits and vegetables is to intensify the desirable qualities and eliminate the undesirable ones. It is evident, therefore, Mr. Goff says, that, if the color of the flesh has a direct relation to its flavor and tenderness, we have a valuable index in the work of selection. If by whitening the flesh of a fruit we can eliminate acid and solidity, or if by darkening the flesh of another fruit, already too tender and insipid, in the same way, we can heighten its characteristic flavor and increase its firmness, we have gained a new faculty in making the products of Nature subservient to our wants. Mr. Goff supports his view by the citation of a number of fruits and vegetables of peculiar qualities, and quotes descriptions by various authors, which appear to be in agreement with it.

The Harp-Seal in the St. Lawrence River.—It has been long known that the harp-seal (*Phoca Groenlandica*) was accustomed to visit the Gulf of St. Lawrence for bringing forth its young; but Dr. C. Hart Merriam has collected evidence that its existence in that river is far more general and fixed than had been supposed. Mr. Napoleon A. Comeau, who lives near the point of the expansion of the river into the gulf, says that this species is the most abundant of all the seals of that locality, and roves up and down the St. Lawrence in its migrations in immense numbers; and he adds that it is tolerably common as far up as the Saguenay. From the information furnished by Mr. Comeau and from other data, it appears to Dr. Merriam that the harp-seal is a permanent resident in the St. Lawrence; that it spends the summer wandering about, sometimes singly or in small schools, sometimes in large herds; that it ascends the river at least as far as the Saguenay, and is common between Mille Vasches and Manicouagan; that it frequents with considerable regularity particular shores and estuaries to feed on the small fish that congregate there at certain states of the tide; that it works down the river early in the winter, and is particularly abundant about Point des Monts in December, January, and the early part of February; that it then passes farther down to whelp on the heavy ice in the gulf; that its young are born during the latter part of February or early March; that, as soon as the young are able to shift for themselves, the parents at once return, passing Point des Monts in great numbers on their way up the river.

Alleged Nerve-exciting Properties of American Air.—A correspondent of the London "Times" notices as a fact coming within his own personal experience the effect of the American air, particularly in New York, in exciting nervous sensibility. It is partly an effect of dryness, partly electrical, as is witnessed by the power sometimes observed of lighting a gas-jet with the electric spark developed by shuffling rapidly over the carpet. It is observed also in the greater intensity of the effect of spirituous liquors in this country than in Europe. It is partly local, for it is more marked in New York than in any other place. It seems to be evolving a new type of mind, and ultimately possibly a new physical type; and the American appears to be becoming a more nervous and more spirited man. Hence, we have peculiarities in our statistics of insanity; our army of tramps —"individuals of all classes, though mainly of the poorer, who can not endure the drive and strain necessary to keep up with their fellows, and whose inertia triumphs"—and our cranks—"people who carry eccentricity almost to insanity, but are recognized as responsible persons." After noticing an increasing development of insanity among our native-born population, the writer mentions two questions that suggest themselves: "Are we becoming a nation of madmen," or "are we developing a specialized race from those who can endure the pressure, and who by the survival of the fittest will form the future American stock, while the feeble intellectual natures will become tramps and lunatics?"

The Weather and Health.—Dr. J. W. Tripe read a paper at the Meteorological Conference, held in connection with the London Health Exhibition, on "The Relations of Meteorological Phenomena to Health." It is only recently that systematic observations have made the collation of knowledge on this subject possible. Ordinary variations of the barometer at ordinary elevations produce but little effect on health. At considerable elevations disagreeable feelings follow the diminished pressure. Nevertheless, consumptive and other invalids have experienced relief at mountain-stations; but this was because the reduced temperature, with the total change in the habits of life, more than compensated for the effects of the lessened pressure. In residences a sudden diminution of atmospheric pressure is likely to be attended with an escape of ground-air from the soil, and thereby to cause injury to health. Changes of temperature when rapid are liable to cause derangements in either direction; otherwise man can with precautions endure a range of about 200° Fahr. without serious injury. Hot climates, however, eventually, unless habits are carefully adjusted to them, sap the foundations of life among Europeans. The direct influence of rain on man is not very marked in temperate regions, except by giving moisture to the air by evaporation from the ground and from vegetable life, and by altering the level of ground-water. Considerable and sudden fluctuations in the level of the ground-water generally cause ill health, and if such water stands at less than five feet below the surface it is dangerous. Varying amounts of moisture in the air materially affect health and comfort. Moist air is a better conductor of heat than dry air, hence we feel more chill in thaws than during crisp, cold weather. Fogs are injurious, not only on account of the vapors they contain, but because the air is saturated with moisture at a low temperature. Variations in temperature and pressure exert a considerable influence on the circulation of air contained in the soil (ground-air), and this frequently contains that which it is not well to breathe. Winds affect health directly by promoting evaporation from the skin and abstracting heat from the body, and indirectly by their influence on the temperature and pressure of the air. Scarlet fever prevails most when the mean temperature is between 45° and 57° Fahr. Diseases of the lungs are fatal in proportion to the lowness of the temperature and the presence of excess of moisture and fog. Relations appear to exist between a high summer temperature and mortality from diarrhœa. The relations between the weather and disease are not always uniform, for a discordance has been observed in the curves for whooping-cough, typhoid fever, and scarlet fever, between London and New York, and in diarrhœa between London and India. Better information is needed on this subject.

Spectro-photometric Study of Pigments.—Edward L. Nichols, Ph. D., in a paper read at the last meeting of the American Association on "A Spectro-photometric Study of Pigments," finds that the spectroscope shows that pigments can not be considered even in the roughest approximation as reflecting monochromatic light, but that they are more nearly related to white. Hence, "the attempt to express the hue of non-luminous bodies by comparison with isolated spectral tints is founded upon a false conception of the nature of the light which they reflect. To determine the hue of a pigment from the analysis of the light it reflects is a problem in physiological optics, the solution of which varies with the character of the observer's eye. The three primary color-curves of the eye must be determined, and the total intensity of each wave-length of the spectrum of the pigment must be divided in the proportions indicated by the color-curves into three components—red, green, and violet. Summing up each of these components for the entire spectrum, we obtain an expression for the hue in terms of the three color-sensations of which it is the resultant. In default of this method, which is difficult of execution, the curves themselves are an expression of the hue, the only requisite for the interpretation of which is practice in associating the sensation of color produced by pigments with the form of curve representing them."

The Manufacture and Applications of Iridium.—The manufacture of articles from iridium has recently assumed considerable importance through the discovery of practicable methods for making the metal. Iridium is obtained, in Russia and California, as a by-product in the working of the ores of platinum and gold, and is found only in the condition of grains, not larger than grains of rice, or of a fine powder, and often alloyed with platinum or osmium. It is one of the hardest substances known, being in that respect nearly the peer of the ruby, is not readily or permanently acted upon by oxygen, and is soluble in no single acid, and only slightly soluble in *aqua regia*. Its principal use hitherto has been for the pointing of gold pens, for which purpose the grains had to be taken as they were found, and soldered on without working over. The discovery of the process for working iridium is due to two gentlemen of Cincinnati, Mr. John Holland, a gold-pen manufacturer, who found that it could be melted with phosphorus; and Mr. W. L. Dudley, who devised a method for afterward eliminating the phosphorus. Mr. Holland, seeking larger pieces of iridium than could be found in Nature, discovered, after many experiments, that by heating it to a white heat and adding phosphorus, with a few minutes more of heating, he could obtain a perfect fusion, and could pour out the molten metal and get a casting of it. The product proved nearly as hard as the natural grains of iridium, and to have nearly all the properties of the metal itself, but, containing from 7·52 to 7·74 per cent of phosphorus, was liable to fusion, and could not therefore be used for purposes, as in electrical apparatus, where it would have to withstand a white heat. Mr. Dudley undertook the removal of the phosphorus, and found that this could be effected perfectly by heating the metal with lime in an electric furnace. The manufactured metal will then resist as much heat without fusion as the native metal. Iridium is sawed by a copper disk between four inches and eight inches in diameter, making twenty-five hundred revolutions a minute, and dipping into a bath of cotton-seed oil and corundum or diamond-dust. Many new uses are opening for it since it has been possible to melt and cast it. It is used for draw-plates, to replace the ruby plate, in the manufacture of gold and silver wire; for knife-edges for scales and balances; for tipping hypodermic needles; for the negative poles of arc-lamps; and for many other purposes. One of the most important applications is for the contact-points of telegraphic instruments. These points outlive many platinum contacts, and do not oxidize or stick. Mr. Dudley is making experiments, with a fair promise of reaching commercial success, in the electric deposition of iridium.

The Chaldean Lunar Cycle.—M. Oppert recently read a paper before the Academy of Inscriptions and Belles-Lettres on an Assyrian inscription concerning lunar cycles. More than twenty years ago he discovered in the inscriptions of King Sargon allusions to a great lunar cycle one of the revolutions of which terminated in the year B. C. 712. He was afterward convinced that this cycle was the period of 1805 years, after which the series of lunar eclipses recur in the same order. The knowledge of this period supposes continuous astronomical observations among the Chaldeans already of many centuries' duration. They began the calculation of the period from the year 11,542 before our era. This is also the year in which the Sothiac periods (of the Egyptians) of 1460 years begin, one of which ended B. C. 139. These two cycles of 1460 years and 1805 years play an important part in the chronological computations of the ancient East. Twelve of each of them form respectively 17,520 and 21,660 years, or 292 and 561 sixties of years, numbers which occur in the Bible, according to M. Oppert, to express the length of time between the Flood and the birth of Abraham, and from the birth of Abraham to the end of the history in Genesis.

NOTES.

Thirty years ago pines were planted in the Sologne, a tract of waste land near Blois, France. Fifteen years afterward, as the pines were cut away, oaks sprang up spontaneously to take their places, thus tending to restore what history tells was the ancient vegetation of the country. M. Émile Hausen-Blangsted states, in illustration of the struggle for existence among trees, that the pine is dislodging the larch in the Grisons, while there and in the Jura the beech prevails over both. In Switzerland generally the beech gains the place of the oak, fir, and birch, and in Prussia the pine encroaches on the oak and the birch. Birches and the ash are extending themselves in the pine-forests of Russia, and the birch is dislodging the aboriginal pines in Siberia.

Mr. Frederick Ransome is making a cement from blast-furnace slag and lime, much superior to the cements previously made from this refuse matter. He uses lime from the gas-works, gets rid of the sulphur by calcination with coal or coke, and then dissipates it in the form of sulphureted hydrogen. While Portland cement breaks under a load of 818 pounds, this cement, under the same circumstances, exhibits a power of cohesion up to 1,170 pounds.

The *Convallaria polygonatum*, whose name indicates its relation to the lilies-of-the-valley, may fairly be described as a traveling plant. It has a root formed of knots, by which it annually advances about an inch from the place where the plant was first rooted. Every year another knot is added, and this drags the plant farther on; so that in twenty years' time the plant will have traveled about twenty inches from its original place.

The continued publication of the "Index Medicus" has been undertaken, after arrangement with the editors and the representatives of the late Mr. F. Leypoldt, the former publisher, by Mr. George S. Davis, of Detroit. The first number of the journal for the current year, having been necessarily delayed, will comprise the literature of January, February, and March. Further publication will be made monthly as usual. At the end of the year, in addition to the usual index of names, subscribers will be furnished with an index of subjects to the volume.

The Geological Society has awarded the Wollaston medal to Mr. George Busk for his researches on fossil polyzoa and pleistocene mammalia; the Murchison medal to Professor Ferdinand Roemer, of Breslau; the Lyell medal to Professor H. G. Seeley, for his long-continued work on fossil saurians; and the Bigsby medal to M. Renard, of the Brussels Museum, for his petrographical researches.

The "Saturday Review" gives some more illustrations of the learning that is fostered by the English School-Board cram examinations. One is, that "the earth's axis is a pole put through the center of the sun, which turns it round." Another pupil stated that "the Nile is the only remarkable river in the world. It was discovered by Dr. Livingstone, and rises in Mungo Park." On ancient Britain the examinations brought out statements that Julius Cæsar invaded the country B. C. 400; that the women "wore their hair down their backs, with torches in their hands"; and that the "Druids were an ancient people, supposed to be Roman Catholics."

The latest reports from Sydney with reference to the *Monotremata* state that Mr. Caldwell has exhibited specimens "showing the stages in the development of the monotremes from the laying of the egg to the hatching," and that Baron Miklucho-Maclay, who had found that the temperature of *Echidna* was 82·5° Fahr., now finds that that of the Ornithorhyncus is only 76° Fahr., or more than 20° below that of man.

Messrs. Schulz, Knaudt & Co., Essen, Germany, are now producing, from the refuse of the fire-grates of the puddling and reheating furnaces, two hundred cubic metres of water-gas per hour, which contains forty-eight per cent of hydrogen, and forty-four per cent of carbonic oxide. The gas is used for welding and in the production of incandescent lights. The firm are about to build apparatus that will generate fourteen thousand cubic metres of the gas per day.

In a recent paper by MM. Fremy and Urbain, before the French Academy of Sciences, attention is called to *cutose*, the substance that covers and protects the aërial organs of plants, which is shown to approach the fatty bodies in its properties and composition. It resists the action of energetic acids, is insoluble in dilute alkalies, and is not acted upon by neutral solvents, but is modified in its conditions by boiling alkaline liquids.

In a recent paper before the Royal Society on "Underground Temperatures," Professor Prestwich, after considering the sources of error that affect thermometric observations in collieries and mines, suggested, as the result of a large number of observations in mines, Artesian-well borings, and Alpine-railway tunnels, that the mean thermic gradient is about forty-five feet for every degree Fahrenheit.

OBITUARY NOTES.

General Helmersen, a Russian officer of considerable distinction as a geologist and explorer, is dead.

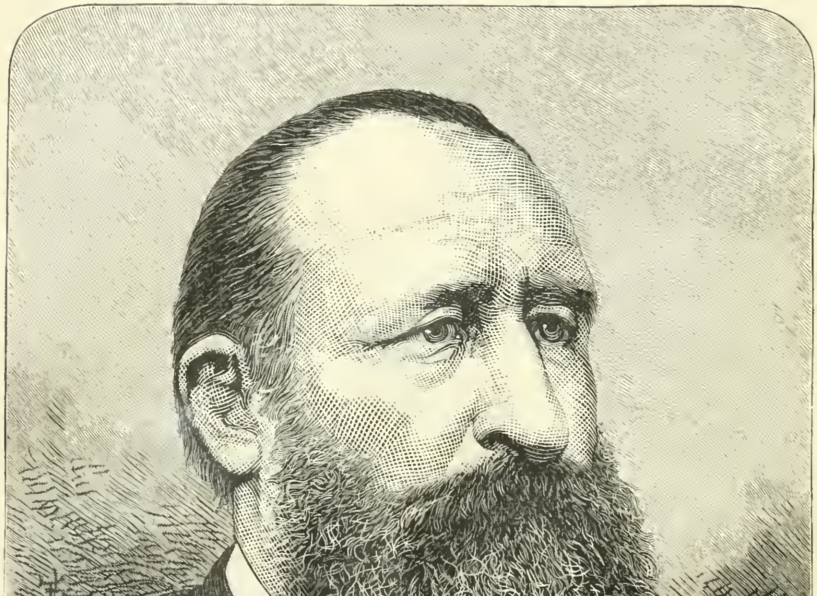
The death is announced of Hofrath Schmid, Professor of Mineralogy at Jena.

Mr. John Francis Campbell, who recently died in England, was the inventor of a "sunshine recorder," a curious instrument in which the sun burned out its path for every hour of the day when visible, and indicated by the amount of charring the ever-varying intensity of the influence of its rays. Other instruments have been invented with similar purpose, but their power is generally limited to the registration of the chemical action of the sun's rays.

Mr. Hodder M. Westropp, archæologist, author of a "Manual of Archæology" and other works, is dead.

Mr. Thomas C. Archer, Director of the Edinburgh Museum of Science and Art, died February 19th. While a customs clerk in Liverpool, he was appointed to take charge of the exhibit of that town in the Great Exhibition of 1851. He afterward added to his usual duties the work of lecturing at local institutions and educational establishments, and became a professor in the Liverpool Institution. He was appointed to the Museum in Edinburgh in 1860. Among his scientific publications are a text-book on "Economic Botany," and papers before the Royal Society of Edinburgh on "Graphite in Siberia," on an undescribed variety of flexible sandstone, on "Two Species of Foraminifera," and on "some objects from the Nicobar Islands of great ethnological interest."

Mr. Sidney Gilchrist Thomas, whose name is inseparably associated with the basic or Thomas-Gilchrist process for making steel from phosphoric pig-iron, died in Paris on the 1st of February. He was educated at Dulwich College, England, and was intended for the medical profession, but entered the civil service, while he kept up all his life a strong interest in the study of chemistry. The first announcement of the discovery in iron-working which he and his relative, Mr. Gilchrist, had made, was given in a paper which he read before the Iron and Steel Institute in 1878, "On the Elimination of Phosphorus."



ALFRED E. BREHM.

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ARE WE TO BECOME AFRICANIZED?

By HENRY GANNETT.

DURING the past few months the presence of the negro in the United States, his future, and his possible influence upon our social and political fabric, have become a fertile subject of discussion. Thus far the argument has tended entirely in one direction, all writers seeming to be agreed that the country is rapidly getting into a bad way, by reason of its millions of black laborers. Various remedies have been prescribed, all of them more or less difficult to apply.

It would appear that the wisest course to pursue would be to first study the case thoroughly, and make sure that the alleged patient is really ill, before pouring into him any nauseous draughts. It is possible that he is merely a hypochondriac.

In "The Popular Science Monthly" for February, 1883, there appeared an article by Professor E. W. Gilliam, entitled "The African in the United States," in which, by a free handling of the statistics of the last two censuses, the author attempted to prove that the colored race is increasing in this country at a much more rapid rate than the whites, and that consequently, unless some effectual preventive measure against this increase be taken at once, we are in imminent danger of becoming Africanized. He proposed, as the cure for the impending evils, a wholesale, forced migration of the colored people.

This article is re-enforced by another from the same author, in the November number of the "North American," in which the same views are reiterated.

As these articles have attracted much attention, it is desirable to notice them in some detail. The argument upon which Professor Gilliam bases his conclusion that the negroes are increasing faster than the whites runs as follows: During the decade 1870–'80 the whites increased, upon the face of the returns, 29 per cent, and the blacks 34 per cent. From the former rate of increase he subtracts 9 per cent, to account, as he says, for foreign immigration, leaving 20 per cent to represent what he calls the native increase. From the per cent of increase of the blacks, he deducts 5 per cent to allow for his surmise as to the extent of omissions in the ninth census, "leaving 30 per cent" (*sic*). Then he restores the 5 per cent, making a normal rate of increase of 35 per cent for the blacks, on the ground that in the future they will increase more rapidly than in the past. It can not be denied that, with these rates of increase for the two races, Professor Gilliam is well equipped for the task of Africanizing the country, and, if these figures, or any approach to them, are correct, we may well feel anxious for the fate of the "white man's government."

With these figures as a basis, Professor Gilliam goes on to predict the population a century hence, with results as follows: Northern whites, 240,000,000; Southern whites, 96,000,000; Southern blacks, 192,000,000.

An analysis of the author's curious method of deducing these results will, however, aid to dispel this frightful vision of the future. The increase of white population between 1870 and 1880 was slightly less than ten millions. The number of immigrants during this period was a little in excess of two million eight hundred thousand. Subtracting the latter from the former, there is left a number which is 23 per cent of the population in 1870, not 20 per cent, as Professor Gilliam has it. But what does this 20 or 23 per cent (it matters not which) represent? Certainly not the increase of native whites, as he interprets it. The census gives directly the numbers of native whites in 1870 and in 1880, and the proportional gain of this class during the decade was not less than 31 per cent. These are the figures which he should have used in making his comparisons.

Now as to the increase of the colored element. Professor Gilliam, at the outset, deducts from its rate of increase 5 per cent, representing about a quarter of a million persons, on account of the imperfections of the census of 1870. Concerning the omissions of this census little is known, except that they were generally distributed through the cotton States, were largely, if not mainly, of the colored element, and, of that element, approximated nearer three fourths of a million than one fourth, and certainly exceeded half a million. Professor Gilliam's subsequent addition of 5 per cent, "as an obvious consideration points to the conclusion that the blacks will for the future develop in the South under conditions more and more favorable," certainly is not warranted by the facts or the probabilities, and, as we are reasoning from what has been and is, and not from what may be, it looks very much like begging the whole question.

Correcting Professor Gilliam's statements, it appears that the ratios of gain during the past decade were, as nearly as can be known, as follows: For native whites, 31 per cent; for blacks, not above 25 per cent.

But all such comparisons, based upon the results of the ninth census, are utterly worthless. No reliable conclusions regarding the increase of negroes can be drawn from a comparison in which these statistics enter. The extent of the omissions can be a matter, within certain wide limits, of conjecture only. The only comparisons which yield results of any value are those made between the statistics of the eighth and tenth censuses. That the former was, to a certain slight extent, incomplete, is doubtless true, especially in regard to the colored element, but the omissions were trifling as compared with those of the ninth census. A comparison between the results of the eighth and tenth censuses shows the advantage to be clearly in favor of the native whites, who increased 61 per cent in the twenty years, while the colored element increased but 48 per cent. This great increase of the native whites was effected in spite of the fact that the ranks of the adult males were depleted to the extent of over a million by the casualties of war, which the negroes scarcely felt.

This relatively greater increase of the whites is sustained by the record during the days of slavery. In but one decennial period since 1790 did the negroes increase as rapidly as the whites, and in most cases their increase was far less, as appears in the following table, extracted from Scribner's "Statistical Atlas":

DECADE.	PERCENTAGE OF INCREASE.	
	White.	Colored.
1790 to 1800	35·76	32·38
1800 to 1810	36·13	37·46
1810 to 1820	34·12	28·57
1820 to 1830	34·03	31·41
1830 to 1840	34·72	23·28
1840 to 1850	37·74	26·61
1850 to 1860	37·69	22·06
1860 to 1870	24·76	9·86
1870 to 1880	29·21	34·85

It will be noticed that the only period during which the colored element increased faster than the white element was between 1800 and 1810, during the continuance of the African slave-trade, which ceased in 1807. It will also be seen that the rate of increase of the negroes, while irregular, shows a marked and rapid decrease—a much greater decrease than that of the whites—even up to 1850, when immigration from Europe began to make itself felt.

This decrease of the colored race in proportion to the whites is set forth still more strongly in the following table, quoted from the same work:

CENSUS.	PROPORTION OF—	
	Whites.	Colored.
1790	80·73	19·27
1800	81·13	18·87
1810	80·97	19·03
1820	81·61	18·39
1830	81·90	18·10
1840	83·17	16·83
1850	84·31	15·69
1860	85·62	14·13
1870	87·11	12·65
1880	86·54	13·12

Between 1790 and 1860 the proportion of colored to total population is seen to fall from over 19 per cent to but little in excess of 14 per cent—a decrease of fully one fourth. In the half-century which elapsed between the date of the first census and 1840, during which time immigration was very slight, it decreased not less than $2\frac{44}{100}$ per cent, although for one third of this period the slave-trade was being carried on.

Such being the history of the negroes in *ante-bellum* days, when they were property, and when every consideration of self-interest prompted their owners to watch over their health, to encourage child-bearing, and to protect and preserve the children, is it to be supposed for a moment that this careless, improvident, ignorant race, thrown suddenly upon its own resources, should at once, or within a generation, take on a rate of increase more rapid than before emancipation? The wonder is, that in the past twenty years they have not fallen further behind.

Considering the colored race in this country as a whole, it is seen that it has not held its own, either in a state of slavery or thus far in freedom. It is but another illustration of the fact, that an inferior race can not thrive side by side with a superior one. It would seem, therefore, under the circumstances, more profitable to study ways and means for preserving and strengthening the manual labor element of the South, rather than to debate the methods of getting rid of it.

In "An Appeal to Cæsar," by Judge Tourgee, the question of the future of the colored element is discussed from a somewhat different point of view. Without committing himself as to the increase or decrease of the colored element in the country at large, in proportion to the whites, the author finds, upon a somewhat superficial study of the statistics bearing upon the question, that in the South Atlantic and Gulf States the negroes have increased decidedly in proportion to the whites, while in those States which he classes as border States they have relatively decreased. This massing of the negroes in what may, for convenience, be denominated the cotton States, coupled with the steady sharpening of the line of separation between the two races—a line which, as the author claims, becomes more and more accentuated as the inferior race increases in numbers and advances in education—will lead to inevitable conflict between the two races. As the negro becomes numerically the stronger, and, through education, appreciates more fully his present position, he will commence a struggle for the mastery, and then the days of the Ku-klux will be eclipsed in blood and slaughter. Such is the condition to which these ill-fated States are hurrying. To ward off this impending evil, Judge Tourgee urges upon the General Government the work of educating the blacks. Such, in brief, is the "Appeal to Cæsar."

Education seems to be regarded as a universal panacea for all the ills of the people, but in this case, according to the author's own statement of the situation, the education of the negroes would but precipitate the impending conflict. Our only safety would seem to be in leaving them in ignorance.

The whole "Appeal" is based upon the theory that the negroes are migrating southward from the border States into those of the South Atlantic and the Gulf in great numbers. This theory the author attempts to establish by deductions from census statistics.

It may, in passing, be suggested that a careful revision of his figures will show many important arithmetical errors, which may modify very sensibly some of his conclusions. It is unnecessary to follow his methods of reasoning, as the truth regarding the questions at issue can be arrived at much more directly. The fact is, that the negro is not migrating southward. There is no massing of the colored people in the cotton States. In 1860 the colored element of these States formed 66 per cent of the colored element of the country. In 1880 it formed precisely the same proportion. Between 1860 and 1880 the colored element of the country increased 48 per cent. The same element of the cotton States increased, in this interval, in precisely the same proportion, neither more nor less. These figures are conclusive upon this point, and from them there is no appeal.

But the fact remains that, in these cotton States, the colored element was in 1880, in comparison with the white element, slightly stronger than it was twenty years before. This, however, is due not to a southward movement of the colored people, but to a decrease in the rate of increase of the whites of those States. While the increase of the native white population in the country at large between 1860 and 1880 was sixty-one per cent, that part of the same element resident in the cotton States increased but thirty-nine per cent. This low rate of increase among the whites might seem to establish Judge Tourgee's position, though not in the way he states it, were it not for the fact that three fourths of this increase took place during the decade between 1870 and 1880. The increase of whites in the South received a most effectual check during the four years of war, in which every male capable of bearing arms was in the field, and in which fully half a million laid down their lives. Since the war the white race has taken up a rate of increase equal to, if not greater than, that of the country at large, a greater rate than that of the colored people within its borders, and there is no apparent reason why they should not maintain it. It is not, then, a migration of the negroes southward which has caused their relative gain in these States, but it is the losses of the white race—losses which, however, are rapidly being repaired.

As the negroes are not increasing as rapidly as the whites, either in the country at large or in the cotton States, and therefore are destined to become constantly of less numerical importance, the pressing necessity for doing something to ward off the evils predicted by the authors above quoted does not appear to exist.

THE NERVOUS SYSTEM AND CONSCIOUSNESS.

By W. R. BENEDICT,

PROFESSOR OF PSYCHOLOGY AND LOGIC IN THE UNIVERSITY OF CINCINNATI.

III.

WE are beginning to hear lamentations over the realism of our time. Not only are the gods dead, God is dead. Art finds no place for Imagination, save in setting her to devise ways and means for a more complete photographic process. Among the crimes laid to the account of Science, *this* is not the least; indeed, perhaps this may sum them all, that she has taken away our Lord and will show us nothing in return but the geologic formation of a sepulchre. While this charge is unjust, radically unjust, it must be allowed that the manner of commendation employed by many advocates of science is responsible, in large measure, for our bread-and-butter attitude. The fault lies in the original constitution of certain men—not that they are scientists, but that they are small scientists; men for whom a formula, or a compound, or a root, or a fact whatsoever, is the end. To know the most names of the most classifications is to be saved, to apply chemistry in the manufacture of salable beer is to make "calling and election" sure. The devotion of these little men to science is not only at the expense of all that is highest, but is, as was intimated, largely responsible for the realism over which so many weep. Men of science, that is to say *men* of science, are not accountable for deadness of soul. The wonder with which those early Greeks looked out upon the face of all things may not for one instant be compared with the wonder that fills the soul to-day before this stupendous universe:

> "Die Geisterwelt ist nicht verschlossen:
> Dein Sinn ist zu, dein Herz ist todt."

Because we have learned that color is not in sunset or rose, is there therefore no color? Is the marvel anywise diminished by knowing that, upon matter so adjusted and so acting as the brain is adjusted and acts, all color depends? Because there is no sound in bell, or breeze, or ocean, is there therefore no sound? And wherein is the wonder of it diminished when we have learned the construction of the ear, its possible relation to a particular fold in the brain, and the necessity of this for all the harmonies that fill the soul with glory? Are we, the thinking, sorrowing, hoping selves, any the less real because *all* this thinking, all this sorrowing, and all this hoping depend in strictest sense upon that most highly organized form of matter the human brain?

George Eliot spoke truly when she said, "To advance in knowledge is to outline, more perfectly, our ignorance"; and who does not wonder before the unknown? When man is brought, as, if he is capable of it, science will bring him, face to face with the darkness of mystery, does he boast himself of all that he has learned? We may rest assured that the glory of mystery has not departed from off the face of the heavens or of the deep. I know not where this mystery is greater, or the wonder of it more manifest, than in the relation which obtains between the brain and consciousness, between the brain and the personality that thinks and feels and wills. This relation is a fact. All that we call our soul-life, from the sensations, the "building-stones" of this life, to the most abstract thought and holiest desire, stands dependent upon the activities of nerve-matter. Surely no one will be led to say, so are these things dependent on stomach, lungs, and heart. *Such* dependence is indirect, mediate, the other direct and immediate. Between consciousness and the brain, between nerve-matter and ourselves, there is a relation close, constant, immediate; we may well strive to reason upon the character of this relation. Here at the outset, this term reason must have clear meaning. I intend to use the word as expressive of the process of inferring, of drawing a conclusion from premises. I have now no concern with those who intuitively perceive truths beyond the territories of sense and inference. Those for whom the immateriality of the soul is a direct deliverance of consciousness may smile at the crawling pace of my induction; still, it is an honest and a needful endeavor to search after those conclusions respecting brain and consciousness which the inductive, inferential process shall necessitate.

In such search, nothing, as I think, is more important than to be assured that, in reasoning from the knowledge given by our senses to conclusions which transcend such knowledge, we must proceed according to *discerned resemblance.*

Two things agreeing with, which means, for us, resembling, one and the same third thing, agree with, that is resemble, each other; and two things, of which one agrees with, that is, for us, resembles, and the other does not agree with, that is, for us, does not resemble, a third thing, do not resemble each other. If the manifestations of nerve-matter and the manifestations of consciousness disagree, seem *unlike* after our best examinations, it is unreasonable to give them a common cause; they can not, by us as rational beings, be brought into such close relation.

Permit me to ask attention to a further consideration. Neither the direct knowledge given by our senses, nor this inferred knowledge, furnishes a solution of the mystery which belongs to the subjects we investigate. It is often said and as often forgotten that all explanation of natural processes consists solely in the resolution of involved combinations of activities into their elements. We make a false demand of the evolutionist when we insist that he shall tell us *how* the biological is evolved from the a-biological, and he makes a false demand of the spiritualist when he requires to be told *how* mind acts on brain or brain on mind. There is no such thing as being told the how of what takes place. The starting-points are unknowable in their nature and in the reasons of their operations. If I have not completely misunderstood that vigorous book, "Modern Physical Concepts," the purpose of its writer was to show that the so-called bases of physical science do not represent *entities* any more than the terms vitality, justice, humanity, law, represent entities, but that the bases of physical science stand for the *present* highest generalizations of the mind working inductively, that these bases do not exist out yonder among the spaces, but here within the thinker, and that when we affirm matter to be, outside of us, *exactly* thus and so, force exactly thus and so, we are but repeating the mediæval procedure of declaring that beneath the oak-tree there is an oak nature, beneath human beings a human nature. Judge Stallo, as I think, found the mind at its old trick in modern physical science, the trick of actualizing, and thrusting out yonder into space, its thoughts, its concepts, and of worshiping them as lords of all, explainers forever. Service is rendered here, not for orthodoxy as against heterodoxy, not for spiritualism as against materialism, but for all truth as against all error. We need to keep in mind that the only thing which can be accomplished by science, or by philosophy, as the unification of the sciences, is a detection and expression of resemblance between phenomena and between the modes of their activity. This may give us a law of evolution extending over *all* manifestations, a law not perched up on matter compelling it to evolve, but a law expressive of our feeling of similarity where we had previously felt diversity.

This resemblance is detected by *observation*. Now, observation is a process, not a thing. Its character is never determined by the object observed. Observation is not an instrument possessed by the physicist alone. Observation is an *intellectual* operation, and may be as genuine, as honest, when directed to thoughts, emotions, volitions, as when brought to bear on stars, rocks, or brains. The time has come when the truth shall assert itself that philosophy is an attempt to *unify all* our experiences, an attempt to be able to say that whereas here and here and here my experiences seemed unlike, separate, they now seem alike and conjoined.

The application of all this to man is plain ; indeed, has been for these past years most impressively operative. Formerly, man was supposed to possess an intellectual and moral nature distinct in kind ; in him was thought to reside a force peculiar, above and beyond all other forces. Observation has had much to say, as many believe, in contravention of these conclusions ; and it is now well known that the doctrine of evolution is brought to bear on all sides of human psychology in a way special and searching. I have not here in mind the work of Spencer or Bain, or their immediate disciples. Within very recent days books have been published which show painstaking research in distinct psychological departments. Ribot has discussed the physiology and pathology of memory ; Grant Allen has offered help in the "tangled territory" of æsthetics ; Leslie Stephen has written a science of ethics, stating as his purpose, "to lay down an ethical doctrine in harmony with the doctrine of evolution" ; G. H. Schneider, author of a work on the animal will, has just published a careful treatise on the human will from the stand-point of the modern development theory ; Professor Preyer, at Jena, has set out the results of his observations on the soul of the child—observations made with greatest care three times each day during the first three years of child-life. I might extend my list at length ; for this there is no need. We are face to face with the question of the relation between brain and consciousness. I have said that this relation is positive and constant, though few, except physicians, realize the meaning of such a fact. It means, in the first place, that changes of consciousness coincide with molecular changes in the brain. For every alteration in consciousness, however slight and transient, there has been a molecular change in the brain. This relation means, in the second place, that there is a physical basis for memory. Whether we accept or reject localization of functions in the cerebral hemispheres, we must believe that the cell-modifications which coincide with specific sensations remain permanently, thus furnishing a physical, organic requisite for memory. In the third place, this relation means that, in a recollection of any of our experiences, there is presupposed a renewed activity of those very portions of the brain which assisted in the experience. There are no transcendentalists so transcendental that they may transcend this direct relationship between what they are pleased to call gross matter and their sublimest ecstasy. What opinion must we form as to the nature of this relation ?

We have choice of two conclusions which are alternatives. We may say the relation of brain-matter and consciousness is one of correlation, conversion—or we may say it is one of instrument to personality. Personality is here, as everywhere, a term chosen to represent a series of manifestations so alike among themselves and so unlike all other manifestations as to necessitate a specific designation. By adopting the term personality, we should affirm our belief in the existence of some form of being, which, *for us*, is persistently unlike every other form of being with which we come into relation. Here the element of *speculation*, which is a necessary part of all reasoning, appears. Whether we accept correlation or personality, we accept what can no more be *directly known* than the mortality of men now living, or the return of the seasons. All reasoning is beyond the facts, and is in this a speculation; but reasoning need be no more an unsafe guide on such subjects as the one before us than on any of the complex affairs where we gladly trust its teachings. Our demand of Reason must be that, though she lead us beyond the facts, she shall never lead us *contrary* to the facts. Again, I would say, it should be recognized that neither of the conclusions above indicated is a solution of the mystery attendant upon consciousness. The pride of the little scientists induces them all too often to declare that, by the first of these alternatives, they have cleared away the obscurity which they love to call metaphysical and let in the white light of comprehension.

So, in turn, the other party, seizing hold of the fact of personality, forthwith affirm that, by it, man's immateriality, immortality, and divinity, are forever made visible in the light of consciousness. All this is quite aside from that inferential process which, as reasoning beings, we should prescribe for ourselves. Is the relation between brain and consciousness one of correlation; may we, according to the evidence, believe it to be one of correlation? Physiological materialism is an extension of the doctrine of correlation to consciousness. It is needful to know what is meant by correlation. Correlation is a *necessary, reciprocal production.* "Any force capable of producing another may be produced by it. Each mode of force is capable of producing the others, and none of them can be produced but by some other as an anterior force. The various affections of matter, heat, light, electricity, have a reciprocal dependence; either may produce or be convertible into any of the others." The materialism of physiology extends this doctrine of correlation to consciousness. The well-worn language of Professor Huxley ("Darwin and his Critics") is again in point. "As the electric force, the light-waves and the nerve-vibrations caused by the impact of the light-waves on the retina are all expressions of the molecular changes which are taking place in the elements of the battery, so consciousness is, *in the same sense*, an expression of the molecular changes which take place in that nervous matter which is the organ of consciousness." A short sentence from Dr. Carpenter to the same effect: "*There is just the same* evidence of what has been termed correlation between nerve-force and that primary state of mental activity which we call sensation that there is between light and nerve-force." Now, the proposition, fundamental to my paper, is that such a conclusion can not *rationally* be drawn, unless the characteristics of consciousness, as we know them and are obliged to know them, *resemble* the characteristics of brain-activity as we know them and are obliged to know them. It will not avail to say there are striking differences between heat, electricity, and light; there are striking resemblances—one positive, constant resemblance—they are all modes of *motion.* Between the characteristics of consciousness and the characteristics of nerve-matter, as we know them, *there are no resemblances whatsoever.* If the smaller physiological materialists (for the larger do it fully) would but think it worth their while, and a truly scientific procedure, to fasten their attention upon consciousness, they might be struck by its peculiarities. The distinctive features of consciousness in general have often been indicated. I shall restate them here as they have been compared with nerve-activities, arranging them in pairs for the sake of clearness:

1. *Nerve-activities:*

   All are modes of extension and motion.

   Consciousness-activities:

   None can be conceived as extended or moving.

2. *Nerve-activities:*

   They may be observed through the senses.

   Consciousness-activities:

   They are never known through the senses.

3. *Nerve-activities:*

   They are external to the observer.

   Consciousness-activities:

   They are internal to the observer.

4. *Nerve-activities:*

   Each may be directly seen at the same time by many observers.

   Consciousness-activities:

   They can be directly known by one person only, viz., he who experiences them.

5. *Nerve-activities:*

   They consist of parts external to each other and are divisible.

   Consciousness-activities:

   They have no distinction of parts and are indivisible.

It may surprise some readers to be told that this contrast is fully recognized by many leading upholders of evolution. Mr. Spencer says, "There lies before us, in the study of consciousness, a class of facts absolutely without any *perceptible* or *conceivable* community of nature with the facts that have occupied us in the study of the nervous system."

Dr. Tyndall ("Address on Scientific Materialism," Norwich) says: "The passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. The chasm between the two classes of phenomena is *intellectually impassable.*" Professor Huxley says: "I know nothing whatever, and never expect to know anything, of the steps by which the passage from molecular movement to states of consciousness is effected. I entirely agree with the sense of the passage from Dr. Tyndall."

In view of the dissimilarity, the *thorough* dissimilarity, between nerve-activities and consciousness-activities, we are not justified in regarding the former as the *sole* cause of the latter. Chemists, after a somewhat protracted examination of the substances found in nature, announce the discovery of sixty-four *different* bodies, from which they can not, by any means *now* at hand, separate simpler substances. This does not intend to say that these sixty-four elements are absolutely simple, but that "they are so as far as our knowledge extends." Now, why are these sixty-four elements maintained to have a real existence? Why is aluminium believed in as a fact distinct from antimony, or arsenic as a fact distinct from bromine, and so on throughout the list? Because, and simply because, the states of consciousness are persistently distinct when dealing with these so-called elements. The chemist is unable to experience resemblance between the actions—i. e., the manifestations—of aluminium and antimony. *Therefore*, and therefore alone, he says, there *are* here different substances.

This is the kind of reasoning, and no other, that we wish applied to the subject of our examination. If the passage between brain-activity and consciousness-activity be unthinkable, intellectually impassable, why is it so? Not from any *a priori* or "high-priori" inconceivability, but because these activities persistently fail to resemble one another, i. e., to produce in us similar states of consciousness. They can not be rationally called "diverse operations of energy mutually convertible like light, heat, and the other physical forces." Such correlation is opposed through and through to experience. Here is the irrationality of physiological materialism. This materialism makes a break in the physical continuity of Nature's workings; a break found nowhere else; a break, moreover, which is not found here by any examination of which we are capable.

Correlation requires that motion should be transformed into something not motion, and then resume its course as motion. Motion set up at the periphery of the body produces a definite and measurable quantity of motion in the brain; this is well called a mechanical problem out and out. We find no measurable consciousness, yet consciousness is a reality; we find no break in physical processes elsewhere, yet, if correlation be true here, such a break there is. It will, I hope, be clearly seen that this difficulty is nowise related to the old and worthless difficulty thought to be suggested by those who ask the materialist *how* motion is transformed into consciousness. As to the how of things they have learned most who have learned that they know nothing. The question is not how are brain-motions transformed into consciousness, but the question is exactly this, What ground have we to believe that such transformation exists?

Permit me to repeat the statement that there is no reasoning here along the "high-priori" road of inconceivability. I see no more inconceivability in supposing that a brain-change should be followed by a thought than that it should be followed by an increased secretion. The thing needed is, to know the fact in the case. Are brain-changes transformed into consciousness, or does the soul, on occasion of these changes, respond in its peculiar language?

The brain-changes, as we know them and must know them, consist of attractions, repulsions, motions, and co-ordinations of the brain-particles. These, according to the physiological materialist and the young physician, are transformed into states of consciousness, which states are not material changes, but separated from them by a chasm "intellectually impassable." It has been wisely said that the position which a thorough-going scientific evolution ought to defend is this: thoughts, feelings, volitions, any and all states of consciousness, have no existence for physical science. Indeed, the annoyance caused by consciousness as a useless "surplusage" is nowhere more strikingly illustrated than in the following passage from Professor Huxley's paper "On the Hypothesis that Animals are Automata." The author writes: "Though we may see reason to disagree with Descartes's hypothesis that brutes are unconscious machines, it does not follow that he was wrong in regarding them as automata. We believe, in short, that they are machines, one part of which (the nervous system) not only sets the rest in motion and co-ordinates its movements in relation with changes in surrounding bodies, but is provided with special apparatus, the function of which is the calling into existence of those states of consciousness which are termed sensations, emotions, ideas. It may be assumed, then, that molecular changes in the brain are the causes of all the states of consciousness in brutes. Is there any evidence that these states of consciousness may, conversely, cause those molecular changes which give rise to muscular motion? I see no such evidence. The frog walks, hops, swims, quite as well without consciousness as with it, and if a frog, in his natural state, possesses anything corresponding with what we call volition, there is no reason to think that it is anything but a concomitant of molecular changes in the brain which form part of the series involved in the production of motion. The consciousness of brutes would appear to be related to the mechanism of their body as a *collateral product* of its working, and to be as completely without any power of modifying that working as the steam-whistle which accompanies the work of a locomotive-engine is without influence upon its machinery. Their volition, if they have any, is an emotion (?) indicative of physical changes, not a cause of such changes. It is quite true that this reasoning holds equally good of men, and therefore that all states of consciousness in us, as in them, are *immediately* caused by molecular changes of the brain-substance. It seems to me that, in men as in brutes, there *is no proof* that any state of consciousness is the cause of change in the motion of the matter of the organism. If these positions are well based, it follows that our mental conditions are *simply the symbols* in consciousness of the changes which take place *automatically* in the organism, and that, to take an extreme illustration, the feeling (?) we call volition is *not* the cause of a voluntary act, but a symbol of that state of the brain which is the immediate cause of the act. We are conscious automata." (The italics in the above quotation are the present writer's.) This passage, published in 1874, will remain unique as an attempt to "get on" in our examination of man without consciousness. Consciousness is a collateral product of brain-change. Whatever may be meant by "collateral," it can not be so one-sided an affair as to save the break in physical continuity previously described. If consciousness be at all the product of brain-changes, it appears, and must appear, as a stranger to these changes, destitute of a single one of their features. Further, and with sincere deference, I would say that the reasoning in the passage before us seems to me peculiar. Consciousness is produced by brain-changes; nay more, these are the sole cause of consciousness, and yet there is no ground to believe that consciousness in its turn ever occasions brain-changes or muscular movements. Volition is not the cause of a voluntary act, but a token that such an act is taking place. This would be termed in logic a contradiction, both in form and matter.

When we are told that consciousness is completely without the power of modifying the working of our body, we do, indeed, feel that consciousness might as well give up and cease to be; at the same time we know that consciousness, in the shape of volition, is adjusting, directing, and in manifold other ways modifying our organism from day to day. My reason for bringing up this disposition of consciousness was not so much to show its deficiency (which has been well done by Dr. Carpenter and others), as to insist upon the fact that consciousness is not susceptible of scientific treatment by any physical or physiological method. I wished also to show that no half-way recognition of consciousness would meet the demands of investigation. Perhaps the chiefest benefit to come from the physiological psychology of our day will be in this, that it will make unmistakably clear its own inadequacy for a treatment of consciousness as such. I trust I may not be misunderstood in this remark. I yield to no one in the belief that an inestimable advantage has been conferred on psychology by physiology. It is now possible to study the sensations, both general and special, with a thoroughness unknown a few years since. The intimacy of connection between brain-changes and what we term soul-states has been once and for all established and proclaimed. Much may be accomplished toward a localization of functions in the hemispheres; the time may even come when people at large shall know that most of their stupidity, peevishness, and sin, results from unhealthful brain-activity. The relation between digestion, ventilation, sleep, and morals, may attain general acceptance, to the destruction of a huge load of the world's misery. All this and more may come, but physiology will never remove or investigate a state of consciousness; it will never front the inner side of a single sensation. This, if I mistake not, is the annoying thing to many specialists. The resort has, for a long time, been a vigorous pooh-poohing of consciousness, or a ridicule of it as somehow synonymous with metaphysics and nonsense. It is a singular and natural thing—singular in its intensity and narrowness, natural in its origin—this conviction among many of the younger specialists that logical and psychological investigations are but rattle-boxes for babes and fools. The natural origin of this, I say, is plain. The chairs in many of our colleges and universities are occupied by men nobly endowed by nature for their special studies, and cultivated through years of investigation abroad. They have not, however, escaped the working of the association of ideas. All they have ever known about psychology, logic, or ethics, dates back to a few hours' perfunctory stumbling over the pages of Haven's "Mental Philosophy," Day's "Logic," Whately's "Logic," Thompson's "Outlines of the Laws of Thought," Butler's "Analogy," Haven's "Moral Philosophy," or, if specially fortunate, Hamilton's "Metaphysics." These exercises in torture were held during those groping years of college-boy experience. Here were given all the facts ever furnished for coming to an understanding of the processes of thought or the principles of morals. Interest in these matters, an interest natural to all who share human nature, was blasted at the outset of its development. Other pursuits that could and did take on the semblance of reality fastened attention, and led to the years of toil that fitted for life-work. What more natural than that henceforth (must it be said forever?) each approach to the subject of consciousness is, for these minds, an approach to confusion worse confounded? The fact that I occupy a chair in Philosophy will very much weaken the force of what I am about to say; still, the conviction will get itself expressed with whatsoever power it may have. The work of the workers would rise faster, stand firmer, come to more universal recognition, if guided by some living logic, and some appreciation of the processes of thought, emotion, and will. The fact is, that in consciousness and in consciousness alone all things are known. No physicist ever fronted or ever will front a *pure* fact, a thing as it is, apart from consciousness. What the physicist knows are not substances *in themselves*, out of consciousness. Force and matter are, in the way in which he uses them and must use them, products of his consciousness. He, the conscious person, is affected so and so, that is, is made to have such and such states of consciousness; to the *common* or resembling elements in these states, he gives a common name, believing, beyond a doubt, in the existence of a cause for these states, but often failing to realize that such cause is unknown and unknowable, not at all revealed, in its essence and apart from consciousness, by the abstract terms which he has formed to express it. The physiological materialist can never meet the demand which a proof of his belief requires, viz., that he should be able to consider the nervous system apart from consciousness before declaring it the sole cause of consciousness. All that is known of the nervous system is known through consciousness; is there, then, no importance, no necessity, for some examination of consciousness for those who would give an account of their knowledge, be its content what it may? This position, rightly understood, will vindicate my assertion that, for all forms of investigation, the need at present is a critique of knowing, a critique which shall be not simply a "Zurückgehen auf Kant" (profitable as this might prove for an understanding of his relation to materialism), but a critique which shall embody the contributions of recent years from investigators in the territories of the senses, the understanding, and the emotions.

It may be asked, Why should this appeal for consciousness come so late in the present discussion? Ought it not rather to have preceded the statement of the characteristics of consciousness, and so prevented a break in the course of thought? Such a break is, of course, undesirable; still, it is one not to be avoided, as I think, under the circumstances.

There remain for consideration certain special features of consciousness, for whose examination and estimation special entreaty was needed. This solicitation will have more force when placed in direct connection with the features themselves. The writer ventured to hope that those broader, more noticeable characteristics of consciousness which lie, as it were, upon the surface, might be left to awaken attention by their size. Not so with matters now to be brought forward. While there is no purpose to leave, even for an instant, the territory of experience, we enter a portion of that territory which, to many, will be new, and therefore, without effort against prejudice, untrue.

There are certain special facts in consciousness, i. e., certain distinctive features in each person's experience, which prevent, out and out, the acceptance of correlation as a proper account of the relations between brain and consciousness. Few would refuse to admit that sensation is a fact, yet there is danger of studying sensation with the sensation omitted.

Every sensation has four physical antecedents which, though distinct, are not different in kind from one another. This is such a preponderance of the physical that the other element is likely to go unnoticed. The physical requisites for every sensation are: 1. Some outward, exciting cause or excitation—this is physical movement, nothing else; it may be of ponderable matter or of an imponderable instrument, as light. 2. The contact of this physical condition of movement with a sensitive portion of the body. 3. The excitation-condition of the sensitive nerve-fibers. This is produced by the outward irritation, but is a purely physical and inward nervous process, having no other resemblance to its cause than that it is motion, and having *no resemblance* to the *sensation* which is conditioned upon it. 4. The transfer of this condition of the nerve-fiber to the central parts of the nervous system, especially to the brain. These are the mechanical antecedents for sensation. They are susceptible of physical treatment. They may, and often do, operate without any sensation arising; more than this, they may operate so as to produce a reflex activity, causing violent motions, still without the faintest appearance of sensation. It is plain, then, that to know anything about sensation we must pass from physiology to personal experience. It seems a just charge against the materialism of physiology, both general and medical, that it takes no account of *the* element in a sensation-process.

How shall we escape saying that the last step in this process is the sensation itself, which the soul calls forth from itself in consequence of the antecedents described? The sensation is no picture of the outer thing, the retinal image works, in all probability, chemically upon the retina, but that image does not and can not get itself transferred to the cerebral hemispheres. The sensation is an answer to the excitation in the brain-mass, arising from that image, an answer in such peculiar language that it must be called language of the soul—not as thereby explaining it in the sense of resolving its mystery, yet as thereby explaining it in the only way in which explanation is *anywhere* possible, viz., by resolving the combined activities into their elements.

It is a necessary part of this discussion to note that one of these elements is personality, i. e., a consciousness of the sensation as *mine*. It seems unfortunate that, in dealing with this experience of personality, the strength and weakness of the development theory are not rightly estimated. The strength of the theory lies in those rudimentary sensations connected with infant life, and with the organic processes where it seems but just to say that only *feeling* is present, i. e., no true consciousness, no knowledge of the sensation as mine. The weakness of the theory, and it is a fatal one, lies in the failure to recognize the distinction between a matured idea of self which comes only with years, and a consciousness that the sensation is mine, however rudimentary this sensation may be. The most primitive distinctions in consciousness, those of pleasure and pain, can not be experienced without being known. When this is realized, the inadequacy of the attempt to dispense with personality, or to derive it from anything more elementary than itself, must appear; the two factors in every phenomenon, viz., that which manifests itself, and that to which it manifests itself, are at once disclosed.

Memory, which, though lying in the so-called fog-land of consciousness, is yet a reality, has been brought forward as decisive against the application of evolution to the origin of knowledge. Memory is a prerequisite for all psychical development. Unless we can compare the experience of yesterday with the experience of to-day, any advance of ourselves from the brute condition is impossible. Now, such comparison demands that the *first* experience should have been known as mine. From this demand there is no escape. Complying with it, something, some form of being called personality, must lie at the bottom of the inner side of our nature. Lotze has pertinently said: "We have this unity of consciousness not because we *appear* to ourselves to have it; we have it because we appear to *ourselves* to have it."

In each sensation there is consciousness of self in a particular state. Our sensations are varied and successive. We hear the sound of a bell, then of a railway-train, then of the wind; we see cloud, moon, and mountain-top. Here we have the sensation, the succession of sensations, the discrimination of sensations, and discrimination of things by the sensations. Devolve this whole business upon nerve-matter in the cerebral hemispheres. Is such ascription of functions rational? Is it in keeping with our knowledge of brain-structure? If we surmount the difficulty of transformation of motions into non-motions (that is, consciousness), what provision do we anywhere find in the hemispheres for the *unification* of such sensations as above described, their unification in self?

A further question at once arises. Physiology has arranged for diversity of result. What has it done toward comparing these differences? By comparison, and by that alone, each sensation is known as distinct from every other. All that physiology offers or can offer is the integrity of each nerve-fiber. As has been justly said, this fiber is like every other in construction and action. What provision have we, apart from personality, for detecting difference in sensations?

Personality is the place at which both parties should expend their strength. Mr. Mill and Mr. Bain, understanding this, have sought to obliterate the distinction between feeling and self-consciousness. They have maintained the priority of an impersonal feeling. Here is the starting-point, not in personality, but in feeling. Personality is a development from impersonality by what Mr. Mill calls a "process of reference." This is one of those magical terms, like the newer word "functionate," which serve to obscure the failure of an undertaking. Mr. Bain also starts with a nervous system and feeling, and gives what may be taken as the latest expression of the movement toward unification of soul and body. He says: "The arguments for the two substances—mind and matter—have, we believe, entirely lost their validity; they are no longer compatible with ascertained science and clear thinking. One substance with two sets of attributes, two sides (a physical and a mental), a double-faced unity, would appear to comply with all the exigencies of the case." This assertion of a double-faced unity not only fails to bridge the chasm that is rationally impassable, not only increases the confusion by uniting contradictory attributes in too small a compass, but it is a pure metaphysical or ontological predication, from which reason defend us! As to the existence of any Spinozistic substance holding in itself the irreconcilables thought and extension, how can it any longer be worth while to express an opinion? Perhaps matter is double-faced. This is a speculation which, as it transcends, contradicts experience.

If I mistake not, Mr. Mill and Mr. Bain have themselves refuted their position with regard to the development of personality from impersonal feeling. Mr. Mill ("Examination of Hamilton," page 242) says: "If, therefore, we speak of the mind as a series of feelings, we are obliged to complete the statement by calling it a series which is aware of itself as past and present; and we are reduced to the alternative of believing that the mind or ego is something different from any series of feelings or possibilities of them, or of accepting the paradox that something which, by hypothesis, is but a series of feelings, can be aware of itself as a series." In his edition of "The Analysis of the Human Mind" (i, 230) he further says, "There is no meaning in the word ego, or I, unless the I of to-day is also the I of yesterday." This must be taken as an admission that personality is an essential for personal identity.

Mr. Bain says: "We may be in a state of pleasure with *little* or nothing of thought" (personal consciousness) "accompanying. We are still properly said to be conscious or under consciousness. It is thus correct to draw a line between feeling and knowing that we feel, *although there is great delicacy in the operation.* [Italics are the writer's.] It may be said in one sense that we can not feel without knowing that we feel; but the assertion is verging on error, for a feeling may be accompanied with a *minimum* of cognitive energy or, *as good as*, none at all." I am unable to appreciate this passage as other than an abandonment of the development theory applied to personality. The language of Professor Calderwood seems just when he writes, "If in every sensation, every feeling, there is a particle of cognitive energy" (if the sensation be known as mine in any sense) "the development theory as an account of personality fails."

Under the influence of the *a priori* procedure, both metaphysical and theological, most of us flee with raised hands of horror at sound of the word will. Recollections of "you shall and you sha'n't, you can and you can't, you will and you won't," crowd round in ever-thickening confusion. Still, it must be said that, apart from all talk about freedom and bondage, volition is a decidedly large fact in human experience. Though Goethe is right in saying, "Ein kleiner Ring begränzt unser Leben," a ring of circumstance, of inheritance, yet within the circle of that ring a measure of action prevails which no word describes save the word willed. The action is determined by personality. It is impossible to find provision for this in the nervous system. Inhibitory nerves there may be, but the experience of ourselves as using within fixed limits this physical organism is an experience too unique to come within nerve-actions and reactions before pleasure and pain.

There is no need to multiply illustrations of the exercise of will in holding muscles still against pain or of those higher manifestations where we endure agony, not from any present suffering, but to avoid future loss.

In conclusion, and for completeness, reference should be made to the moral consciousness, i. e., the knowledge of obligation. This, too, is a fact in human experience, and as such demands to be traced to its ultimates. A significant thing, from the philosophical side, is Mr. Spencer's anticipatory publication of the "Data of Ethics." By this publication Mr. Spencer has recognized, what many of his smaller adherents fail to know, that, in ethics, as an attempt to give a rational account of the consciousness of obligation, all thinking finds its highest and most serious application.

We discover in the nervous system no provision for the consciousness of duty; indeed, put in this bald way, no materialist would look there for any such consciousness. Duty as something to be done for its own sake, apart from creed, or sect, or party, or consequences, is properly considered an evidence of culture in thought and action. It is futile to attempt to resist the application of evolution to ethics by any appeal to the transcendent beauty of the moral ideal. The rose is a transcendent thing in color, fragrance, and outline; still, it develops from that which has none of these.

Development of some kind is a fact. The stress of inquiry in ethics is, I think, here: Can the sense of right and wrong, however rudimentary, be produced by pains and pleasures? In the nervous system we have the physical antecedents for pain and pleasure; though no such sensations are in the nervous system, they are in us. Ethics therefore presents the development theory a further difficulty, viz., the one of passing rationally from pains and pleasures to right and wrong. Even Mr. Spencer's form of the development theory, which would seek to find in the conduct called ethical but a part of conduct in general, and to regard all conduct, both ethical and non-ethical, as adjustments of means to ends; even this form of the theory must be able to make it plain that the transition from conduct non-ethical to conduct ethical is *gradual*, composed of many steps, and not, as experience seems to teach, sudden, distinct, and sharp.

What belief, then, does reason require in our present state of knowledge as to the relation between nerve-matter and consciousness? We distinguish two series, two kinds of experiences; these stand to one another as outward and inward, physical and spiritual, compound and simple. We do not know the nature of either. The terms matter and soul are our highest generalizations from experience. The materialist errs when he pronounces upon the character of matter, affirming that *in itself*, as it lies beyond his vision, it is hard, round, inelastic, double-faced. The spiritualist errs when he pronounces upon the nature of spirit, as it lies beyond his ken, naming it, in essence, immortal, divine.

Unity there somehow is in this universe. There are no breaks if we could read aright. Perhaps this reading should see the beginning in the end, not the end in the beginning. The charcoal sketch of Angelo would indeed be promise and potency of greater things, and this because in it was more than charcoal. So it may be well, even rational, to interpret all things and all beings.

THE STATE *VERSUS* THE MAN:

A CRITICISM OF MR. HERBERT SPENCER.

By ÉMILE DE LAVELEYE.

"La nature est l'injustice même."—Renan.

FOUR articles of Mr. Herbert Spencer's, which appeared in the Contemporary Review, have recently been reprinted together, and form now a work which Mr. Spencer has entitled "The Man *versus* The State." This little volume merits the most attentive study, because in it the great sociological question of our day is treated in the most masterly manner. The individualist theory was, I think, never expounded better or with stronger arguments based on first principles, or supported by so great a number of clearly analyzed and admirably grouped facts. These pages are also full of important truths and of lessons, from whence both nations and governments may derive great benefit. Mr. Spencer's deductions are so concise and forcible that one feels oneself drawn, against one's will, to accept his conclusions; and yet, the more I have thought on the subject, the more convinced have I become that these conclusions are not in the true interest of humanity. Mr. Herbert Spencer's object is to prove the error and danger of State socialism, or, in other words, the error and danger of that system which consists in appropriating State, or communal, revenues to the purpose of establishing greater equality among men.

The eminent philosopher's statement, that in most civilized countries governments are more and more adopting this course, is indisputable. In England Parliament is taking the lead; in Germany Prince Bismarck, in spite of Parliament; and elsewhere either Parliament or town councils are doing the same thing. Mr. Spencer considers that this effort for the improvement of the condition of the working-classes, which is being everywhere made, with greater or less energy, is a violation of natural laws, which will not fail to bring its own punishment on nations, thus misguided by a blind philanthropy.

I believe, on the contrary, that this effort, taken as a whole, and setting aside certain mistaken measures, is not only in strict accordance with the spirit of Christianity, but is also in conformity with the true principles of politics and of political economy.

Let us first consider a preliminary question, on which I accept Mr. Spencer's views, but for different reasons from his: On what are individual rights founded, and what are the limits of State power? Mr. Spencer refutes with pitiless logic the opinions of those who, with Bentham, maintain that individual rights are State concessions, or who, like Matthew Arnold, deny the existence of natural rights. The absurdity of Bentham's system is palpably evident. Who creates the government? The people, says he. So the government, thus created, creates rights, and then, having created rights, it confers them on the separate members of the sovereign people, by which it was itself created. The real truth is, that government defines and sanctions rights, and employs the public strength to enforce their being respected, but the rights themselves existed before.

Referring to the history of all primitive civilization, Mr. Herbert Spencer proves to Mr. Matthew Arnold that in familial and tribal communities there existed certain customs, which conferred recognised and respected rights, before ever any superior authority which could be designated by the name of State had been formed. Only, I think Mr. Herbert Spencer is wrong in making use of the term "natural rights." This expression was an invention of the French philosophers of the eighteenth century, and it is still employed in Germany by a certain school of philosophers as *Naturrecht*. Sir Henry Maine's clever and just criticism of this expression in his book "Ancient Law" should warn us all of the vague and equivocal meaning it conceals. The jurists and philosophers of the seventeenth and eighteenth centuries attached two very different significations to the term "natural rights." They sometimes applied it to the condition of primitive societies, in which their optimism led them to dream of a reign of justice, liberty, and equality, and at other times they made use of it when speaking of the totality of rights which should be possessed by every individual, by reason of his manhood. These two conceptions are equally erroneous. In primitive societies, in spite of certain customs which are the embryo of rights, might reigns supreme, as among animals, and the best armed annihilate their weaker neighbours. Certainly, one would look in vain there for a model of a political constitution or code suitable to a civilized people. Neither can it be maintained that the "Rights of man," as proclaimed by the American and French Revolutions, belong to each individual, only because he forms part of the human species. The limit of rights which may be claimed by any one individual must depend upon his aptitudes for making good use of them. The same civil code and the same political institutions will not equally suit a savage tribe and a civilized nation. If the granting of the suffrage to all were likely to lead a people to anarchy or to despotism, it could not be called a natural right, for suicide is not a right.

If one analyze completely the expression "natural rights," one finds that it is really not sense. Xavier de Maistre, annoyed by the constant appeals to nature which are to be found in all the writings of the eighteenth century, said, very wittily: "Nature, who and what is this woman?" Nature is subject to certain laws, which are invariable; as, for instance, the law of gravitation. We may call these "laws of nature," but in human institutions, which are ever varying, nothing of the sort can exist. This superior and ideal right, which is invoked for the purpose of condemning existing laws, and claiming their reform or suppression, should rather be called *rational right*—that is to say, right in conformity with reason.

In every country, and at all times, an order of things may be conceived—civil, political, penal and administrative laws—which would best conform to the general interest, and be the most favourable to the well-being and progress of the nation. This order of things is not the existing one. If it were, one might say, with the optimists, that all is for the best in the best of possible worlds, and a demand for any amelioration would be a rebellion against natural laws, and an absurdity. But this order of things may be caught sight of by reason, and defined with more or less accuracy by science; hence its name of rational order. If I ask for free trade in France, for a better division of property in England, and for greater liberty in Russia, I do so in the name of this rational order, as I believe that these changes would increase men's happiness.

This theory permits of our tracing a limit between individual liberty and State power.

Mr. Herbert Spencer proves very clearly that there are certain things which no man would ever choose to abandon to State power; his religious convictions, for instance. On the other hand, all would agree that the State should accept the charge of protecting frontiers and punishing theft and murder, that is to say, the maintaining of peace and security at home and abroad; only here, like most Englishmen, Mr. Herbert Spencer invokes human will. Find out, he says, on the one hand, what the great majority of mankind would choose to reserve to an individual sphere of action, and, on the other, what they would consent to abandon to State decisions, and you will then be able to fix the limit of the power of public authority.

I cannot myself admit that human will is the source of rights. Until quite recently, in all lands, slavery was considered a necessary and legitimate institution. But did this unanimous opinion make it any more a right? Certainly not. It is in direct opposition to the order of things which would be best for the general welfare; it cannot, therefore, be a right.

Until the sixteenth century, with the exception of a few Anabaptists who were burnt at the stake, all believed that the State ought to punish heretics and atheists. But this general opinion did not suffice to justify the intolerance then practised. The following line of argument, I think, would be most in keeping with individual interests, and, consequently, with the interests of society in general: A certain portion of men's acts ought not to be in any way subject to sovereign authority, be it republican or monarchical. But what is to be the boundary of this inviolable domain of individual activity? The will of the majority, or even of the entire population, is not competent to trace it, for history has proved but too often how gross have been the errors committed in such instances. This limit can, therefore, only be fixed by science, which, at each fresh progress in civilization, can discover and proclaim aloud where State power should cease to interfere. Sociological science, for instance, announces that liberty of conscience should always be respected as man's most sacred possession, and because religious advancement is only to be achieved at this price; that true property, or, in other words, the fruit of personal labour, must not be tampered with, or labour would be discouraged and production would diminish; that criminals must not go unpunished, but that justice must be strictly impartial, so that the innocent be not punished with the guilty.

It would not be at all impossible to draw up a formula of these essential rights, which M. Thiers called necessary liberties, and which are already inscribed in the constitutions of America, England, France, Belgium, Holland, and all other free nations. It it sometimes very difficult to know where to set bounds to individual liberty, in the interests of public order and of the well-being of others; and it is true, of course, that either the king, the assembly, or the people enacts the requisite laws, but if science has clearly demonstrated a given fact it imposes itself. When certain truths have been frequently and clearly explained, they come to be respected. The evidence of them forms the general opinion, and this engenders laws.

To be brief, I agree with Mr. Herbert Spencer that, contrary to Rousseau's doctrine, State power ought to be limited, and that a domain should be reserved to individual liberty which should be always respected; but the limits of this domain should be fixed, not by the people, but by reason and science, keeping in view what is best for the public welfare.

This brings me to the principal question I desire to treat. I am of opinion that the State should make use of its legitimate powers of action for the establishment of greater equality among men, in proportion to their personal merits, and I believe that this would be in conformity, not only with its mission properly speaking, but also with rational rights, with the progress of humanity; in a word, with all the rights and all the interests invoked by Mr. Herbert Spencer.

I will briefly resume the motives given by Mr. Herbert Spencer to show that any wish to improve the condition of the working-classes by law, or by the action of public power, so as to bring about a greater degree of equality among men, would be to run against the stream of history, and a violation of natural laws. There are, he says, two types of social organization, broadly distinguishable as the "militant" and the "industrial" type. The first of these is characterized by the *régime* of status, the second by the *régime* of contract. The latter has become general among modern nations, especially in England and America, whereas the militant type was almost universal formerly. These two types may be defined as the system of compulsory co-operation and the system of voluntary co-operation. The typical structure of the one may be seen in an army formed of conscripts, in which each unit must fulfil commands under pain of death, and receives, in exchange for his services, food and clothing; while the typical structure of the other may be seen in a body of workers who agree freely to exchange specified services at a given price, and who are at liberty to separate at will. So long as States are in constant war against each other, governments must perforce be on a military footing, as in antiquity. Personal defence, then, being society's great object, it must necessarily give absolute obedience to a chief, as in an army. It is absolutely impossible to unite the blessings of freedom and justice at home with the habitual commission of acts of violence and brutality abroad.

Thanks to the almost insensible progress of civilization and to gradual liberal reforms, the ancient militant State was little by little despoiled of its arbitrary powers, the circle of its interventions grew narrower and narrower, and men became free economically, as well as politically. We were advancing rapidly towards an industrial *régime* of free contract. But, recently, the Liberals in all countries have adopted an entirely opposite course. Instead of restricting the powers of the State, they are extending them, and this leads to socialism, the ideal of which is to give to government the direction of all social activity. Men imagine that, by thus acting, they are consulting the interests of the working-classes. They believe that a remedy may be found for the sufferings which result from the present order of things, and that it is the State's mission to discover and apply that remedy. By thus acting they simply increase the evils they would fain cure, and prepare the way for a universal bondage, which awaits us all—*the Coming Slavery*. Be the authority exercised by king, assembly, or people, I am none the less a slave if I am forced to obey in all things, and to give up to others the net produce of my labour. Contemporary progressism not only runs against the stream of history, by carrying us back to despotic organizations of the militant system, but it also violates natural laws, and thus prepares the degeneration of humanity. In family life the gratuitous parental aid must be great in proportion as the young one is of little worth either to itself or to others, and benefits received must be inversely as the power or ability of the receiver.

"Throughout the rest of its life each adult gets benefit in proportion to merit, reward in proportion to desert, merit and desert being understood as ability to fulfil all the requirements of life. Placed in competition with members of its own species, and in antagonism with members of other species, it dwindles and gets killed off, or thrives and propagates, according as it is ill-endowed or well-endowed. If the benefits received by each individual were proportionate to its inferiority, if, as a consequence, multiplication of the inferior was furthered and multiplication of the superior hindered, progressive degradation would result, and eventually the degenerated species would fail to hold its ground in presence of antagonistic species and competing species." (Page 65.)

"The poverty of the incapable, the distress that comes upon the imprudent, the starvation of the idle, and the shouldering aside of the weak by the strong, which leave so many 'in shallows and in miseries,' are the decrees of a large, far-seeing benevolence." (Page 67.)

When the State, guided by a wrongly inspired philanthropy, prevents the application of this wise law, instead of diminishing suffering it increases it. "It tends to fill the world with those to whom life will bring most pain, and tends to keep out of it those to whom life will bring most pleasure. It inflicts positive misery, and prevents positive happiness." ("Social Statics," p. 381, edit. 1851.)

The law that Mr. Herbert Spencer desires society to adopt is simply Darwin's law—"the survival of the fittest." Mr. Spencer expresses his astonishment that at the present day, more than at any other period of the world's history, everything is done to favour the survival of the unfittest, when, at the same time, the truth as revealed by Darwin, is admitted and accepted by an ever-growing number of educated and influential people!

I have endeavoured to give a brief sketch of the line of argument followed by Mr. Herbert Spencer. We will now see what reply can be made to it. I think one chief point ought not to have escaped the eminent writer. It is this: If the application of the Darwinian law to the government of societies be really justifiable, is it not strange that public opinion, not only in England, but in all other countries, is so strenuously opposed to it, at an epoch which is becoming more and more enlightened, and when sociological studies are pursued with so much interest? If the intervention of public power for the improvement of the condition of the working-classes be a contradiction of history, and a return to ancient militant society, how is it that the country in which the new industrial organization is the most developed—that is to say, England—is also the country where State intervention is the most rapidly increasing, and where opinion is at the same time pressing for these powers of interference to be still further extended? There is no other land in which the effort to succour outcasts and the needy poor occupies so large a portion of the time and means of the well-to-do and of the public exchequer ; there is nowhere else to be found a poor-law which grants assistance to even able-bodied men ; nowhere else would it ever have been even suggested to attack free contract, and consequently the very first principles of proprietorship, as the Irish Land Bill has done ; and nowhere else would a Minister have dared to draw up a programme of reforms such as those announced by Mr. Chamberlain at the Liberal Reform Club at Ipswich (Jan. 14, 1885). On the Continent all this would be looked upon as rank socialism. If, then, as a country becomes more civilized and enlightened it shows more inclination to return to what Mr. Herbert Spencer calls militant organization, and to violate the Darwinian law applied to human society, may we not be led to conclude that this so-called retrogression is really progress? This conclusion would very easily explain what Mr. Herbert Spencer designates as the "wheeling round" of the Liberal party with which he so eloquently reproaches them.

Why did the Liberals formerly do their utmost to restrict State power? Because this power was then exercised in the interests of the upper classes and to the detriment of the lower. To mention but one example : When, in former times, it was desired to fix a scale of prices and wages, it was with a view to preventing their being raised, while, to-day, there is a clamour for a lessening of hours of labour with increased remuneration. Why do Liberals now wish to add to the power and authority of the State? To be able to ameliorate the intellectual, moral, and material condition of a greater number of citizens. There is no inconsistency in their programme ; the object in view, which is the great aim of all civilization, has been always the same—to assure to each individual liberty and well-being in proportion to his merit and activity !

I think that the great fundamental error of Mr. Herbert Spencer's system, which is so generally accepted at the present day, consists in the belief that if State power were but sufficiently reduced to narrow it to the circle traced by orthodox economists, the Darwinian law and the survival of the fittest would naturally follow without difficulty. Mr. Spencer has simply borrowed from old-fashioned political economy, without submitting to the fire of his inexorable criticism, the superficial and false notion that, if the *laissez-faire* and free contract *régime* were proclaimed, the so-called natural laws would govern the social order. He forgets that all individual activity is accomplished under the empire of laws, which enact as to ownership, hereditary succession, mutual obligations, trade and industry, political institutions and administrations, besides a multitude of laws referring to material interests, banking organizations, money, credit, colonies, army, navy, railways, etc.

For natural laws, and especially the law of the survival of the fittest, to become established, it would be necessary to annihilate the immense existing edifice of legislation, and to return to the wild state of society when primitive men lived, in all probability, much as do animals, with no possessions, no successions, no protection of the weak by the State.

Those who, with Mr. Spencer and Haeckel and other Conservative evolutionists, are anxious to see the law of the survival of the fittest and of natural selection adopted in human society, do not realize that the animal kingdom and social organization are two such totally different domains that the same law, applied to each, would produce wholly opposite effects. Mr. Herbert Spencer gives an admirable description of the manner in which natural selection is accomplished among animals :—

"Their carnivorous enemies not only remove from herbivorous herds individuals past their prime, but also weed out the sickly, the malformed, and the least fleet and powerful. By the aid of which purifying process, as well as by the fighting so universal in the pairing season, all vitiation of the race through the multiplication of its inferior samples is prevented, and the maintenance of a constitution completely adapted to surrounding conditions, and therefore most productive of happiness, is ensured."

This is the ideal order of things which, we are told, ought to prevail in human societies, but everything in our present organization (which economists, and even Mr. Spencer himself, admit, however, to be natural) is wholly opposed to any such conditions. An old and sickly lion captured a gazelle ; his younger and stronger brother arrives, snatches away his prize, and lives to perpetuate the species ; the old one dies in the struggle, or is starved to death. Such is the beneficent law of the "survival of the fittest." It was thus among barbarian tribes. But could such a law exist in our present social order ? Certainly not ! The rich man, feebly constituted and sickly, protected by the law, enjoys his wealth, marries and has offspring, and if an Apollo of herculean strength attempted to take from him his possessions, or his wife, he would be thrown into prison, and were he to attempt to practise the Darwinian law of selection, he would certainly run a fair risk of the gallows, for this law may be briefly expressed as follows : Room for the mighty, for might is right. It will be objected that in industrial societies the quality the most deserving of recompense, and which indeed receives the most frequent reward, is not the talent of killing one's fellow-man, but an aptitude for labour and producing. But at the present time is this really so ? Stuart Mill says that from the top to the bottom of the social ladder remuneration lessens as the work accomplished increases. I admit that this statement may be somewhat exaggerated, but, I think, no one will deny that it contains a large amount of truth. Let us but cast our eyes around us, and we see everywhere those who do nothing living in ease and even opulence, while the workers who have the hardest labour to perform, who toil from night to morning in mines, or unhealthy workshops, or on the sea in tempests, in constant danger of death, are paid, in exchange for all these hardships, a salary hardly sufficient for their means of subsistence, and which, just now, has become smaller and smaller, in consequence of the ever-recurring strikes, and the necessary closing of so many factories, mines, etc., owing to the long-continued depression of trade. What rapid fortunes have been made by stock-broking manœuvres, by trickeries in supplying goods, by sending unseaworthy vessels to sea to become the coffins of their crews! Do not such sights as these urge the partisans of progress to demand the State's interference in favour of the classes who receive so inadequate a payment for their labours?

The economists of the old school promised that, if the *laissez-faire* and free contract *régime* were proclaimed, justice would reign universally; but when people saw that these fine promises were not realized, they had recourse to public power for the obtaining of those results which the much-boasted "liberty" had not secured.

The system of accumulating wealth and hereditary succession alone would suffice to prevent the Darwinian law ever gaining a footing in civilized communities. Among animals, the survival of the fittest takes place quite naturally, because, as generations succeed each other, each one must create his own position according to his strength and abilities; and in this way the purifying process, which Mr. Herbert Spencer so extols, is effected. A similar system was generally prevalent among barbarians; but, at the present day, traces of it may be seen only in instances of "self-made men;" it disappears in their children, who, even if they inherit their parents' talents and capacities, are brought up, as a rule, in so much ease and luxury that the germs of such talents are destroyed. Their lot in life is assured to them, so why need they exert themselves? Thus they fail to cultivate the qualities and tastes they may have inherited from their parents, and they and their descendants become in all points inferior to their ancestors who secured to them, by labour and industry, the privileged position they hold. Hence the proverb, *A père économe fils prodigue* (To a thrifty father, a spendthrift son).

It follows, therefore, that those who wish to see the law of natural selection, by the transmission of hereditary aptitudes, established amongst us should begin by demanding the abolition of hereditary succession.

Among animals, the vitiation of the race through the multiplication of its inferior samples is prevented "by the fighting so universal in the pairing season." In the social order the accumulation and hereditary transmission of wealth effectually impede the process of perfecting the race. In Greece after the athletic sports, or in those fortunate and chimerical days of which the Troubadours sang, "the most beautiful was sometimes given as a prize to the most valiant;"

but, in our prosaic age, rank and fortune too often triumph over beauty, strength, and health. In the animal world, the destiny of each one is decided by its personal qualities. In society, a man attains a high position, or marries a beautiful woman, because he is of high birth, or wealthy, although he may be ugly, lazy, and extravagant. The permanent army and the navy would also have to be destroyed, before the Darwinian law could triumph. Conscription on the Continent and enlistment in England (to a less degree) condemn many of the strongest and most warlike men to enforced celibacy; and, as they are subjected to exceptional dangers in the way of hazardous expeditions and wars, the death-rate is far higher amongst them than it would be under ordinary circumstances. In pre-historic times, or in a general way, such men would certainly have begotten offspring, as being the strongest and most apt to survive; in our societies, they are decimated or condemned to celibacy.

Having borrowed from orthodox political economy the notion that it would suffice to put a check on inopportune State intervention for the reign of justice to become established, Mr. Herbert Spencer proceeds to demonstrate that the legislators who enacted the poor-law, and all recent and present law-makers "who have made regulations which have brought into being a permanent body of tramps, who ramble from union to union, and which maintain a constant supply of felons by sending back convicts into society under such conditions that they are almost compelled again to commit crimes," are alone responsible for the sufferings of the working-classes. But may we not blame law-makers, or, rather, our own social order, for measures more fatal in their results than either of these—for instance, the law which concentrates all property into the hands of a few owners? Some years ago, Mr. Herbert Spencer wrote some lines on this subject which are the most severe indictment against the present social order that has ever fallen from the pen of a really competent writer:—

"Given a race of beings having like claims to pursue the objects of their desires—given a world adapted to the gratification of those desires—a world into which such beings are similarly born, and it unavoidably follows that they have equal rights to the use of this world. For if each of them 'has freedom to do all that he wills, provided he infringes not the equal freedom of any other,' then each of them is free to use the earth for the satisfaction of his wants, provided he allows all others the same liberty. And, conversely, it is manifest that no one or part of them may use the earth in such a way as to prevent the rest from similarly using it, seeing that to do this is to assume greater freedom than the rest, and, consequently, to break the law. Equity, therefore, does not permit property in land. On examination, all existing titles to such property turn out to be invalid; those founded on reclamation inclusive. It appears that not even an equal apportionment of the earth amongst its inhabitants could generate a legitimate proprietorship. We find that, if pushed to its ultimate consequences, a claim to exclusive possession of the soil involves a land-owning despotism. We further find that such a claim is constantly denied by the enactments of our legislature. And we find, lastly, that the theory of the co-heirship of all men to the soil is consistent with the highest civilization; and that, however difficult it may be to embody that theory in fact, equity sternly commands it to be done." "By-and-by, men may learn that to deprive others of their rights to the use of the earth is to commit a crime inferior only in wickedness to the crime of taking away their lives or personal liberties." ("Social Statics," chap. ix.)

Has Mr. Herbert Spencer changed his opinions as to the proprietorship of the soil since these lines were written? Not at all, for, in the chapter entitled "The Coming Slavery," he writes that "the movement for land-nationalization is aiming at a system of land-tenure equitable in the abstract." But if society, in depriving numbers of persons of their right of co-heirship of the soil, has "committed a crime inferior only in wickedness to the crime of taking away their lives or personal liberties," ought it not, in common justice, to endeavour to repair the injury done? The help given by public assistance compensates very feebly for the advantages they are deprived of. In his important book, "La Propriété Sociale," M. Alfred Fouillée, examining the question from another standpoint, very accurately calls this assistance "la justice reparative." The numerous and admirable charitable organizations which exist in England, the keen emotion and deep commiseration manifested when the little pamphlet, "The Bitter Cry of Outcast London," was first published, the growing pre-occupation of Government with the condition of the working-classes, must be attributed, in the first instance certainly to Christian feeling, but also, in a great measure, to a clearer perception of certain ill-defined rights possessed by those who have been kept deprived of national or rather communal co-heirship. Mr. Herbert Spencer has expressed this idea so clearly and eloquently that I hope I may be allowed to quote the passage :—

"We must not overlook the fact that, erroneous as are these poor-law and communist theories, these assertions of a man's right to maintenance and of his right to have work provided for him, they are nevertheless nearly related to a truth. They are unsuccessful efforts to express the fact that whoso is born on this planet of ours thereby obtains some interest in it—may not be summarily dismissed again—may not have his existence ignored by those in possession. In other words, they are attempts to embody that thought which finds its legitimate utterance in the law: All men have equal rights to the use of the earth. . . . After getting from under the grosser injustice of slavery, men could not help beginning in course of time to feel what a monstrous thing it was that nine people out of ten should live in the world on sufferance, not having even standing room save by allowance of those who claim the earth's surface." ("Social Staties," p. 345.)

When one reads through that substantial essay, "The Man *versus* The State," it appears as if the principal or, indeed, the sole aim of State socialism were the extension of public assistance and increased succour for the unworthy, whereas the reality is quite the reverse of this! Scientific socialism seeks, first of all, the means of so raising the working-classes that they may be better able to maintain themselves and, consequently, to dispense with the help of others; and, secondly, it seeks to find what laws are the most in conformity with absolute justice, and with that admirable precept, "Benefit in proportion to merit, reward in proportion to desert." In the speech delivered by Mr. Shaw Lefevre, last year (1884), as President of the Congress of Social Science, at its opening meeting at Birmingham, he traced, in most striking language, all the good that State intervention had effected in England of late years: Greater justice enforced in the relations between man and man, children better educated and better prepared to become useful and self-supporting members of the community, the farmer better guaranteed against the exaggerated or unjust demands of the proprietor, greater facilities for saving offered, health ensured to future generations by the hours of labour being limited, the lives of miners further safeguarded, so that there are less frequent appeals to public assistance, and, as a practical result of this last measure, the mortality in mines fallen in the last three years to 22·1 per thousand, as compared to 27·2 per thousand during the ten previous years—a decrease of 20 per cent.! One fact is sufficient to show the great progress due to this State legislation: in an ever-increasing population, crime is rapidly and greatly diminishing.

Suppose that, through making better laws, men arrive gradually at the condition of the Norwegian peasantry, or at an organization similar to that existing in the agricultural cantons of Switzerland; that is to say, that each family living in the country has a plot of ground to cultivate and a house to live in: in this case every one is allowed to enjoy the full fruit of his labour, and receives reward in proportion to his activity and industry, which is certainly the very ideal of justice—*cuique suum.*

The true instinct of humanity has ever so understood social organization that property is the indispensable basis of the family, and a necessary condition of freedom. To prevent any one individual from being deprived of a share in the soil, which was in primitive ages considered to be the collective property of the tribe, it was subjected to periodical divisions; these, indeed, still take place in the Swiss Allmend, in some Scottish townships, in the greater part of Java, and in the Russian Mir.

If such a *régime* as this were established, there would be no more "tramps wandering from union to union." In such a state of society as this, not in such as ours, the supreme law which ought to govern all economic relations might be realized. Mr. Herbert Spencer admirably defines this law in the following passage:—

"I suppose a dictum on which the current creed and the creed of science are at one may be considered to have as high an authority as can be found. Well, the command, *If any would not work, neither should he eat*, is simply a Christian enunciation of that universal law of nature under which life has reached its present height, the law that a creature not energetic enough to maintain itself must die; the sole difference being, that the law which in one case is to be artificially enforced is in the other case a natural necessity."

This passage ought to be transcribed at the commencement of every treatise on social science as the supreme aim of all sociological research ; only the delusion, borrowed from the old political economy, which consists in the belief that this dictum of science and Christianity is in practice in our midst, ought to be suppressed.

Is it not a fact that, everywhere, those who can prove by authentic documents that, for centuries past, their ancestors have thriven in idleness are the richest, the most powerful, the most sought after? Only at some future date will this dictum of science and Christianity be brought to bear on our social organization, and our descendants will then establish an order of things which will create economic responsibility, and ensure to each the integral enjoyment of the produce of his labour. The difficult but necessary work of sociology is to endeavour to discover what this organization should be, and to prepare its advent. Mr. Shaw Lefevre's speech shows very clearly the road that ought to be taken.

Mr. Herbert Spencer thinks, however, that this road would lead us directly to a condition of universal slavery. The State would gradually monopolize all industrial enterprises, beginning with the railways and telegraphs as it has already done in Germany and Belgium, then some other industries as in France, then mines, and finally, after the nationalization of land, it would also take up agricultural enterprise. The freedom enjoyed by a citizen must be measured, he says, not by the nature of the government under which he lives, but by the small number of laws to which he is subject. The essential characteristic of the slave is that he is forced to work for another's benefit. The degree of his slavery varies according to the greater or smaller extent to which effort is compulsorily expended for the benefit of another, instead of for self-benefit ; in the *régime* which is approaching, man will have to work for the State, and to give up to it the largest portion of his produce. What matters it that the master under whose command he labours is not an individual, but society? Thus argues Mr. Herbert Spencer.

In my opinion, the State will never arrive at a monopoly of all industries, for the very simple reason that such a system would never answer. It is possible that some day a social organization such as M. Albert Schäffle, formerly Finance Minister in Austria, has explained, may grow up, in which all branches of production are placed in the hands of co-operative societies. But, be that as it may, men would be no more slaves in workshops belonging to the State than in those of merchants or manufacturers of the present day. Mr. Herbert Spencer can very easily assure himself of this fact. Let him visit the State collieries at Saarbruck, or inspect the Belgian railways, and interrogate all the officials and workmen employed; he will find that, from the highest to the lowest, they are quite as free, quite as contented with their lot, as those engaged in any private industry. There is even far more guarantee against arbitrary measures, so that their real freedom is greater than elsewhere. The proof of this is the fact that posts in any industries belonging to the State are always sought for by the best workmen. If the degree of man's slavery varies according to the ratio between that which he is forced to yield up and that which he is allowed to retain, then it must be admitted that the majority of workmen and small farmers are certainly slaves now, for they have very little or no property, and, as their condition almost entirely depends on the hard law of competition, they can only retain for themselves the mere necessaries of life! Are the Italian *contadini*, whose sad lot I depicted in my "Lettres d'Italie," free? They are reduced to live entirely on bad maize, which subjects them to that terrible scourge, the *pellagra*. What sad truth is contained in their reply to the Minister who advised them not to emigrate!—

"What do you mean by the nation? Do you refer to the most miserable of the inhabitants of the land? If so, we are indeed the nation. Look at our pale and emaciated faces, our bodies worn out with over-fatigue and insufficient food. We sow and reap corn, but never taste white bread; we cultivate the vine, but a drop of wine never touches our lips. We raise cattle, but never eat meat; we are covered with rags, we live in wretched hovels; in winter we suffer from the cold, and both winter and summer from the pangs of hunger. Can a land which does not provide its inhabitants, who are willing to work, with sufficient to live upon, be considered by them as a fatherland?"

The Flemish agricultural labourer, who earns less than a shilling a day, and the small farmer, whose rack-rent absorbs the entire net profits; the Highland crofters, who have been deprived of the communal land, the sacred inheritance of primitive times, where they could at least raise a few head of cattle; the Egyptian fellahs, whose very life-blood is drained by European creditors—in a word, all the wretched beings all over the world where the soil is owned by non-workers, and who labour for insufficient remuneration; can they, any of them, be called free? It is just possible that, if the State were to become the universal industry director (which, in my opinion, is an impossible hypothesis), their condition would not be improved; but at all events it could not be worse than it is now.

I do not believe that "liberty must be surrendered in proportion as the material welfare is cared for." On the contrary, a certain degree of well-being is a necessary condition of liberty. It is a mockery to call a man free who, by labour, cannot secure to himself the necessaries of existence, or to whom labour is impossible because he possesses nothing of his own, and no one will employ him!

Compare the life of the soldier with that of the hired workman either in a mine or a factory. The first is the type of the serf in "The Coming Slavery," and the second the type of the independent man in an industrial organization under the free contract *régime.* Which of the two possesses the most real liberty? The soldier, when his daily duties are accomplished, may read, walk, or enjoy himself in accordance with his tastes; the workman, when he returns home worn out with fatigue after eleven or twelve hours' hard labour, too often finds no other recreation than the gin-palace. The labourer at his task must always, and all day long, obey the foreman or overseer, whether he be employed by a private individual, by the State, or by a co-operative society.

"Hitherto," says Mr. Herbert Spencer, "you have been free to spend your earnings in any way which pleases you; hereafter you shall not be free to spend it, but it will be spent for the general benefit." The important point, he adds, is the amount taken from me, not the hand that takes it. But if what is taken from my revenue is employed to make a public park which I am free to enter whenever I feel inclined, to build public baths where I may bathe in summer or winter, to open libraries for my recreation and instruction, clubs where I may spend my evenings, and schools where my children may receive an education which will enable them to make their own way in the world; to build healthy houses, let at a low rent, which save me the cruel necessity of living in slums, where the soul and the body are alike degraded; if all this be done, would the result be the same as if this sum were taken by some private Crœsus to spend on his personal pleasures and caprices? In the course of last summer, while in Switzerland and Baden, I visited several villages where each family is supplied, from forests belonging to the commune, with wood for building purposes and for fuel; also with pasturage for their cattle, and with a small plot of ground on which to grow potatoes, fruit, and vegetables. In addition to this, the wages of all public servants are paid for from the communal revenue, so that there is no local taxation whatever.* Suppose that these woods and meadows, and this land,

* I may mention as an example, the township of Freudenstadt, at the foot of the Kniebis, in Baden. Not a single farthing of taxation has been paid since its foundation in 1557. The commune possesses about 5,000 acres of pine-forest and meadow-land, worth about £10,000 sterling. The 1,420 inhabitants have each as much wood for their building purposes and firing as they wish for, and each one can send out to pasture, during the summer, his cattle, which he feeds during the winter months. The schools, church, thoroughfares, and fountains are all well cared for, and every year considerable improvements are made. 100,000 marks were employed in 1883 for the establishment in the village, of a distribution of water, with iron pipes. A hospital has been built, and a pavilion in the market-place, where a band plays on fête-days. Each year a distribution of the surplus revenue is made amongst the families, and they each obtain from 50 to 60 marks, or shillings, and more still when an extraordinary quantity of timber has been sold. In 1882, 80,000 marks were distributed amongst the 1,420 villagers. What a favoured country, is it not?

all belonged to a landed proprietor, instead of to the commune; he would go and lavish the revenue in large capitals or in travelling. What an immense difference this would make to the inhabitants! To appreciate this, it suffices merely to compare the condition of the Highland crofters, the free citizens of one of the richest countries in the world, and whose race has ever been laborious, with that of the population of these villages, hidden away in the Alpine cantons of Switzerland or in the gorges of the Black Forest. If, in the Highland villages of Scotland, rentals had been, as in these happy communes of Switzerland and Baden, partly reserved for the inhabitants, and partly employed in objects of general utility, how very different would have been the lot of these poor people! Had they but been allowed to keep for themselves the sea-weed and the kelp which the sea brings them, how far better off would they have been than they now are, as is admirably proved in Mr. Blackie's interesting book, "The Scottish Highlanders."

A similar remark may also be applied to politics. What matters it, says Mr. Herbert Spencer, that I myself contribute to make laws if these laws deprive me of my liberty? He mentions ancient Greece as an example to startle us at the notion of our coming state of slavery. He writes: "In ancient Greece the accepted principle was, that the citizen belonged neither to himself nor to his family, but to his city—the city being, with the Greek, equivalent to the community. And this doctrine, proper to a state of constant warfare, is one which socialism unawares re-introduces into a state intended to be purely industrial." It is perfectly certain that the *régime* of ancient Greek cities, which was founded on slavery, cannot be suitable to modern society, which is based on a system of labour. But we must not allow ourselves to forget what Greece was, nor all we owe to that Greek civilization, which, Mr. Herbert Spencer says, the "coming slavery" threatens to re-introduce amongst us. Not only philosophy, literature, and arts flourished as they have never done in any other age, but the political system so stamped characters with individuality that the illustrious men of Greece are types of human greatness, whose deeds and sayings will be engraven on the memory of men so long as the world lasts. If the "coming slavery" gives us such men as Pisistratus, Plato, Aristotle, Xenophon, Lycurgus, Sophocles, Thucydides, Epaminondas, Aristides, or Pericles, we shall, I think, have no cause to complain! But how is it that Greece produced such a bevy of great men? By her democratic institutions, combined with a marvellous system of education, which developed simultaneously the faculties of the mind and the body.

The German army, in spite of its iron discipline, arrives at results somewhat similar, though in a less degree. A rough peasant joins a regiment; he is taught to walk properly, to swim, and to shift for himself; his education is made more complete, and he becomes a man of independent character, better fitted to survive in the struggle for life. If the authorities in towns levy heavy taxes, and employ the money in improving the condition of the inhabitants and in forming those who need forming, even more than in the German army, and after the fashion of the ancient Greeks, will not the generations yet to come be better able to earn their own livelihood, and to maintain an honourable position, than if they had been allowed to pass their childhood in the gutters? Mr. Herbert Spencer reasons falsely when he says, "What matters it that I make the laws if these laws deprive me of my liberty?" Laws which tax me to degrade and rob me are odious, but laws which deprive me of what I have for my own good and for the further development of my faculties are well-meaning, as is the constraint imposed on his children by a wise father for their instruction or correction. Besides, to contribute to make laws elevates a man's character. As Stuart Mill has proved, this is indeed one of the great advantages of an extension of the suffrage. A man called upon to vote is naturally raised from the sphere of personal to that of general interests. He will read, discuss, and endeavour to obtain information. Others will argue with him, try to change his opinions, and he will himself realize that he has a certain importance of his own, that he has a word to say in the direction of public affairs. The elevating influence of this sentiment over French, and still more over Swiss, citizens is remarkable.

It is perfectly true that, for political and social reforms to be productive of fruits, the society into which they are introduced must be in a sufficiently advanced condition to be able to understand and apply them, but it must not be forgotten that improved institutions make better men.

Go to Norway; crimes are hardly known there. In the country people never close their doors at night, locks and bolts are scarcely known, and there are no robberies; probably, first, because the people are moral and religious, but certainly, also, because property is very equally divided. None live in opulence and none in absolute beggary, and certainly misery and degradation, which often results from misery, are the causes of the great majority of crimes.

The rich financier, Helvetius, wrote, very truly, that, if every citizen were an owner of property, the general tone of the nation would be conservative, but if the majority have nothing, robbery then becomes the general aim. ("De l'Homme," sect. vi. chap. vii.)

In conclusion, let us try to go to the root of the matter. Two systems are suggested as cures for the evils under which society is suffering. On the one hand, it may be said, in accordance with the doctrines of Christianity and socialism, that these evils are the consequences of men's perversity and selfishness, and that it behoves charity and fraternity to remedy them. We must do our best to assist our unfortunate brethren. But how? By trying, Christ tells us, to imitate God's Kingdom, where "the last shall be first and the first last;" —or by "having all things in common," say the Apostles in all the ardour of primitive Christianity, and later on certain religious communities;—or by the giving of alms and other charitable acts, says the Christianity of the middle ages;—while socialism maintains that this may be effected by reforms in the laws regulating the division of property. On the other hand, political economy and evolutionary sociology teach us that these miseries are the inevitable and beneficent consequences of natural laws; that these laws, being necessary conditions of progress, any endeavour to do away with them would be to disturb the order of nature and delay the dawn of better things. By "the weeding out of the sickly and infirm," and the survival of the fittest, the process of amelioration of species in the animal kingdom is accomplished. This law of natural selection should be allowed free and ample scope in human society. "Society is not a manufacture, but a growth." Might is really right, for it is to the general interest that the mighty should triumph and perpetuate the race. Thus argues what is now called *Science.*

In a book entitled "The True History of Joshua Davidson," the author places ideal Christianity and contemporary society face to face, and shows very clearly the opposition which exists between the doctrines of would-be science and those of the Gospel:—

"If the dogmas of political economy are really exact, if the laws of the struggle for life and the survival of the fittest must really be applied to human society, as well as to plants and animals, then let us at once admit that Christianity, which gives assistance to the poor and needy, and which stretches out a hand to the sinner, is a mere folly; and let us at once abandon a belief which influences neither our political institutions nor our social arrangements, and which *ought* not to influence them. If Christ was right, then our present Christianity is wrong, and if sociology really contains scientific truth, then Jesus of Nazareth spoke and acted in vain, or rather He rebelled against the immutable laws of nature." (Tauchnitz edition, p. 252.)

Mr. William Graham, in his "Creed of Science" (p. 278), writes as follows:—

"This great and far-reaching controversy, the most important in the history of our species, which is probably as old as human society itself, and certainly as old as the 'Republic' of Plato, in which it is discussed, or as Christianity, which began with a communistic form of society, had yet only within the past half century come to be felt as a controversy involving real and living issues of a momentous character, and not utopias only remotely bordering upon the possible."

I think it may be proved that this so-called "doctrine of science" is contrary to facts, and is, consequently, not scientific; whereas the creed of Christianity is in keeping with both present facts and ideal humanity.

Darwin borrowed his idea of the struggle for existence and the survival of the fittest from Malthus, from whom he also drew his theories of evolution and of transformism; but no naturalist ever dreamt of applying either of these laws to human society. It has been reserved to sociology to attempt this, because it has accepted, blindfolded, from the hands of economists, this most erroneous principle: that society is governed by natural laws, and that it suffices to give them free scope for the greatest possible happiness and prosperity to reign. It is manifestly true that, as human society is comprehended in what we call Nature, it must obey her laws; but the laws and institutions, in all their different forms, which decree as to the acquisition and transmission of property or possessions, and hereditary succession, in a word, all civil and penal laws, emanate from men's will, and from the decisions of legislators; and if experience, or a higher conception of justice, shows us that these laws are bad, or in any way lacking, we are free to change them. As far as the Darwinian laws are concerned, it would be perfectly impossible to apply them to existing society without more radically destroying all established institutions than the most avowed Nihilist would wish to do.

If it be really advisable that the law of the "survival of the fittest" should be established amongst us, the first step to be taken would be the abolition of all laws which punish theft and murder. Animals provide themselves with food by physical activity and the use of their muscles. Among men, in consequence of successive institutions, such as slavery, servitude, and revenue, numbers of people now live in plenty on their income, and do nothing at all. If Mr. Herbert Spencer is really desirous to see the supreme principle, "reward in proportion to desert," in force amongst us, he must obtain, first of all, the suppression of the existing regulations as to property. In the animal world, the destiny of each is decided by its aptitudes. Among ourselves, the destiny of each is determined by the advantages obtained or inherited from parents, and the heir to, or owner of, a large estate is sure to be well received everywhere. We see then, that before Darwinian laws can become established, family succession must be abolished. Animals, like plants, obey the instincts of nature, and reproduce themselves rapidly; but incessant carnage prevents their too excessive multiplication! As men become more civilized, peace becomes more general; they talk of their fellow-men as their brothers, and some philosophers even dream—the madmen!—of arbitration supplanting war! The equilibrium between the births and the deaths is thus upset! To balance it again, let us glorify battles, and exclaim, with General Moltke, that the idea of suppressing them is a mischievous utopia; let us impose silence on those dangerous fanatics who repeat incessantly, "Peace on earth, good will towards men."

In the very heart of nature reigns seeming injustice; or, as M. Renan puts it more strongly, nature is the embodiment of injustice.

A falling stone crushes both the honest man and the scamp! A bird goes out to find food for its young, and after long search is returning to its nest with its well-earned gains, when an eagle, the despot of the air, swoops down and steals the food; we think this iniquitous and odious, and would not tolerate such an instance amongst us. Vigorous Cain kills gentle Abel. Right and justice protest. They should not do so, for it is the mere putting in practice "of the purifying process by which nature weeds out the least powerful and prevents the vitiation of the race by the multiplication of its inferior samples." Helvetius admirably defines, for its condemnation, this Darwinian law which Herbert Spencer would have society accept:—

"The savage says to those who are weaker than himself: Look up to the skies and you see the eagle swooping down on the dove; cast your eyes on the earth and you see the lion tearing to pieces the stag or the antelope; while in the depths of the ocean small fishes are destroyed by sharks. The whole of nature announces that the weak must be the prey of the strong. Strength is a gift of the gods. Through it I become possessor of all it is in my power to capture." ("De l'Homme," iv. 8.)

The constant effort of moralists and legislators has been to replace the reign of might by a reign of justice. As Bacon says, *In societate aut vis aut lex viget.* The object is to subject men's actions more and more to the empire of the law, and that the law should be more and more in conformity with equity. Society has ever been, and still is, to a great extent, too much a reflection of nature. Violations of justice are numerous, and, if these are to be put a stop to, we must oppose ourselves still more to the laws of nature, instead of contemplating their re-establishment.

This is why Christianity, which is an ardent aspiration after justice, is in real accordance with true science. In the book of Job the problem is tragically proposed. The unjust are equally happy with the just, and, as in nature, the strong live at the cost of the weak. Right protests against this, and the voice of the poor is raised against their oppressors. Listen. What deep thought is contained in the following passage!—"Wherefore do the wicked live, become old, yea, are mighty in power? Their seed is established in their sight with them, and their offspring before their eyes. Their houses are safe from fear, neither is the rod of God upon them" (Job xxi. 7–9). "Some remove land-marks; they violently take away flocks and feed thereof. They cause him to go naked without clothing, and they take away the sheaf from the hungry; which make oil within their walls, and tread their wine-presses, and suffer thirst" (Job xxiv. 2, 10, 11).

The prophets of Israel raised an eloquent protest against the evils then reigning in society, and announced that a time should come when justice would be established upon the earth. These hopes of a Messiah were expressed in such precise terms that they may serve as a programme of the reforms which yet remain to be accomplished. "He shall judge the poor of the people, He shall save the children of the needy, and shall break in pieces the oppressor. He shall spare the poor and needy, and shall save the souls of the needy. There shall be an handful of corn in the earth upon the top of the mountains" (Psalm lxxii. 4, 13, 16). "And the work of righteousness shall be peace; and the effect of righteousness, quietness and assurance for ever" (Isaiah xxxii. 17). "Surely I will no more give thy corn to be meat for thine enemies, and the sons of the stranger shall not drink thy wine, for the which thou hast laboured; but they that have gathered it shall eat it, and praise the Lord; and they that have brought it together shall drink it in the courts of My holiness" (Isaiah lxii. 8, 9). In the New Jerusalem "there shall be no more sorrow nor crying." "They shall not build, and another inhabit; they shall not plant, and another eat; for as the days of a tree are the days of My people, and Mine elect shall long enjoy the work of their hands" (Isaiah lxv. 21, 22).

The prophet thus raises his voice in favour of the poor, in the name of justice, not of charity and mercy. "The Lord will enter into judgment with the ancients of His people and the princes thereof: for ye have eaten up the vineyard; the spoil of the poor is in your houses. What mean ye that ye beat My people to pieces, and grind the faces of the poor? saith the Lord God of hosts" (Isaiah iii. 14, 15). "Woe unto them that join house to house, that lay field to field till there be no place, that they may be placed alone in the midst of the earth" (Isaiah v. 8). In the future society property will be ensured to all, and every one will "sit under his vine and under his fig-tree" (Micah iv. 4).

The ideal of the prophets comprehends, then, in the first place, the triumph of justice, which will bring liberty to the oppressed, consolation to the outcast, and the produce of their labours to the workers; and secondly, and chiefly, it will bring the glorification and domination of the elect people—Israel.

The ideal of the Gospel makes less of this second consideration of national grandeur and pre-eminence, and places in the foreground the radical transformation of the social order. The Gospel is the "good tidings of great joy," the Εὐαγγέλιον, carried to the poor, the approach of the Kingdom of God—that is to say, of the reign of justice. "The last shall be first;" therefore the pretended "natural order" will be reversed!

Who will possess the earth? Not the mightiest, as in the animal creation, and as Darwinian laws decree; not the rich, "for it is easier for a camel to go through a needle's eye than for a rich man to enter the Kingdom of God." Lazarus is received into Abraham's bosom, while Dives is cast into the place of torment, "where there is weeping and gnashing of teeth." The first of biological precepts, the one respecting the survival of the fittest, as it immolates others for personal benefit, is essentially selfish, which is a vice incessantly reprobated in the New Testament. "Look not every man on his own things, but every man also on the things of others" (Philippians ii. 4). The chief of all Christian virtues is charity; it is the very essence of the Gospel. "Seek ye first the Kingdom of God and His righteousness, and all these things shall be added unto you" (St. Matthew vi. 33).

How very true is the economic doctrine that, with equitable laws, each should enjoy the integral produce of his labour, and that, were this the case, personal activity would attain its highest degree. Nothing is more adverse to the prosperity of a nation than unjust laws; and this is precisely what the prophets and Christ teach us.

If Darwinian laws were applied to human society, the utility of history, considered as a moral lesson for both kings and people, would be destroyed. The history of man might then be looked upon as a mere zoölogical strife between nations, and a simple lengthening out of natural history. What moral instruction can possibly be drawn from the study of the animal world, where the strong devour or destroy the weak? No spectacle could be more odious or more demoralizing!

The incomparable sublimity of the Gospel, which is, alas! only too often misinterpreted, consists in an ardent longing for perfection, in that aspiration for an ideal of justice which urged Jesus and His earliest disciples to condemn the world as it then was. Thence sprang the hatred of evil in its many various forms, the desire for better things, for reforms and progress! Why do Mahometans stand still in the march of civilization, while Christian countries advance ever more and more rapidly? Because the first are resigned to evil, whereas the second combat and endeavour to extirpate it. The stoicism—the elevated character of which can hardly be sufficiently admired—the austerity, and purity of such ancients as Marcus Aurelius, nervertheless, bowed before absolute facts, looking upon them as the inevitable results of the actual and natural order of things. Like modern evolutionists, they glorified the laws of nature, considering them perfect. Their optimism led them so far as to adore the cosmos as a divinity. "All that thou wilt, O Cosmos," says Marcus Aurelius, "is my will; nothing is too early or too late for me, if it be at the hour thou decidest upon. My fruit is such as thy seasons bring, O Nature! From thee comes all. Thou art all. All go towards thee. If the gods be essentially good and just, they must have permitted nothing, in the arrangement of the world, contrary to right and justice." What a contrast between this serene satisfaction and the complaints of Job, of the prophets, and of Christ Himself! The true Christian, in direct opposition to stoics and to Mr. Herbert Spencer, holds that the world is completely infected with evil; he avoids it carefully, and lives in the hope of a general cataclysm, which will reduce our globe to ashes, and make place for a new and purified heaven and earth ! The belief of stoics and of evolutionary sociologists logically advocates inaction, for it respects the present order of things as attributable to natural laws. The Christian's belief leads him to ardently desire reform and progress, but also, when he is deceived and reduced to despair, it occasionally culminates in revolutionary violence and in Nihilism.

Not only Jesus, but all great religious reformers, such as Buddha, Mahomet, Luther, and the great philosophers, especially Socrates and Plato, and the great lawgivers, from Solon and Lycurgus to the legislators of the French Revolution—all the elect of humanity, in fact—are struck with the evils under which our race is forced to suffer, and have imagined and revealed an ideal social order more in conformity with the ideal of justice ; and in their writings they place this Utopia in contrast with the existing order. The more Christianity becomes despoiled of dogmas, and the more the ideas of moral and social reform, contained in Christ's teachings, are brought forward as the chief aim, the more Mr. Herbert Spencer's principles will be shunned and avoided. In the splendid development of Roman law, which lasted fifteen hundred years, a similar evolution took place. In the beginning, in the laws of the twelve tables, many traces of the hard law in favour of the mighty may be found. This is symbolized by the lance (*quir*), which gave its name to the quiritarian right. The father was allowed to sell or destroy his children, as they were his possession. He had absolute power over his slaves, who were his "things." The creditor might throw his debtor in prison, or even cause him to be cut in pieces —*in partes secanto.* The wife was entirely in her husband's power—*in manu.* Little by little, as centuries rolled on, eminent lawgivers succeeded each other, and gradual changes were made, so that, finally, just and humanitarian principles penetrated the entire Roman code, and the Darwinian law, which glorifies might, gave place to the Christian law, which extols justice.

This movement will most assuredly continue, in spite of all the abuse it may receive from Mr. Herbert Spencer, and from others who think as he does. It is a result of the advance of civilization from the commencement of Christianity, and even from the time of the prophets of Israel. It will manifest itself, not as it did in the middle ages, by works of mercy, but, under the control of economic science, by the intervention of the State in favour of the disinherited, and by measures such as Mr. Shaw Lefevre approves of, so that each and all should be placed in a position to be able to command reward in proportion to the amount of useful labour accomplished.

Darwinian laws, generally admitted in the domain of natural history and in the animal kingdom, will never be applied to human societies, until the sentiments of charity and justice, which Christianity engraves on our hearts, are completely eradicated.—*Contemporary Review.*

A REJOINDER TO M. DE LAVELEYE.

By HERBERT SPENCER.

THE Editor of the CONTEMPORARY REVIEW having kindly allowed me to see a proof of the foregoing article by M. de Laveleye, and having assented to my request that I might be allowed to append a few explanations and comments, in place of a more formal reply in a future number of the Review, I have, in the following pages, set down as much as seems needful to prevent the grave misunderstandings likely to be produced by M. de Laveleye's criticisms, if they are permitted to pass unnoticed.

On the first page of his essay, M. de Laveleye, referring to the effort to establish "greater equality among men" by "appropriating State, or communal, revenues" for that end, writes—

> "Mr. Spencer considers that this effort for the improvement of the condition of the working-classes, which is being everywhere made with greater or less energy, is a violation of natural laws, which will not fail to bring its own punishment on nations, thus misguided by a blind philanthropy" (p. 485).

As this sentence stands, and especially as joined with all which follows, it is calculated to produce the impression that I am opposed to measures "for the improvement of the condition of the working-classes." This is quite untrue, as numerous passages from my books would show. Two questions are involved—What are the measures? and—What is the agency for carrying them out? In the first place, there are various measures conducive to "improvement of the condition of the working-classes" which I have always contended, and still contend, devolve on public agencies, general and local—above all, an efficient administration of justice, by which they benefit both directly and indirectly—an administration such as not simply represses violence and fraud, but promptly brings down a penalty on every one who trespasses against his neighbour, even by a nuisance. While contending for the diminution of State-action of the positively-regulative kind, I have contended for the increase of State-action of the negatively-regulative kind—that kind which restrains the activities of citizens within the limits imposed by the existence of other citizens who have like claims to carry on their activities. I have shown that "maladministration of justice raises, very considerably, the cost of living for all;" * and is, therefore, felt especially by the working-classes, whose state is most closely dependent on the cost of living. As one of the evils of over-legislation, I have, from the beginning, urged that, while multitudinous other questions absorb public attention, the justice-question gets scarcely any attention; and social life is everywhere

* "Study of Sociology," p. 415, postscript in library edition.

vitiated by the consequent inequities.* While defending *laissez-faire* in its original and proper sense, I have pointed out that the policy of universal meddling has for its concomitant that vicious *laissez-faire* which leaves dishonesty to flourish at the expense of honesty.† In the second place, there are numerous other measures conducive to "the improvement of the condition of the working-classes" which I desire quite as much as M. de Laveleye to see undertaken; and simply differ from him concerning the agency by which they shall be undertaken. Without wishing to restrain philanthropic action, but quite contrariwise, I have in various places argued that philanthropy will better achieve its ends by non-governmental means than by governmental means.‡ M. de Laveleye is much more familiar than I am with the facts showing that, in societies at large, the organized arrangements which carry on production and distribution have been evolved not only without State-help, but very generally in spite of State-hindrance; and hence I am surprised that he apparently gives no credence to the doctrine that, by private persons acting either individually or in combination, there may be better achieved multitudinous ends which it is the fashion to invoke State-agency for.

Speaking of the domain of individual liberty, M. de Laveleye says—

> "To be brief, I agree with Mr. Herbert Spencer that, contrary to Rousseau's doctrine, State power ought to be limited, and that a domain should be reserved to individual liberty which should be always respected; but the limits of this domain should be fixed, not by the people, but by reason and science, keeping in view what is best for the public welfare" (p. 488).

I am a good deal perplexed at finding the last clause of this sentence apparently addressed to me as though in opposition. "Social Statics" is a work mainly occupied with the endeavour to establish these limits by "reason and science." In the "Data of Ethics," I have sought, in a chapter entitled the "Sociological View," to show how certain limits to individual liberty are deducible from the laws of life as carried on under social conditions. And in "The Man *versus* The State," which M. de Laveleye is more particularly dealing with, one part of the last chapter is devoted to showing, deductively, the derivation of what are called "natural rights" from the vital needs, which each man has to satisfy by activities pursued in presence of other men who have to satisfy like needs; while another part of the chapter is devoted to showing, inductively, how recognition of natural rights began, in the earliest social groups, to be initiated by those retaliations which trespasses called forth—retaliations ever tending to produce respect for the proper limits of action. If M. de Laveleye does not consider

* See "Social Statics: 'The Duty of the State.'" Also "Essays," vol. ii. pp. 94–8; vol. iii. p. 167.

† "Study of Sociology," pp. 351–3, cheap edition.

‡ "Social Statics: 'Poor Laws.'"

this to be an establishment of limits "by reason and science," what are the kinds of "reason and science" by which he expects to establish them?

On another page M. de Laveleye says—

> "I am of opinion that the State should make use of its legitimate powers of action for the establishment of greater equality among men, in proportion to their personal merits" (p. 489).

Merely observing that the expression "its legitimate powers of action" seems to imply a begging of the question, since the chief point in dispute is—What are "its legitimate powers of action;" I go on to express my surprise at such a sentence coming from a distinguished political economist. M. de Laveleye refers to the "old-fashioned political economy," implying that he is one of those younger economists who dissent from its doctrine; but I was quite unprepared to find that his dissent went so far as tacitly to deny that in the average of cases a proportioning of rewards to personal merits naturally takes place under the free play of supply and demand. Still less, after all the exposures made of the miseries inflicted on men throughout the past by the blundering attempts of the State to adjust prices and wages, did I expect to see in a political economist such a revived confidence in the State as would commission it to adjust men's rewards "in proportion to their personal merit." I hear that there are some who contend that payment should be proportionate to the disagreeableness of the work done: the implication, I suppose, being that the knacker and the nightman should receive two or three guineas a day, while a physician's fee should be half-a-crown. But, with such a proportioning, I suspect that, as there would be no returns adequate to repay the cost and time and labor of preparation for the practice of medicine, physicians would quickly disappear; as would, indeed, all those required for the higher social functions. I do not suppose that M. de Laveleye contemplates a proportioning just of this kind. But if in face of all experience, past and present, he trusts officialism to judge of "personal merits," he is sanguine to a degree which surprises me.

One of the questions which M. de Laveleye asks is—

> "If the intervention of public power for the improvement of the condition of the working-classes be a contradiction of history, and a return to ancient militant society, how is it that the country in which the new industrial organization is the most developed—that is to say, England—is also the country where State intervention is the most rapidly increasing, and where opinion is at the same time pressing for these powers of interference to be still further extended?" (p. 491).

Several questions are here raised besides the chief one. I have already pointed out that my objection is not to "intervention of public power for the improvement of the condition of the working-classes," but to interventions of certain kinds. The abolition of laws forbidding trade-combinations, and of laws forbidding the travelling of artisans, were surely measures which improved "the condition of the working-classes;" and these were measures which I should have been eager to join in obtaining. Similarly, at the present time I am desirous of seeing provided the easiest and most efficient remedies for sailors fraudulently betrayed into unseaworthy ships; and I heartily sympathize with those who denounce the continual encroachments of landowners—enclosures of commons and the turf-covered borders of lanes, &c. These, and kindred injustices to the working-classes, stretching far back, I am no less desirous to see remedied than is M. de Laveleye; provided always that due care is taken that other injustices are not committed in remedying them. Evidently, then, this expression of M. de Laveleye raises a false issue. Again, he says that I call this public intervention on behalf of the working-classes "a return to ancient militant society." This is quite a mistake. In ancient militant society the condition of the working-classes was very little cared for, and, indeed, scarcely thought of. My assertion was that the *coercive system* employed was like the coercive system employed in a militant society: the *ends* to which the systems are directed being quite different. But turning to the chief point in his question, I meet it by counter-questions—Why is it that the "new industrial organization" is best developed in England? and—Under what conditions was it developed? I need hardly point out to M. de Laveleye that the period during which industrial organization in England developed more rapidly and extensively than elsewhere, was a period during which the form of government was less coercive than elsewhere, and the individual less interfered with than elsewhere. And if now, led by the admirers of Continental bureaucracies, eager philanthropists are more rapidly extending State-administrations here than they are being extended abroad, it is obviously because there is great scope for the further extension of them here, while abroad there is little scope for the further extension of them.

In justification of coercive methods for "improving the condition of the working-classes," M. de Laveleye says:

> "One fact is sufficient to show the great progress due to this State legislation: in an ever-increasing population, crime is rapidly and greatly diminishing" (p. 496).

Now, without dwelling on the fact, shown in Mr. Pike's "History of Crime in England," that "violence and lawlessness" had increased during the war period which ended at Waterloo; and without dwelling on the fact that, after the recovery from prostration produced by war, there was a diminution of crime along with that great diminution of coercive legislation which characterized the long period of peace; I go on to remark that a primary condition to the correct drawing of inferences is—other things equal. Does M. de Laveleye really think, when comparing the state of the last generation with that of the present, that other things are so equal that to the growth of State-administrations can be ascribed the decrease of crime? He ignores those two factors, far more important than all others, which have produced a social revolution—railways and free-trade: the last resulting from the abolition of governmental restraints after a long struggle, and the first effected by private enterprise carried out in spite of strenuous opposition for some time made in the Legislature. Beyond all question, the prosperity due to these factors has greatly ameliorated the condition of the working-classes, and by so doing has diminished crime; for undoubtedly, diminishing the difficulties of getting food, diminishes one of the temptations to crime. If M. de Laveleye refers to a more recent diminution, then, unless he denies the alleged relation between drunkenness and crime, he must admit that the temperance agitation, with its pledges, its "Bands of Hope," and its "Blue Ribbon League," has had a good deal to do with it.

Before passing to the chief question let me correct M. de Laveleye on some minor points. He says—

> "I think that the great fundamental error of Mr. Herbert Spencer's system, which is so generally accepted at the present day, consists in the belief that if State power were but sufficiently reduced," &c.

Now I set against this a sentence not long since published by Mr. Frederic Harrison:

> "Mr. Spencer has himself just published . . . . 'The Man *versus* The State,' to which he hardly expects to make a convert except here and there, and about which an unfriendly critic might say that it might be entitled 'Mr. Spencer against all England.'" (*Nineteenth Century*, vol. xvi. p. 366.)

The fear lest my arguments should prevail, which I presume prompted M. de Laveleye's article, is evidently ill-founded. I wish I saw reason to believe that his estimate is nearer to the truth than the opposite one.

On p. 490, M. de Laveleye writes—

> "The law that Mr. Herbert Spencer desires society to adopt is simply Darwin's law—'the survival of the fittest.'"

Perhaps I may be excused for wishing here to prevent further confirmation of a current error. In his article, M. de Laveleye has quoted from "Social Statics" passages showing insistance on the benefits resulting from survival of the fittest among mankind, as well as among animals; though he ignores the fact that the work as a whole is an elaborate statement of the conditions under which, and limits within which, the natural process of elimination of the unfit should be allowed to operate. Here my immediate purpose is to correct the impression which his statement, as above worded, produces, by naming the dates:

"Social Statics" was published in 1851; Mr. Darwin's "Origin of Species" in 1859.

And now I pass to the main issue. In pursuance of his statement that I wish society to adopt the survival of the fittest as its guiding principle, M. de Laveleye goes on to describe what would be its action as applied to mankind. Here are his words:

"This is the ideal order of things which, we are told, ought to prevail in human societies, but everything in our present organization (which economists, and even Mr. Spencer himself, admit, however, to be natural) is wholly opposed to any such conditions. An old and sickly lion captured a gazelle; his younger and stronger brother arrives, snatches away his prize, and lives to perpetuate the species; the old one dies in the struggle, or is starved to death. Such is the beneficent law of the 'survival of the fittest.' It was thus among barbarian tribes. But could such a law exist in our present social order? Certainly not! The rich man, feebly constituted and sickly, protected by the law, enjoys his wealth, marries and has offspring, and if an Apollo of herculean strength attempted to take from him his possessions, or his wife, he would be thrown into prison, and were he to attempt to practise the Darwinian law of selection, he would certainly run a fair risk of the gallows" (p. 492).

Now though, on the next page, M. de Laveleye recognizes the fact that the survival of the fittest, as I construe it in its social applications, is the survival of the industrially superior and those who are fittest for the requirements of social life, yet, in the paragraph I have quoted, he implies that the view I hold would countenance violent methods of replacing the inferior by the superior. Unless he desires to suggest that I wish to see the principle operate among men as it operates among brutes, why did he write this paragraph? In the work before him, without referring to other works, he has abundant proof that, above all things, aggression of every kind is hateful to me; and he scarcely needs telling that from my earliest book, written more than a third of a century ago, down to the present time, I have urged the change of all laws which either inflict injustice or fail to remedy injustice, whether committed by one individual against another, or by class against class, or by people against people. Why, then, did M. de Laveleye make it seem that I would, if I could, establish a reign of injustice under its most brutal form? If there needs proof that in my view the struggle for existence as carried on in society, and the greater multiplication of those best fitted for the struggle, must be subject to rigorous limitations, I may quote as sufficient proof a passage from the "Data of Ethics:" premising that the word co-operation used in it, must be understood in its widest sense, as comprehending all those combined activities by which citizens carry on social life:

"The leading traits of a code under which complete living through voluntary co-operation [here antithetically opposed to compulsory co-operation, characterizing the militant type of society] is secured, may be simply stated. The fundamental requirement is that the life-sustaining actions of each shall sever-ally bring him the amounts and kinds of advantage naturally achieved by them; and this implies, firstly, that he shall suffer no direct aggressions on his person or property, and, secondly, that he shall suffer no indirect aggressions by breach of contract. Observance of these negative conditions to voluntary co-operation having facilitated life to the greatest extent by exchange of services under agreement, life is to be further facilitated by exchange of services beyond agreement; the highest life being reached only when, besides helping to complete one another's lives by specified reciprocities of aid, men otherwise help to complete one another's lives" (p. 149).

This passage, indeed, raises in a convenient form the essential question. It will be observed that in it are specified two sets of conditions, by conforming to which men living together may achieve the greatest happiness. The first set of conditions is that which we comprehend under the general name *justice;* the second set of conditions is that which we comprehend under the general name *generosity.* The position of M. de Laveleye, and of the multitudes who think with him, is that the community, through its government, may rightly undertake both to administer justice and to practise generosity. On the other hand, I, and the few who think with me, contend that justice alone is to be administered by the community in its corporate capacity; and that the practice of generosity is to be left to private individuals, and voluntarily-formed combinations of individuals. Insuring each citizen's safety in person and property, as well as insuring him such returns for his services as his fellow-citizens agree to give, is a public affair; while affording him help, and giving him benefits beyond those he has earned, is a private affair. The reason for maintaining this distinction is that the last duty can not be undertaken by the State without breach of the first. The vital requirement to social life must be broken that a non-vital requirement may be fulfilled. Under a reign of absolute justice unqualified by generosity, a social life may be carried on, though not the highest social life; but a reign of generosity without any justice—a system under which those who work are not paid, so that those who have been idle or drunken may be saved from misery—is fatal; and any approach to it is injurious. That only can be a wholesome state in which conduct brings its natural results, good or evil, as the case may be; and it is the business of Government, acting on behalf of all, to see that each citizen shall not be defrauded of the good results, and that he shall not shoulder off the evil results on to others. If others, in their private capacities, are prompted by affection or pity to mitigate the evil results, by all means let them do so: no power can equitably prevent them from making efforts, or giving money, to diminish the sufferings of the unfortunate and the inferior; at the same time that no power can equitably coerce them into doing this.

If M. de Laveleye holds, as he appears to do, that enforcing the normal relations between conduct and consequences, right as it may be in the abstract, is impracticable under existing social conditions, which are in many cases such that men get what they have neither earned nor otherwise equitably received, and in many cases such that they are prevented from earning anything; then my reply is, by all means, where this condition of things is due to unjust arrangements, let us rectify these arrangements as fast as we can. But let us not adopt the disastrous policy of establishing new injustices for the purpose of mitigating the mischiefs produced by old injustices.—*Contemporary Review.*

WHALES, PAST AND PRESENT.*

By Professor W. H. FLOWER, F. R. S.

FEW natural groups present so many remarkable illustrations of several of the most important general laws which appear to have determined the structure of animal bodies as that of the whales. We find the effects of the two opposing forces—that of heredity or conformation to ancestral characters, and that of adaptation to changed environment, whether brought about by the method of natural selection or otherwise—distinctly written in almost every part of their structure. Scarcely anywhere in the animal kingdom do we see so many cases of the persistence of rudimentary and apparently useless organs, those marvelous and suggestive phenomena which at one time seemed hopeless enigmas, causing despair to those who tried to unravel their meaning, but now eagerly welcomed as beacons of true light, casting illuminating beams upon the dark paths through which the organism has traveled on its way to reach the goal of its present condition of existence.

It is chiefly to these rudimentary organs of the Cetacea and to what we may learn from them that I propose to call your attention. In each case the question may well be asked, Are they survivals, remnants of a past condition, become useless owing to change of circumstances and environment; or are they incipient structures, beginnings of what may in future become functional and important parts of the economy?

The term "whale" is commonly but vaguely applied to all the larger and middle-sized Cetacea, and, though such smaller species as the dolphins and porpoises are not usually spoken of as whales, they may to all intents and purposes of zoölogical science be included in the term. Taken all together the *Cetacea* constitute a distinct and natural order of mammals, characterized by their aquatic mode of life and external fish-like form. The body is fusiform, passing anteriorly into the head without any distinct constriction or neck, and posteriorly tapering off grad-

* Abridged from a lecture delivered at the Royal Institution, London, May 25, 1883.

ually toward the extremity of the tail, which is provided with a pair of lateral pointed expansions of skin supported by dense fibrous tissue, called "flukes," forming together a horizontally placed, triangular propelling organ. The fore-limbs are reduced to the condition of flattened ovoid paddles, incased in a continuous integument, showing no external sign of division into arm, fore-arm, and hand, or of separate digits, and without any trace of nails. There are no vestiges of hind-limbs visible externally. The general surface of the body is smooth and glistening, and devoid of hair. In nearly all species a compressed median dorsal fin is present. The nostrils open separately or by a single crescentic valvular aperture, not at the extremity of the snout, but near the vertex.

Animals of the order *Cetacea* abound in all known seas, and some species are inhabitants of the larger rivers of South America and Asia.

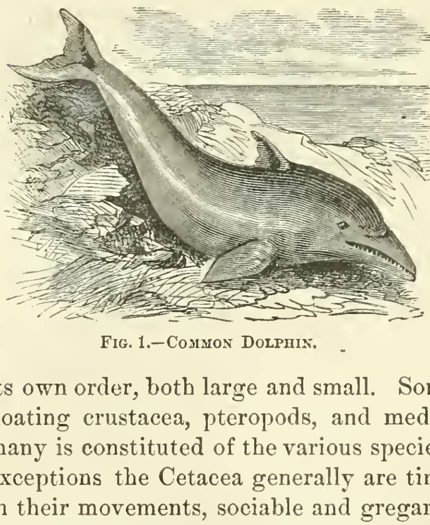

Fig. 1.—Common Dolphin.

Their organization necessitates their life being passed entirely in the water, as on the land they are absolutely helpless; but they have to rise very frequently to the surface for the purpose of respiration. They are all predaceous, subsisting on living animal food of some kind. One genus alone (*Orca*) eats other warm-blooded animals, as seals and even members of its own order, both large and small. Some feed on fish, others on small floating crustacea, pteropods, and medusæ, while the staple food of many is constituted of the various species of Cephalopods. With some exceptions the Cetacea generally are timid, inoffensive animals, active in their movements, sociable and gregarious in their habits.

Among the existing members of the order there are two very distinct types—the toothed whales, or *Odontoceti*, and the baleen (whalebone) whales, or *Mystacoceti*, which present throughout their organization most markedly distinct structural characters, and have in the existing state of nature no transitional forms.

The problem of the origin of the Cetacea and their relations to other forms of life is at present involved in the greatest obscurity. They present no more signs of affinity with any of the lower classes of vertebrated animals than do many of the members of their own class. Indeed, in all that essentially distinguishes a mammal from one of the oviparous vertebrates, they are as truly mammalian as any, even the highest, members of the class. Any supposed signs of inferiority are simply modifications in adaptation to their peculiar mode of life. In the present state of our knowledge, the Cetacea are absolutely isolated, and little satisfactory reason has ever been given for deriving them from any one of the existing divisions of the class more than from any other. The question has indeed often been mooted whether they have been derived from land mammals at all, or whether they may not be the survivors of a primitive aquatic form which was the ancestor not only of the whales, but of all the other members of the class. The materials for—I will not say solving—but for throwing some light upon this problem, must be sought for in two regions—in the structure of the existing members of the order, and in its past history, as revealed by the discovery of fossil remains. In the present state of science it is chiefly on the former that we have to rely.

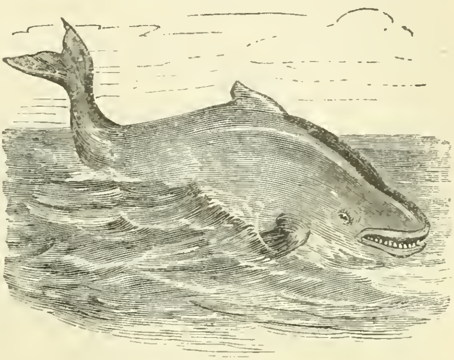

Fig. 2.—Common Porpoise.

One of the most obvious external characteristics by which the mammalia are distinguished from other classes of vertebrates is the more or less complete clothing of the surface by hair. The Cetacea alone appear to be exceptions to this generalization. Their smooth, glistening exterior is, in the greater number of species, at all events in adult life, absolutely bare, though the want of a hairy covering is compensated for functionally by peculiar modifications of the structure of the skin itself, the epidermis being greatly thickened, and a remarkable layer of dense fat closely incorporated with the tissue of the derm or true skin ; modifications admirably adapted for retaining the warmth of the body, without any roughness of surface which might occasion friction and so interfere with perfect facility of gliding through the water. Close examination, however, shows that the mammalian character of hairiness is not entirely wanting in the Cetacea, although it is reduced to a most rudimentary and apparently functionless condition.

In the organs of the senses the Cetacea exhibit some remarkable adaptive modifications of structures essentially formed on the mammalian type, and not on that characteristic of the truly aquatic vertebrates, the fishes.

The modifications of the organs of sight do not so much affect the eyeball as the accessory apparatus. To an animal whose surface is always bathed with fluid, the complex arrangement which mammals generally possess for keeping the surface of the transparent cornea moist and protected, the movable lids, the nictitating membrane, the lachrymal gland, and the arrangements for collecting and removing the superfluous tears when they have served their function can not be needed, and hence we find these parts in a most rudimentary condition or altogether absent. In the same way the organ of hearing in its essential structure is entirely mammalian, having not only the sacculi and semicircular canals common to all but the lowest vertebrates, but the cochlea, and tympanic cavity with its ossicles and membrane, all, however, buried deep in the solid substance of the head; while the parts specially belonging to terrestrial mammals, those which collect the vibrations of the sound traveling through air, the pinna and the tube which conveys it to the sentient structures within, are entirely or practically wanting. Of the pinna or external ear there is no trace.

The organ of smell, when it exists, offers still more remarkable evidence of the origin of the Cetacea. In fishes this organ is specially adapted for the perception of odorous substances permeating the water; the terminations of the olfactory nerves are spread over a cavity near the front part of the nose, to which the fluid in which the animals swim has free access although it is quite unconnected with the respiratory passages. Mammals, on the other hand, smell substances with which the atmosphere they breathe is impregnated; their olfactory nerve is distributed over the more or less complex foldings of the lining of a cavity placed in the head, in immediate relation to the passages through which air is continually driven to and fro on its way to the lungs in respiration, and therefore in a most favorable position for receiving impressions from substances floating in that air. The whalebone whales have an organ of smell exactly on the mammalian type, but in a rudimentary condition. In the more completely modified Odontocetes the olfactory apparatus, as well as that part of the brain specially related to the function of smell, is entirely wanting, but in both groups there is not the slightest trace of the specially aquatic olfactory organ of fishes. Its complete absence and the vestiges of the aërial organ of land mammals found in the Mystacocetes are the clearest possible indications of the origin of the Cetaceæ from air-breathing and air-smelling terrestrial mammalia. With their adaptation to an aquatic mode of existence, organs fitted only for smelling in air became useless, and so have dwindled or completely disappeared. Time and circumstances have not permitted the acquisition of anything analogous to the special aquatic smelling apparatus of fishes, the result being that whales are practically deprived of whatever advantage this sense may be to other animals.

All the Cetacea present some traces of teeth, which in structure and mode of development resemble those of mammals, and not those of the lower vertebrated classes, but they are always found in a more or less imperfect state.

The meaning and utility of some of the strange modifications in the dentition of whales it is impossible, in the imperfect state of our knowledge of the habits of the Cetacea, to explain, but the fact that in almost every case a more full number of rudimentary teeth is present in early stages of existence, which either disappear, or remain as concealed and functionless organs, points to the present condition in the aberrant and specialized forms as being one derived from the more generalized type, in which the teeth were numerous and equal.

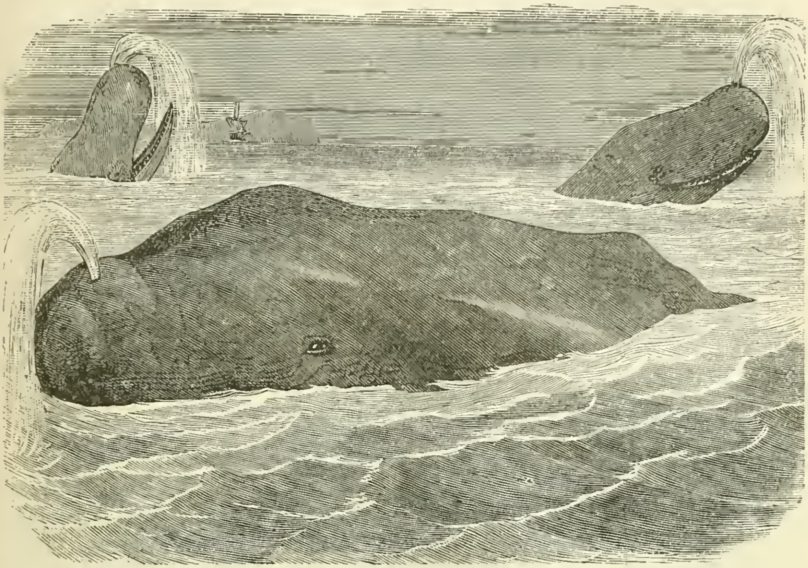

Fig. 3.—Toothed Whale, or Spermaceti Whale.

The Mystacocetes, or whalebone whales, are distinguished by entire absence of teeth, at all events after birth. But it is a remarkable fact, first demonstrated by Geoffroy Saint-Hilaire, and since amply confirmed by Cuvier, Eschricht, Julin, and others, that in the fetal state they have numerous minute calcified teeth lying in the dental groove of both upper and lower jaws. These attain their fullest development about the middle of fetal life, after which period they are absorbed, no trace of them remaining at the time of birth. Their structure and mode of development have been shown to be exactly those characteristic of ordinary mammalian teeth. It is not until after the disappearance of these teeth that the baleen, or whalebone, makes its appearance. This remarkable structure, though only a modification of a part existing in all mammals, is, in its specially developed condition as baleen, peculiar to one group of whales.

Baleen consists of a series of flattened, horny plates, several hundred in number, on each side of the palate, separated by a bare interval along the middle line. They are placed transversely to the long axis of the palate, with very short spaces between them. Each plate or blade is somewhat triangular in form, with the base attached to the palate, and the apex hanging downward. The outer edge of the blade is hard and smooth, but the inner edge and apex fray out into long, bristly fibers, so that the roof of the whale's mouth looks as if covered with hair, as described by Aristotle. The blades are longer near the middle of the series, and gradually diminish near the front and back of the mouth. The horny plates grow from a dense, fibrous, and highly vascular matrix, which covers the palatal surface of the maxillæ, and which sends out lamellar processes, one of which penetrates the base of each blade. Moreover, the free edge of these processes is covered with very long, vascular, thread-like papillæ, one of which forms the central axis of each of the hair-like epidermic fibers of which the blade is mainly composed. The blades are supported and bound together, for a certain distance from their base, by a mass of less hardened epithelium, secreted by the surface of the palatal membrane or matrix of the whalebone in the intervals of the lamellar processes. This is the "intermediate substance" of Hunter, the "gum" of the whalers.

The function of the whalebone is to strain the water from the small marine mollusks, crustaceans, or fish upon which the whales subsist. In feeding they fill the immense mouth with water containing shoals of these small creatures, and then, on their closing the jaws and raising

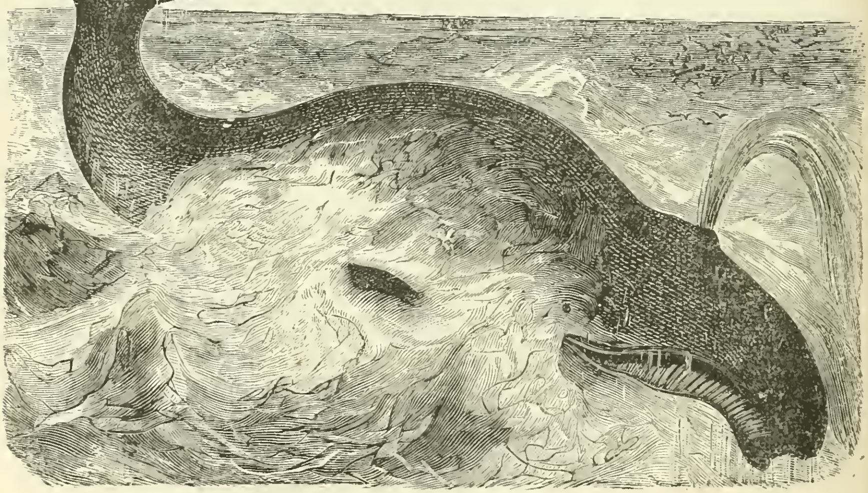

Fig. 4.—Whalebone Whale, or Greenland Whale.

the tongue, so as to diminish the cavity of the mouth, the water streams out through the narrow intervals between the hairy fringe of the whalebone blades, and escapes through the lips, leaving the living prey to be swallowed. Almost all the other structures to which I am specially directing your attention are in a more or less rudimentary state in the Cetacea ; the baleen, on the other hand, is an example of an exactly contrary condition, but an equally instructive one, as illustrating the mode in which Nature works in producing the infinite variety we see in animal structures. Although appearing at first sight an entirely distinct and special formation, it evidently consists of nothing more than the highly modified papillæ of the lining membrane of the mouth, with an excessive and cornified epithelial development.

The bony palate of all mammals is covered with a closely-adhering layer of fibro-vascular tissue, the surface of which is protected by a coating of non-vascular epithelium, the former exactly corresponding to the derm or true skin, and the latter to the epiderm of the external surface of the body. Sometimes this membrane is perfectly smooth, but it is more often raised into ridges, which run in a direction transverse to the axis of the head, and are curved with the concavity backward ; the ridges, moreover, do not extend across the middle line, being interrupted by a median depression or *raphé*. Indications of these ridges are clearly seen in the human palate, but they attain their greatest development in the Ungulata.

Though the early stages by which whalebone has been modified from more simple palate structures are lost to our sight, the conditions in which it now exists in different species of whales show very marked varieties of progress, from a simple, comparatively rudimental and imperfect condition, to what is perhaps the most wonderful example of mechanical adaptation to purpose known in any organic structure.

In the rorquals or fin-whales (genus *Balænoptera*), found in almost all seas, the largest blades in an animal of seventy feet in length do not exceed two feet in length, including their hairy terminations ; they are in most species of a pale horn color, and their structure is coarse and inelastic, separating into thick, stiff fibers, so that they are of no value for the ordinary purposes to which whalebone is applied in the arts. These animals feed on fish of considerable size, from herrings up to cod, and for foraging among shoals of these creatures the construction of their mouth and the structure of their baleen are evidently sufficient. This is the type of the earliest known extinct forms of whales, and it has continued to exist, with several slight modifications, to this day, because it has fulfilled one purpose in the economy of Nature. Other purposes for which it was not sufficient have been supplied by gradual changes taking place, some of the stages of which are seen in the intermediate conditions still exhibited in the Megaptera and the Atlantic and southern right whales.

In the Greenland right whale of the circumpolar seas, the Bowhead of the American whalers (*Balæna mysticetus*), all the peculiarities which distinguish the head and mouth of the whales from other mammals have attained their greatest development. The head is of enormous size, exceeding one third of the whole length of the creature. The cavity of the mouth is actually larger than that of the body, thorax, and abdomen together. The upper jaw is very narrow, but greatly arched from before backward, to increase the height of the cavity and allow for the great length of the baleen ; the enormous rami of the mandibles are widely separated posteriorly, and have a still further outward sweep before they meet at the symphysis in front, giving the floor of the mouth the shape of an immense spoon. The baleen-blades attain the number of three hundred and fifty or more on each side, and those in the middle of the series have a length of ten or even twelve feet. They are black in color, fine and highly elastic in texture, and fray out at the inner edge and ends into long, delicate, soft, almost silky, but very tough hairs.

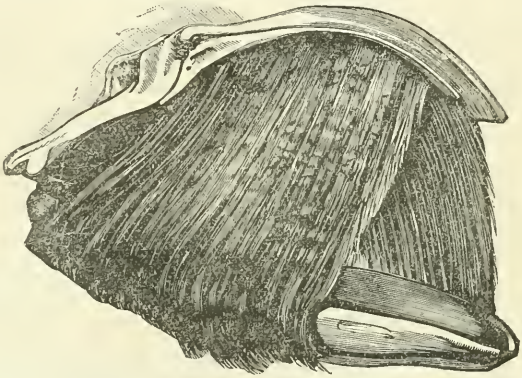

Fig. 5.—Skull of Greenland Whale, showing Whalebone.

How these immensely long blades, depending vertically from the palate, were packed into a mouth the height of which was scarcely more than half their length, was a mystery not solved until a few years ago. Captain David Gray, of Peterhead, at my request, first gave us a clear idea of the arrangement of the baleen in the Greenland whale, and showed that the purpose of its wonderful elasticity was not primarily at least the benefit of the corset and umbrella makers, but that it was essential for the correct performance of its functions. It may here be mentioned that the modification of the mouth-structure of the right whale is entirely in relation to its food. It is by this apparatus that it is enabled to avail itself of the minute but highly nutritious crustaceans and pteropods which swarm in immense shoals in the seas it frequents. The large mouth enables it to take in at one time a sufficient quantity of water filled with these small organisms, and the length and delicate structure of the baleen make it an efficient strainer or hair sieve by which the water can be drained off. If the baleen were, as in the rorquals, short and rigid, and only of the length of the aperture between the upper and lower jaws when the mouth was shut, when the jaws were separated a space would be left beneath it through which the water and the minute particles of food would escape together. But, instead of this, the long, slender, brush-like ends of the whalebone-blades, when the mouth is closed, fold back, the front ones passing below the hinder ones in a channel lying between the tongue and the bone of the lower jaw. When the mouth is opened their elasticity causes them to straighten out like a bow that is unbent, so that, at whatever distance the jaws are separated, the strainer remains in perfect action, filling the whole of the interval. The mechanical perfection of the arrangement is completed by the great development of the lower lip, which rises stiffly above the jawbone, and prevents the long, slender, flexible ends of the baleen being carried outward by the rush of water from the mouth.

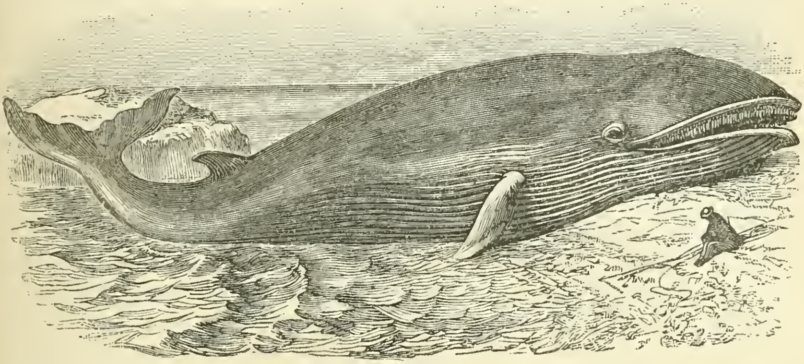

Fig. 6.—Rorqual.

Few points of the structure of whales offer so great a departure from the ordinary mammalian type as the limbs. The fore-limbs are reduced to the condition of simple paddles or oars, variously shaped, but always flattened and more or less oval in outline. They are freely movable at the shoulder-joint, where the humerus or upper-arm bone articulates with the shoulder-blade in the usual manner, but beyond this point, except a slight flexibility and elasticity, there is no motion between the different segments. The bones are all there, corresponding in number and general relations with those of the human or any other mammalian arm, but they are flattened out, and their contiguous ends, instead of presenting hinge-like joints, come in contact by flat surfaces, united together by strong ligamentous bands, and all wrapped up in an undivided covering of skin, which allows externally of no sign of the separate and many-jointed fingers seen in the skeleton.

The changes that have taken place in the hind-limbs are even more remarkable. In all known Cetacea (unless *Platanista* be really an exception) a pair of slender bones are found suspended a short distance below the vertebral column, but not attached to it, about the part where the body and the tail join. In museum skeletons these bones are often not seen, as, unless special care has been taken in the preparation, they are apt to get lost. They are, however, of much importance and interest, as their relations to surrounding parts show that they are the rudimentary representatives of the pelvic or hip bones, which in other mammals play such an important part in connecting the hind-limbs with the rest of the skeleton. The pelvic arch is thus almost universally present, but of the limb proper there is, as far as is yet known, not a vestige in any of the large group of toothed whales, not even in the great Cachalot or sperm whale, although it should be mentioned that it has never been looked for in that animal with any sort of care. With regard to the whalebone whales, at least to some of the species, the case is different. In these animals there are found, attached to the outer and lower side of the pelvic bone, other elements, bony or only cartilaginous as the case may be, clearly representing rudiments of the first and in some cases the second segment of the limb, the thigh or femur, and the leg or tibia.

We have here a case in which it is not difficult to answer the question before alluded to, often asked with regard to rudimentary parts: Are they disappearing, or are they incipient organs? We can have no hesitation in saying that they are the former. All we know of the origin of limbs shows that they commence as outgrowths upon the surface of the body, and that the first-formed portions are the most distal segments. The limb, as proved by its permanent state in the lowest vertebrates, and by its embryological condition in higher forms, is at first a mere projection or outward fold of the skin, which, in the course of development, as it becomes of use in moving or supporting the animal, acquires the internal framework which strengthens it and perfects its functions. It would be impossible, on any theory of causation yet known, to conceive of a limb gradually developed from within outward. On the other hand, its disappearance would naturally take place in the opposite direction.

We turn next to what the researches of paleontology teach of the past history of the order. Unfortunately, this does not at present amount to very much. We know nothing of their condition, if they existed, in the Mesozoic age. Even in the cretaceous seas not a fragment of any whale or whale-like animal has been found. The earliest Cetaceans, of whose organization we have any good evidence, are the Zeuglodons of the Eocene formations of North America. These were creatures whose structure, as far as we know it, was intermediate between that of the existing sub-orders of whales. In fact, *Zeuglodon* is precisely what we might have expected *a priori* an ancestral form of whales to have been. From the middle Miocene period fossil Cetacea are abundant, and distinctly divided into the two groups now existing. The Mystacocetes, or whalebone whales, of the Miocene seas, were, as far as we know now, only *Balænopteræ*, some of which were more generalized than any now existing. In the shape of the mandible also, Van Beneden discerns some approximation to the Odontocetes. Right whales (*Balæna*) have not been found earlier than the Pliocene period, and it is interesting to note that, instead of the individuals diminishing in bulk as we approach the times we live in, as with many other groups of animals, the contrary has been the case, no known extinct species of whales equaling in size those that are now to be met with in the ocean. The size of whales, as of all other things whose most striking attribute is magnitude, has been greatly exaggerated ; but, when reduced to the limits of sober fact, the Greenland right whale of fifty feet long, the sperm whale of sixty, and the great northern rorqual (*Balænoptera Sibbaldii*) of eighty, exceed all other organic structures known, past or present. Instead of living in an age of degeneracy of physical growth, we are in an age of giants, but it may be at the end of that age. For countless ages impulses from within and the forces of circumstances from without have been gradually shaping the whales into their present wonderful form and gigantic size, but the very perfection of their structure and their magnitude combined, the rich supply of oil protecting their internal parts from cold, the beautiful apparatus of whalebone by which their nutrition is provided for, have been fatal gifts, which, under the sudden revolution produced on the surface of the globe by the development of the wants and arts of civilized man, can not but lead in a few years to their extinction.

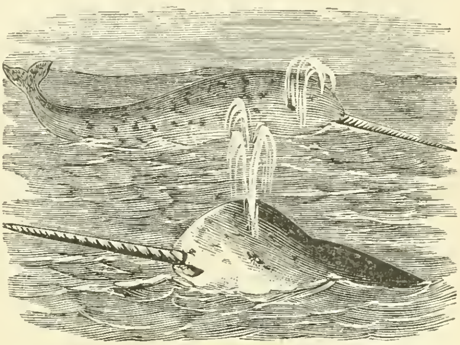

Fig. 7.—Narwhal.

Let us return to the question with which we started, "What was the probable origin of whales?" The evidence is absolutely conclusive that they were not originally aquatic in habit, but are derived from terrestrial mammals of fairly high organization, belonging to the placental division of the class—animals in which a hairy covering was developed, and with sense-organs, especially that of smell, adapted for living on land ; animals, moreover, with four completely developed pairs of limbs on the type of the higher vertebrata, and not of that of fishes.

One of the methods by which a land mammal may have been changed into an aquatic one is clearly shown in the stages which still survive among the carnivora. The seals are obviously modifications of the land carnivora, the Otaria, or sea-lions and sea-bears, being curiously intermediate. Many naturalists have been tempted to think that the whales represent a still further stage of the same kind of modification. But there is to my mind a fatal objection to this view. The seal, of course, has much in common with the whale, inasmuch as it is a mammal adapted for an aquatic life, but it has been converted to its general fish-like form by the peculiar development of its hind-limbs into instruments of propulsion through the water ; for, though the thighs and legs are small, the feet are large and are the special organs of locomotion in the water, the tail being quite rudimentary. In the whales the hind-limbs are aborted and the tail developed into a powerful swimming organ. Now, it is very difficult to suppose that, when the hind-limbs had once become so well adapted to a function so essential to the welfare of the animal as that of swimming, they could ever have become reduced and their action transferred to the tail. It is far more reasonable to suppose that whales were derived from animals with large tails, which were used in swimming, eventually with such effect that the hind-limbs became no longer necessary, and so gradually disappeared. The powerful tail, with lateral cutaneous flanges, of an American species of otter (*Pteronura sandbachii*), or the still more familiar tail of the beaver, may give some idea of this member in the primitive *Cetacea*.

As pointed out long ago by Hunter, there are numerous points in the structure of the visceral organs of the Cetacea far more resembling those of the Ungulata than the Carnivora. These are the complex stomach, simple liver, respiratory organs, and especially the reproductive organs and structures relating to the development of the young. I can not help thinking that some insight has been shown in the common names attached to one of the most familiar of Cetaceans by those whose opportunities of knowing its nature have been greatest—"sea-hog," "sea-pig," or "herring-hog," of our fishermen, *Meerschwein* of the Germans, corrupted into the French "marsouin," and also "porcpoisson," shortened into "porpoise." A difficulty that might be suggested in the derivation of the Cetacea from the Ungulata, arising from the latter being at the present day mainly vegetable-feeders, is not great, as the primitive ungulates were probably omnivorous, as their least modified descendants, the pigs, are still; and the aquatic branch might easily have gradually become more and more piscivorous, as we know, from the structure of their bones and teeth, the purely terrestrial members have become by degrees more exclusively graminivorous.

One other consideration may remove some of the difficulties that may arise in contemplating the transition of land mammals into whales. The Gangetic dolphin (*Platanista*) and the somewhat related *Inia* of South America, which retain several rather generalized mammalian characters, and are related to some of the earliest known European Miocene forms, are both to the present day exclusively fluviatile, being found in the rivers they inhabit almost up to their very sources, more than a thousand miles from the sea. May this not point to the fresh-water origin of the whole group, and thus account for their otherwise inexplicable absence from the Cretaceous seas?

THE FUEL OF THE FUTURE.

By GEORGE WARDMAN.

THE practical application of natural gas, as an article of fuel, to the purpose of manufacturing glass, iron, and steel, promises to work a revolution in the industrial interests of America—promises to work a revolution ; for, notwithstanding the fact that, in many of the largest iron, steel, and glass factories in Pittsburg and its vicinity, natural gas has already been substituted for coal, the managers of some such works are shy of the new fuel, mainly for two reasons : 1. They doubt the continuity and regularity of its supply ; 2. They do not deem the difference between the price of natural gas and coal sufficient, as yet, to justify the expenditure involved in the furnace changes necessary to the substitution of the one for the other. These two objections will doubtless disappear with additional experience in the production and regulation of the gas-supply, and with enlarged competition among the companies engaging in its transmission from the wells to the works. At present the use of natural gas as a substitute for coal in the manufacture of glass, iron, and steel, is in its infancy.

Natural gas is as ancient as the universe. It was known to man in prehistoric times, we must suppose, for the very earliest historical reference to the Magi of Asia records them as worshiping the eternal fires which then blazed, and still blaze, in fissures of the mountain-heights overlooking the Caspian Sea. Those records appertain to a period at least 600 years before the birth of Christ ; but the Magi must have lived and worshiped long anterior to that time.

Zoroaster, reputed founder of the Parsee sect, is placed contemporary with the prophet Daniel, from 2500 to 600 B. C. ; and, although Daniel has been doubted, and Zoroaster may never have seen the light, the fissures of the Caucasus have been flaming since the earliest authentic records.

Tho Parsees (Persians) did not originally worship fire. They believed in two great powers—the Spirit of Light, or Good, and the Spirit of Darkness, or Evil. Subsequent to Zoroaster, when the Persian Empire rose to its greatest power and importance, overspreading the west to the shores of the Caspian and beyond, the tribes of the Caucasus suffered political subjugation ; but the creed of the Magi, founded upon the eternal flame-altars of the mountains, proved sufficiently vigorous to transform the Parseeism of the conquerors to the fire-worship of the conquered.

About the beginning of the seventh century of the Christian era, the Grecian Emperor Heraclius overturned the fire-altars of the Magi at Baku, the chief city on the Caspian, but the fire-worshipers were not expelled from the Caucasus until the Mohammedans subjugated the Persian Empire, when they were driven into the Rangoon, on the Irrawaddy, in India, one of the most noted petroleum-producing districts of the world.

Petroleum and natural gas are so intimately related that one would hardly dare to say whether the gas proceeds from petroleum or the petroleum is deposited from the gas. It is, however, safe to assume that they are the products of one material, the lighter element separating from the heavier under certain degrees of temperature and pressure. Thus, petroleum may separate from the gas as asphaltum separates from petroleum. But some speculative minds consider natural gas to be a product of anthracite coal. The fact that the great supply-field of natural gas in Western Pennsylvania, New York, West Virginia, and Eastern Ohio, is a bituminous and not an anthracite region, does not, of itself, confute that theory ; as the argument for it is, that the gas may be tapped at a remote distance from the source of supply, and, whereas anthracite is not a gas-coal, while bituminous is, we are told to suppose that the gas which once may have been a component part of the anthracite was long ago expelled by Nature, and has since been held in vast reservoirs with slight waste, awaiting the use of man. That is one theory ; and upon that supposition it is suggested that anthracite may exist below the bituminous beds of the region lying between the Alleghany Mountains and the Great Lakes. Another theory is, that natural gas is a product of the sea-weed deposited in the Devonian stratum. But, leaving modern theories on the origin of natural gas and petroleum, we may suppose the natural gas-jets now burning in the fissures of the Caucasus to have started up in flames about the time when, according to the Old Testament, Noah descended from Mount Ararat, or very soon thereafter. In the language of modern science it would be safe to say that those flames sprang up when the Caucasus range was raised from beneath the surface of the universal sea. The believer in biblical chronology may say that those fires have been burning for four thousand years—the geologist may say for four millions.

We know that Alexander the Great penetrated to the Caspian ; and in Plutarch we read : " Hence [Arbela] he marched through the province of Babylon [Media ?], which immediately submitted to him, and in Ecbatana [?] was much surprised at the sight of the place where fire issues in a continuous stream, like a spring of water, out of a cleft in the earth, and the stream of naphtha, which not far from this spot flows out so abundantly as to form a large lake. This naphtha, in other respects resembling bitumen, is so subject to take fire that, before it touches the flame, it will kindle at the very light that surrounds it, and often inflame the intermediate air also. The barbarians, to show the power and nature of it, sprinkled the street that led to the king's lodgings with little drops of it, and, when it was almost night, stood at the farther end with torches, which being applied to the moistened places, the first taking fire, instantly, as quick as a man could think of it, it caught from one end to another in such manner that the whole street was one continued flame. Among those who used to wait upon the king, and find occasion to amuse him, when he anointed and washed himself, there was one Athenophanus, an Athenian, who desired him to make an experiment of the naphtha upon Stephanus, who stood by in the bathing-place, a youth with a ridiculously ugly face, whose talent was singing well. 'For,' said he, 'if it take hold of him, and is not put out, it must undeniably be allowed to be of the most invincible strength.' The youth, as it happened, readily consented to undergo the trial, and, as soon as he was anointed and rubbed with it, his whole body broke out into such a flame, and was so seized by the fire, that Alexander was in the greatest perplexity and alarm for him, and not without reason; for nothing could have prevented his being consumed by it if, by good chance, there had not been people at hand with a great many vessels of water for the service of the bath, with all which they had much ado to extinguish the fire; and his body was so burned all over that he was not cured of it a good while after. And thus it is not without some plausibility that they endeavor to reconcile the fable to truth, who say this was the drug in the tragedies with which Medea anointed the crown and veils which she gave to Creon's daughter."

An interesting reference to the fire-worshipers of the Caucasus is contained in the "History of Zobeide," a tale of the wonderful Arabian Nights Entertainment. It runs thus:

"I bought a ship at Balsora, and freighted it; my sisters chose to go with me, and we set sail with a fair wind. Some weeks after we cast anchor in a harbor which presented itself, with intent to water the ship. As I was tired with having been so long on board, I landed with the first boat, and walked up into the country. I soon came in sight of a great town. When I arrived there I was much surprised to see vast numbers of people in different postures, but all immovable. The merchants were in their shops, the soldiery on guard; every one seemed engaged in his proper avocation, yet all were become as stone. . . . I heard the voice of a man reading Al Koran. . . . Being curious to know why he was the only living creature in the town, . . . he proceeded to tell me that the city was the metropolis of a kingdom now governed by his father; that the former king and all his subjects were Magi, worshipers of fire and of Nardoun, the ancient king of the giants who rebelled against God. 'Though I was born,' continued he, 'of idolatrous parents, it was my good fortune to have a woman governess who was a strict observer of the Mohammedan religion. She taught me Arabic from Al Koran; by her I was instructed in the true religion, which I would never afterward renounce. About three years ago a thundering voice was heard distinctly throughout the city, saying, "Inhabitants, abandon the worship of Nardoun and of fire, and worship the only true God, who showeth mercy!" This voice was heard three years successively, but no one regarded it. At the end of the last year all the inhabitants were in an instant turned to stone. I alone was preserved.'"

In the foregoing tale we doubtless have reference to the destruction of Baku, on the Caspian (though to sail from Balsora to Baku is impossible), and the driving away into India, by the Arabs under Caliph Omar, of all who refused to renounce fire-worship and adopt the creed of the Koran. The turning of the refractory inhabitants into stone is probably the Arabian story-teller's figurative manner of referring to the finding of dead bodies in a mummified condition.

It is known that the Egyptians made use of bitumen, in some form, in the preservation of their dead, a fact with which the Arabians were familiar. As the Magi held the four elements of earth, air, fire, and water to be sacred, they feared to either bury, burn, sink, or expose to air the corrupting bodies of their deceased. Therefore, it was their practice to envelop the corpse in a coating of wax or bitumen, so as to hermetically seal it from immediate contact with either of the four sacred elements. Hence the idea of all the bodies of the Magi left at Baku being turned to stone, while only the true believer in Mohammed remained in the flesh.

Marco Polo, the famous traveler of the thirteenth century, makes reference to the burning jets of the Caucasus, and those fires are known to the Russians as continuing in existence since the army of Peter the Great wrested the regions about the Caspian from the modern Persians. The record of those flaming jets of natural gas is thus brought down in an unbroken chain of evidence from remote antiquity to the present day, and they are still burning.

Numerous Greek and Latin writers testify to the known existence of petroleum about the shores of the Mediterranean two thousand years ago. More modern citations may, however, be read with equal interest. In the "Journal of Sir Philip Skippon's Travels in France," in 1663, we find the following curious entries:

"We stayed in Grenoble till August 1st, and one day rode out, and, after twice fording the river Drac (which makes a great wash) at a league's distance, went over to Pont de Clef, a large arch across that river, where we paid one sol a man; a league further we passed through a large village called Vif, and about a league thence by S. Bathomew, another village, and Chasteau Bernard, where we saw a flame breaking out of the side of a bank, which is vulgarly called *La Fountaine qui Brule;* it is by a small rivulet, and sometimes breaks out in other places; just before our coming some other strangers had fried eggs here. The soil hereabouts is full of a black stone, like our coal, which, perhaps, is the continual fuel of the fire. . . . Near Peroul, about a league from Montpelier, we saw a boiling fountain (as they call it), that is, the water did heave up and bubble as if it boiled. This phenomenon in the water was caused by a vapor ascending out of the earth through the water, as was manifest, for if that one did but dig anywhere near the place, and pour water upon the place new digged, one should observe in it the like bubbling, the vapor arising not only in that place where the fountain was, but all thereabout; the like vapor ascending out of the earth and causing such ebullition in water it passes through hath been observed in Mr. Hawkley's ground, about a mile from the town of Wigan, in Lancashire, which vapor, by the application of a lighted candle, paper, or the like, catches fire and flames vigorously. Whether or not this vapor at Peroul would in like manner catch fire and burn I cannot say, it coming not in our minds to make the experiment. . . . At Gabian, about a day's journey from Montpelier, in the way to Beziers, is a fountain of petroleum. It burns like oil, is of a pungent scent, and a blackish color. It distills out of several places of the rock all the year long, but most in the summer time. They gather it up with ladles and put it in a barrel set on end, which hath a spiggot just at the bottom. When they have put in a good quantity they open the spiggot to let out the water, and when the oil begins to come presently stop it. They pay for the farm of this fountain about fifty crowns per annum. We were told by one Monsieur Beaushoste, a chymist in Montpelier, that petroleum was the very same with oil of jet, and not to be distinguished from it by color, taste, smell, consistency, virtues, or any other accident, as he had by experience found upon the coast of the Mediterranean Sea, in several places, as at Berre, near Martague, in Provence; at Messina, in Sicily, etc."

In Harris's "Voyages," published in 1764, an article on the empire of Persia thus refers to petroleum:

"In several parts of Persia we meet with naphtha, both white and black; it is used in painting and varnish, and sometimes in physic, and there is an oil extracted from it which is applied to several uses, The most famous springs of naphtha are in the neighborhood of Baku. which furnish vast quantities, and there are also upwards of thirty springs about Shamasky, both in the province of Schirwan. The Persians use it as oil for their lamps and in making fireworks, of which they are extremely fond, and in which they are great proficients."

Petroleum has long been known to exist also in the northern part of Italy, the cities of Parma and Genoa having been for many years lighted with it.

In the province of Szechuen, China, natural gas is obtained from beds of rock-salt at a depth of fifteen to sixteen hundred feet. Being brought to the surface, it is conveyed in bamboo tubes and used for lighting as well as for evaporating water in the manufacture of salt. It is asserted that the Chinese used this natural gas for illuminating purposes long before gas-lighting was known to the Europeans. Remembering the unprogressive character of Chinese arts and industries, there is ground for the belief that they may have been using this natural gas as an illuminant these hundreds of years.

In the United States the existence of petroleum was known to the Pilgrim Fathers, who doubtless obtained their first information of it from the Indians, for whom, in New York and Western Pennsylvania, it was called Seneka-oil. It was otherwise known as "British" oil and oil of naphtha, and was considered "a sovereign remedy for an inward bruise."

The record of natural gas in this country is not so complete as that of petroleum, but we learn that an important gas-spring was known in West Bloomfield, N. Y., seventy years ago. In 1864 a well was sunk to a depth of three hundred feet upon that vein, from which a sufficient supply of gas was obtained to illuminate and heat the city of Rochester (twenty-five miles distant) it was supposed. But the pipes which were laid for that purpose, being of wood, were unfitted to withstand the pressure, in consequence of which the scheme was abandoned; but gas from that well is now in use as an illuminant and as fuel both in the town of West Bloomfield and at Honeoye Falls. The village of Fredonia, N. Y., has been using natural gas in lighting the streets for thirty years or thereabout. On Big Sewickley Creek, in Westmoreland County, Pa., natural gas was used for evaporating water in the manufacture of salt thirty years ago, and gas is still issuing at the same place. Natural gas has been in use in several localities in Eastern Ohio for twenty-five years, and the wells are flowing as vigorously as when first known. It has also been in use in West Virginia for a quarter of a century, as well as in the petroleum region of Western Pennsylvania, where it has long been utilized in generating steam for drilling oil-wells.

In 1826 the "American Journal of Science" contained a letter from Dr. S. P. Hildreth, who, in writing of the products of the Muskingum (Ohio) Valley, said: "They have sunk two wells, which are now more than four hundred feet in depth; one of them affords a very strong and pure salt-water, but not in great quantity; the other discharges such vast quantities of petroleum, or, as it is vulgarly called, 'Seneka-oil,' and besides is so subject to such tremendous explosions of gas, as to force out all the water and afford nothing but gas for several days, that they make little or no salt."

The value of the foregoing references is to be found in the testimony they offer as to the duration of the supply of natural gas. Whether we look to the eternal flaming fissures of the Caucasus, or to New York, Pennsylvania, and Ohio, there is much to encourage the belief that the flow of natural gas may be, like the production of petroleum, increased rather than diminished by the draughts made upon it. Petroleum, instead of diminishing in quantity by the millions of barrels drawn from Western Pennsylvania in the last quarter of a century, seems to increase, greater wells being known in 1884 than in any previous year, and prices having fallen from two dollars per bottle for "Seneka-oil" to sixty cents per barrel for the same article under the name of crude petroleum. Hence we may assume that, as new pipe-lines are laid, the supply of natural gas available for use in the great manufacturing district of Pittsburg and vicinity will be increased, and the price of this fuel diminished in a corresponding ratio.

Natural gas is now supplied in Pittsburg at a small discount on the actual cost of coal used last year in the large manufacturing establishments, an additional saving being made in dispensing with firemen and avoidance of hauling ashes from the boiler-room. It is supplied, for domestic purposes, at twenty cents per one thousand cubic feet, which is not cheaper than coal in Pittsburg, but it is a thousand per cent cleaner; and in that respect it promises to prove a great blessing, not only to those who can afford to use it, but to the community at large, in the hope held out that the smoke and soot nuisance may be abated in part, if not wholly subdued, and that gleams of sunshine there may become less phenomenal in the future than they are at the present time. Twenty cents per thousand feet is too high a price to bring gas into general use for domestic purposes in a city where coal is cheap. Ten cents would be too much, and no doubt five cents per thousand would pay a profit. The fact is, the dealers in natural gas appear to be somewhat doubtful of the continuity of supply, and anxious to get back the cost of wells and pipes in one year, which, if successful, would be an enormous return on the investment.

There are objections to the use of natural gas by mill-operators—that it costs too much, and that the continuity of the supply is uncertain; by heads of families, that it is odorless, and, in case of leakage from the pipes, may fill a room and be ready to explode without giving the fragrant warning offered by common gas. Both of these objections will probably disappear under the experience that time must furnish. More wells and tributary lines will lessen the cost and tend to regulate the pressure for manufacturers. Cut-offs and escape-pipes outside of the house will reduce the risk of explosions within. The danger in the house may also be lessened by providing healthful ventilation in all apartments wherein gas shall be consumed.

This subject of the ventilation of rooms in which common gas is ordinarily used is beginning to attract attention. It is stated, upon scientific authority, that a jet of common gas, equivalent to twelve sperm-candles, consumes 5·45 cubic feet of oxygen per hour, producing 3·21 feet of carbonic-acid gas, vitiating, according to Dr. Tidy's "Handbook of Chemistry," 348·25 cubic feet of air. In every five cubic feet of pure air in a room there is one cubic foot of oxygen and four of nitrogen. Without oxygen human life, as well as light, would become extinct. It is asserted that one common gas-jet consumes as much oxygen as five persons.

Carbonic-acid gas is the element which, in deep mines and vaults, causes almost instant insensibility and suffocation to persons subjected to its influences, and instantly extinguishes the flame of any light lowered into it. The normal quantity of this gas contained in the air we breathe is ·04; one per cent of it causes distress in breathing; two per cent is dangerous; four per cent extinguishes life, and four per cent of it is contained in air expelled from the lungs. According to Dr. Tidy's table, each ordinary jet of common gas contributes to the air of a room sixteen by ten feet on the sides and nine feet high, containing 1,440 cubic feet of air, twenty-two per cent of carbonic-acid gas, which, continued for twenty hours without ventilation, would reach the fatal four per cent.

Professor Huxley gives, as a result of chemical analyses, the following table of ratio of carbonic-acid gas in the atmosphere at the points named:

On the Thames, at London	·0343
In the streets of London	·0380
Top of Ben Nevis	·0327
Dress circle of Haymarket Theatre (11.30 P. M.)	·0757
Chancery Court (seven feet from the ground)	·1930
From working mines (average of 339 samples)	·7852
Largest amount in a Cornish mine	2·0500

In addition to the consumption of oxygen and production of carbonic acid by the use of common gas, the gas itself, owing to defectiveness of the burner, is projected into the air. Now, considering the deleterious nature of all illuminating gases, the reasons for perfect ventilation of rooms in which natural gas is used for heating and culinary purposes are self-evident, not alone as a protection against explosions, but for the health of the occupants of the house, remembering that a larger supply of oxygen is said to be necessary for the perfect combustion of natural than of common gas.

Carbonic oxide, formed by the consumption of carbon, with an insufficient supply of air, is the fatal poison of the charcoal-furnace, not infrequently resorted to, in close rooms, as a means of suicide. The less sufficient the air toward perfect combustion, the smaller the quantity of carbonic acid and the greater the amount of carbonic oxide. That is to say, at the time of ignition the chief product of combustion is carbonic oxide, and, unless sufficient air be added to convert the oxide to carbonic acid, a decidedly dangerous product is given off into the room. Yet, by means of a flue to carry off the poisonous gases from burning jets, the combustion of gas, creating a current, is made an aid to ventilation. Unfortunately, this important fact, if commonly known, is not much heeded by heads of families or builders of houses. But in any large community where gas comes into general use as an article of fuel, this fact will gradually become recognized and respected.

The property of indicating the presence of very minute quantities of gas in a room is claimed for an instrument recently described by C. von Jahn, in the "Revue Industrielle." This is a porous cup, inverted and closed by a perforated rubber stopper. Through the perforation in the stopper the interior of the cup is connected with a pressure-gauge containing colored water. It is claimed that the diffusion of gas through the earthenware raises the level of the water in the gauge so delicately that the presence of one half of one per cent of gas may be detected by it. Other instruments of a slightly different character are credited by their inventors with most sensitive power of indicating gas-leakages, but their practical efficiency remains to be demonstrated. An automatic cut-off for use outside of houses in which natural gas is consumed has been invented, but this writer knows nothing of either its mode of action or its effectiveness.

The great economic question, however, connected with the use of natural gas is, How will it affect the industrial interests of the country? There are grounds for the belief that a sufficient supply of natural gas may be found in the vicinity of Pittsburg to reduce the cost of fuel to such a degree as to make competition in the manufacture of iron, steel, and glass, in any part of the country where coal must be used, out of the question. Such a condition of affairs would probably result in driving the great manufacturing concerns of the country into the region where natural gas is to be obtained. That may be anywhere from the western slope of the Alleghanies to Lake Erie or to Lake Michigan. And, if the cost of producing iron, steel, and glass can be so cheapened by the new fuel, the tariff question may undergo some important modification in politics. For, if the reduction in the cost of fuel should ever become an offset to the lower rate of wages in Europe, the manufacturers of Pennsylvania, who have long been the chief support of the protective policy of the country, may lose their present interest in that question, and leave the tariff to shift for itself elsewhere. It should be remembered that natural gas is not, as yet, much cheaper than coal in Pittsburg. But it may safely be assumed that it will cheapen, as petroleum has done, by a development of the territory in which it is known to exist in enormous quantities. It is quite possible that, instead of buying gas, many factories will bore for it with success, or remove convenient to its natural sources, so that a gas-well may ultimately become an essential part of the "plant" of a mill or factory. Even now coal can not compete with gas in the manufacture of window-glass, for, the gas being free from sulphur and other impurities contained in coal, produces a superior quality of glass; so that in this branch of industry the question of superiority seems already settled.

Having said thus much of an industry now in its infancy but promising great growth, I submit tables of analyses of common and of the natural or marsh gas, the latter from a paper recently prepared by a

TABLE OF ANALYSIS OF NATURAL GAS—FROM VARIOUS SOURCES.

CONSTITUENTS.	1. Petrolia, Canada.	2. West Bloomfield, N. Y.	3. Olean, N. Y.	4. Fredonia, N. Y.	5. Pioneer Run, Venango Co., Pa.	6. Burns's Well, near St. Joe., Butler Co., Pa.	7. Harvey Well, Butler Co., Pa.	8. Cherry Tree, Indiana Co., Pa.	9. Leechburg, Pa.	10. Creighton, Pa.	11. Penn Fuel Co.'s Well, Murraysville, Pa.	12. Fuel Gas Co.'s Well, Murraysville.	13. Roger's Gulch, Wirt Co., W. Va.	14. Gas from Marsh Ground.	15. Baku, on the Caspian Sea.	16. Gas occluded in Wigan cannel-coal.	17. Blower in coal-mine, South Wales.
Hydrogen..........	Chiefly marsh-gas, with ethane and some carbonic acid.	....	....	A mixture of marsh-gas, ethane, and butane.	Chiefly propane, with small quantities of carbonic acid and nitrogen.	6·10	13·50	22·50	4 79	....	Marsh-gas, with a little carbonic acid.	19·56	Chiefly marsh-gas, with small quantities of nitrogen and 15·86 per cent carbonic acid.	....	0 98	....	....
Marsh-gas..........		82·41	96·50			75·44	80·11	60·27	89·65	96·34		78·24		47·37	93·09	80·69	95·42
Ethane............		....	....			18·12	5·72	6·80	4·39	....		....		....	....	4·75	....
Propane......... ..		...	....			trace.	....	....	trace.	....		....		....	....	....	....
Carbonic acid......		10·11	....			0·34	0·66	2·28	0·35	3·64		....		3·10	2·18	6·44	0·60
Carbonic oxide.....		....	0·50			trace.	trace.	trace.	0 26	Trace of heavy hydrocarbons.		....		....	....	....	....
Nitrogen..........		4·31	....			....	....	7·32	....			....		49·39	0·49	8·12	3·98
Oxygen...........		0·23	2·00			....	....	0·83	....			2·20		0·17	....	....	....
"Illuminating hydrocarbons."		2·94	1·00			....	....	....	0·56			....		....	3·26	....	....
		100·00	100·00			100.00	99·99	100·00	100·00			100·00		100·03	100·00	100·00	100·00
Specific gravity......		0·693	0·692			0·6148	0·5119		0·5580	0·5923	0·56						

1. Fouqué, "Comptes Rendus," lxvii, p. 1045.
2. H. Wurtz, "Am. Jour. Arts and Sci." (2), xlix, p. 336.
3. Robert Young.
4. Fouqué, "Comptes Rendus," lxvii, p. 1045.
5. Fouqué, "Comptes Rendus," lxvii, p. 1045.
6. S. P. Sadtler, "Report L, 2d Geol. Sur. Pa.," p. 153.
7. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 152.
8. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 153.
9. S. P. Sadtler, "Report L, 3d Geol. Sur., Pa.," p. 153.
10. F. C. Phillips.
11. Robert Young.
12. Rogers.
13. Fouqué, "Comptes Rendus," lxvii, p. 1045.
14. Bischof's "Chemical Geology," I, p. 730.
15. Bischof's "Chemical Geology," I, p. 730.
16. J. W. Thomas, London, "Chemical Society's Journal," 1876, p. 793.
17. Same, 1875, p. 793.

Petroleum is composed of about 85 per cent of carbon and 15 per cent of nitrogen.

committee of the Engineers' Society of Western Pennsylvania, and for the use of which I am indebted to that association :

COMMON GAS.

Hydrogen	46·0
Light carbureted hydrogen (marsh-gas)	39·5
Condensible hydrocarbon	3·8
Carbonic oxide	7·5
" acid	0·6
Aqueous vapor	2·0
Oxygen	0·1
Nitrogen	0·5
	100·00

Natural gas is now conveyed to Pittsburg through four lines of 5⅝-inch pipe, and one line of eight-inch pipe. A line of ten-inch pipe is also being laid. The pressure of the gas at the wells is from 150 to 230 pounds to the square inch. As the wells are on one side eighteen and on the other about twenty-five miles distant, and as the consumption is variable, the pressure at the city can not be given. Greater pressure might be obtained at the wells, but this would increase the liability to leakage and bursting of pipes. For the prevention of such casualties safety-valves are provided at the wells, permitting the escape of all superfluous gas. The enormous force of this gas may be appreciated from a comparison of, say, 200 pounds pressure at the wells with a two-ounce pressure of common gas for ordinary lighting. The amount of natural gas now furnished for use in Pittsburg is supposed to be something like 25,000,000 cubic feet per day ; the ten-inch pipe now laying is estimated to increase the supply to 40,000,000 feet. The amount of manufactured gas used for lighting the same city probably falls below 3,000,000 feet. About fifty mills and factories of various kinds in Pittsburg now use natural gas. It is used for domestic purposes in two hundred houses. Its superiority over coal in the manufacture of window-glass is unquestioned. That it is not used in all the glass-houses of Pittsburg is due to the fact that its advantages were not fully known when the furnaces were fired last summer, and it costs a large sum to permit the furnaces to cool off after being heated for melting. When the fires cool down, and before they are started up again, the furnaces now using coal will doubtless all be changed so as to admit natural gas. The superiority of French over American glass is said to be due to the fact that the French use wood and the Americans coal in their furnaces, wood being free from sulphur, phosphorus, etc. The substitution of gas for coal, while not increasing the cost, improves the quality of American glass, making it as nearly perfect as possible.

While the gas is not used as yet in any smelting-furnace nor in the Bessemer converters, it is preferred in open-hearth and crucible steel furnaces, and is said to be vastly superior to coal for puddling.

The charge of a puddling-furnace, consisting of 500 pounds of pig-metal and eighty pounds of "fix," produces with coal-fuel 490 to 500 pounds of iron. With gas for fuel, it is claimed that the same charge will yield 520 to 530 pounds of iron. In an iron-mill of thirty furnaces, running eight heats each for twenty-four hours, this would make a difference in favor of the gas of, say, $8 \times 30 \times 25 = 6{,}000$ pounds of iron per day. This is an important item of itself, leaving out the cost of firing with coal and hauling ashes.

For generating steam in large establishments, one man will attend a battery of twelve or twenty boilers, using gas as fuel, keep the pressure uniform, and have the fire-room clean as a parlor. For burning brick and earthenware, gas offers the double advantage of freedom from smoke and a uniform heat. The use of gas in public bakeries promises the abolition of the ash-box and its accumulation of miscellaneous filth, which is said to often impregnate the "sponge" with impurities.

In short, the advantages of natural gas as a fuel are so obvious to those who have given it a trial, that the prediction is made that, should the supply fail, many who are now using it will never return to the consumption of crude coal in factories, but, if necessary, convert it or petroleum into gas at their own works.

It seems, indeed, that, until we shall have acquired the wisdom enabling us to conserve and concentrate the heat of the sun, gas must be the fuel of the future.

USE OF SULPHUROUS DISINFECTANTS.

By GASTON TISSANDIER.

AMONG the most convenient and efficacious substances to be used for purposes of disinfection are sulphurous acid and bisulphide of carbon. The question of the merits of these substances and the advantages of using them was recently considered, in the "Journal de Pharmacie et de Chimie," by M. Alfred Riche, who said: "M. Dujardin-Beaumetz recently requested the concurrence of MM. Pasteur and Roux in instituting new experiments on the value of disinfectants, and has just published the results of the same in the 'Bulletin' of the Academy of Medicine. Two rooms of about a hundred cubic metres capacity were selected in the wooden barracks attached to the hôpital Cochin. The walls of these rooms, made of jointed planks, gave passage to the air through numerous cracks, although the precaution had been taken of stopping the larger ones with paper. Each of the rooms was furnished with a bed, the usual furniture, and cloths of different colors. Bromine, chlorine, and sulphate of nitrosyle were successively rejected. Three sources of sulphurous acid were experimented upon—the combustion of sulphur, liquefied sulphurous acid, and the combustion of bisulphide of carbon. The room was closed for twenty-four hours. Tubes containing culture-infusions sowed with different proto-organisms, especially the comma microbe described by Koch, were placed in rooms, together with tubes containing vaccine lymph. After each experiment the tubes were taken to M. Pasteur's laboratory, and there compared with other tubes used as tests. The process of the combustion of sulphur is the simplest and cheapest. To perform this combustion, it is sufficient to set on the floor a sheet-iron plate—a large potsherd on the ground gives a satisfactory result—on which is placed a furnace of bricks and mortar, or better, one of those small, nearly square furnaces of fire-clay recommended by M. Pasteur, twenty-five centimetres long and twenty centimetres wide, and having the sides pierced with air-holes. To obtain a complete combustion of the flowers of sulphur, it is necessary to

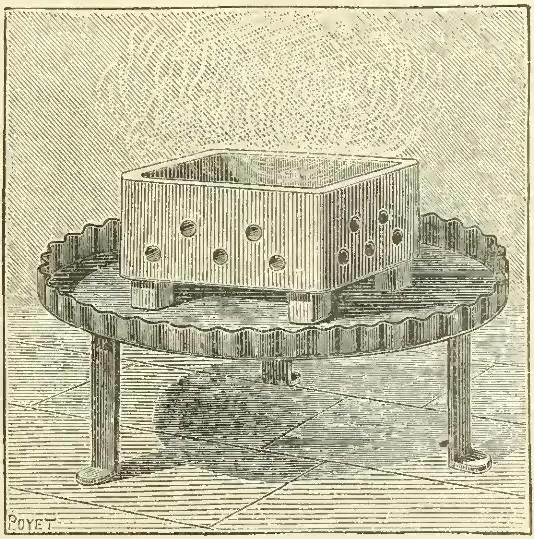

FIG. 1.—BURNER FOR SULPHUR.

take care that the whole surface be evenly burned ; this may be effected by wetting the sulphur with alcohol and inflaming the alcohol. By this method we can burn completely and absolutely as large a quantity as forty or fifty grammes per cubic metre of flowers of sulphur. With twenty grammes per cubic metre, all of the culture-infusions experimented upon were sterilized, except the one containing the carbuncular (anthrax) bacteria. The activity of the vaccine virus was destroyed. The only probable inconveniences involved in the application of this economical process arise from the danger of fire in case the furnace is badly constructed, and from the liability of the metallic objects that may be present to be tarnished. This may take place from particles of the burning element flying around the room, and, settling on articles of copper and iron, covering them with a sulphurous coating.

"The process of using liquid anhydrous sulphurous acid in siphons is free from these inconveniences. The siphons contain 750 grammes of the acid, and one of them is efficient for the disinfection of twenty cubic metres of space. In using the siphons a vessel is set in the middle of the room, and is put in communication with the outside by means of an India-rubber tube passing through a hole in the door. The door having been closed, the orifice of the siphon is inserted into the India-rubber tube, and, the liquid being let in through it, is freely evaporated in the air of the room. This process is very convenient; it avoids the danger of fire, and does not affect metallic objects; and the penetrative force of sulphurous acid thus administered appears to be greater than that of the acid obtained by burning sulphur. The only drawback to its use is the high cost. The siphons are sold to the general public for a dollar each, but can be bought in large quan-

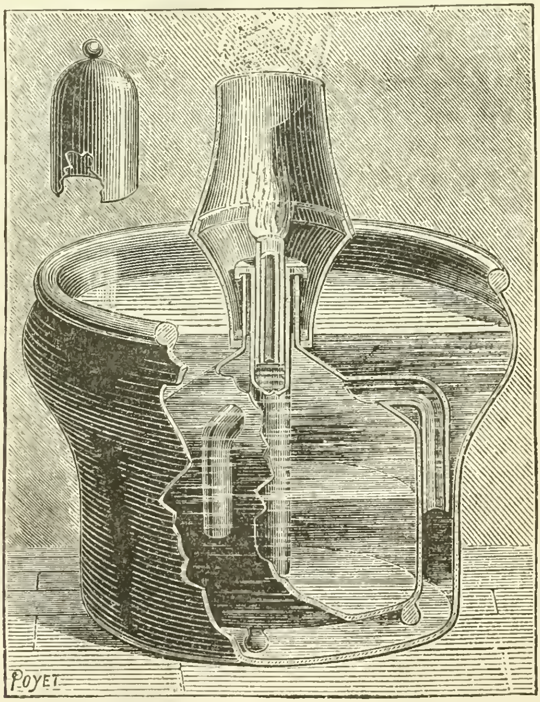

Fig. 2.—M. Ckiandi Bey's Burner for Bisulphide of Carbon.

tities for half that price. Thus the expense of disinfecting a room of one hundred cubic metres with this preparation would be from two and a half to five dollars."

The process of the combustion of bisulphide of carbon was suggested by M. E. Peligot; and all danger in employing it is obviated in the new burner invented by M. Ckiandi Bey, engineer. This apparatus is illustrated, with a view of its interior arrangement, in Fig. 2; and a more detailed explanation of its parts can be obtained from the examination of Fig. 3.

M. Ckiandi's burner is composed of an exterior receiver of tinned copper, A B C D, containing an interior vessel, I H E F, to the sides of which are fixed three siphons, R S. To put it in operation, the cylindrical tube, K L M N, is placed in the interior vessel; sulphide of carbon is poured in up to the level *a a*, and the exterior receiver is then filled with water up to the level *b b*. By means of the siphons the water

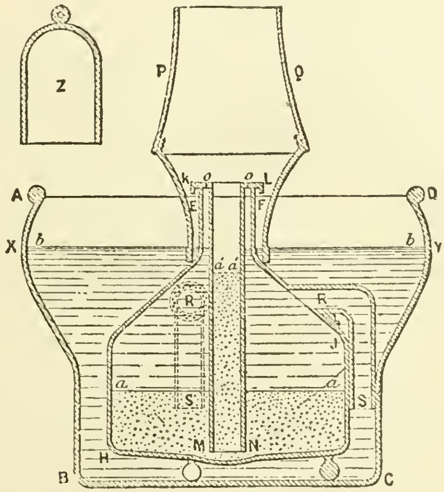

FIG. 3.—M. CKIANDI BEY'S BURNER, SECTIONAL VIEW.

penetrates into the interior vessel, presses upon the sulphide of carbon, which is heavier than it, and drives it in the interior tube up to the level *a' a'*, where it is taken up by a cotton wick, which is lighted. The upper end of the tube is crowned with a chimney, P Q, to facilitate the draught. The combustion of the sulphide of carbon may be increased or slackened at will by raising or lowering the level, *b b*, of the water in the external receiver; and this facility will be found of advantage in many cases.

The burner is placed in the room to be disinfected and lit, when the room is evacuated and shut up tight. When all the sulphide of carbon has been burned, its place is taken by water, and the lamp goes out of itself; in the mean time the burning goes on with great regularity, and without any danger. About two and a half kilogrammes (six and a quarter pounds) of sulphide of carbon are sufficient for a room of a hundred cubic metres. The process is effective and economical enough; for sulphide of carbon is sold commercially for fifty centimes (about ten cents) per kilogramme, which gives about twenty-five cents as the price of disinfecting a room of a hundred cubic metres. The burner costs ten dollars, but it will last for a very long time. This process is evidently practicable and convenient. It does not tarnish metallic objects, and furnishes a continuous, slow, and regular disengagement of the disinfecting gas.—*Translated for the Popular Science Monthly from La Nature.*

THE MEDITERRANEAN OF CANADA.

By J. MACDONALD OXLEY.

IN the month of February last a report was laid before the Parliament of Canada detailing the results of an expedition dispatched by the Government of that country particularly for the purpose of inquiring into the navigability of Hudson Strait and Bay, and, at the same time, of gathering information concerning the resources of that region, and its availability as a field for settled habitation. This report represents the first properly organized attempt that has ever been made to pierce the secrets of Hudson Bay for the public benefit.

It is at first blush not easy to understand why this mighty expanse of water, occupying the peculiarly important position that it does, should remain for so many generations comparatively unexplored, and wholly unutilized, except as a hunting-ground for a few New Bedford whalers, or a medium of easy communication between some half-dozen scattered factories of the Hudson Bay Company. Although called a bay, it is really an inland sea, 1,000 miles in length by 600 in width, having thus an area of about 500,000 square miles, or quite half that of the Mediterranean. It drains an expanse of country spreading out more than 2,000 miles from east to west, and 1,500 from north to south, or an area of 3,000,000 square miles. Into its majestic waters pour feeders which take their rise in the Rocky Mountains on the west and in Labrador on the east, while southward it stretches out its river-roots away below the 49th parallel until they tap the same lake-source which sends a stream into the Gulf of Mexico. Despite its distance northward, its blue waves are never bound by icy fetters, and its broad gateway to the Atlantic is certainly navigable four months out of the year, and possibly all the year round to properly equipped steamships. Its depths abound in finny wealth, from the mammoth whale to the tiny caplin. Its shores are serrated by numerous streams, some navigable for long distances inland, and all stocked with the finest of fresh-water fish, and clothed as to their banks with valuable timber ready for the lumberman's axe. Its islands are rich in mineral ore of many kinds. The country whose margin its tides lave is well adapted for tillage and pasturage, while all around the region swarms with animals and birds whose flesh or fur renders their chase a highly lucrative employment. How comes it, then, that, for all this superabundant endowment, the only population outside the wandering bands of Eskimos and native Indians to be found there to-day gathers in little circles around the company's forts which dot the shore at immense intervals?

The explanation of this apparent enigma is not far to seek. It lies simply in the fact that, until little more than a decade ago, Hudson Bay and vicinity was the subject of a monopoly, which effectually excluded from it all but the employés of a single corporation. It was first visited in 1610 by Henry Hudson, who, after giving his name to the Hudson River, in his rude little bark, well named Discovery, dauntlessly pushed his way thither in search of the mythical northwest passage to the Pacific, and made it both his imperishable monument and his grave. The stories that his mutinous crew took home with them did not prevent other vessels being dispatched on the same hopeless quest, and, if these latter failed to find the northwest passage, they at all events found sufficient cause for the Hudson Bay Company being founded in 1668. This astute corporation, easily obtaining a grant of the bay and its environing territory, together with the most extensive powers from a king who knew nothing of its value, and cared less, forthwith set about excluding all possible rivals from their invaluable fur-preserve. For half a century or more they had a serious obstacle to the execution of their laudable design in the presence of the French, and the bay became the theatre of many a hard-fought conflict.

It was not until, by the Treaty of Utrecht in 1713, the whole of Hudson Bay was ceded to the British, that the company were left to the undisputed possession of their vast estate—the most stupendous landed property ever owned by one corporation, embracing, as it then did, the entire Northwest of Canada. As the day for violence had gone by, they resorted to a subtler but incomparably more effective method of keeping the country to themselves. The most ingeniously false and distorted accounts were sedulously spread abroad concerning this region. According to them, it was a land of eternal snow and ice, utterly unfit for human settlement. The perils of the passage through the strait were grossly magnified. Preposterous tales were circulated as to the rigors of the climate, the fierceness of the wild animals, and the barbarous character of the inhabitants. The company's efforts were crowned with the most gratifying success. Decade after decade slipped by, and they were still in unquestioned possession, and probably would have continued so to this day, but for their having been bought out in 1870 for the tidy sum of £300,000, by the Canadian Government, to whom, with some reservation, they transferred all their real estate.

With the change of ownership came a complete change in policy. Under the new *régime*, the great object held in view was no longer to keep the country a solitude, unbroken by the hum of human life, but to ascertain in how far it might be available as a field for settlement. In fulfillment of this policy, Dr. Bell, Assistant Director of the Geological Survey, was sent up there with an exploring party for six successive seasons, and his observations constitute some of the most interesting portions of the reports of that survey. The vast importance of this region rapidly dawned upon the public mind, when it became known that here was an immense range of country, having a temperate climate, a fertile soil, and boundless wealth in forest and mine, awaiting the long-delayed advent of the farmer, the lumberman, and the miner. And not only so, but the phenomenal development of the great Northwest drew attention to Hudson Bay upon another and even more immediately important ground.

Entering as this bay does into the very heart of the continent, and being connected by navigable rivers with a network of great lakes which spreads out until it touches the western boundaries of Manitoba, the keen-eyed farmers of that fertile province espied in it a hopeful solution of the vital problem how they should most cheaply transport their grain to the markets of the Old World. By reference to a map of the northern hemisphere it will at once be seen that the shortest possible route between the Northwest Territories and Europe lies through Hudson Bay. As the result of careful calculations, it has been ascertained that even the city of Winnipeg, which is situated in the extreme southeastern part of these Territories, is at least eight hundred miles nearer to Liverpool, for instance, by the Hudson Bay route, than by the St. Lawrence, while the difference in favor of the former necessarily increases the farther we advance northwestward. If, as Dr. Bell has so clearly pointed out, we take the central point of the agricultural lands of the Northwest, we shall find that the distance from it to Winnipeg is about the same as it is to Churchill, the finest harbor in Hudson Bay. Now, the distance between Churchill and Liverpool is a little less (about sixty-four miles) than it is between Montreal and that great entrepot of commerce. The conclusion consequently is that, as between the above-named center and Liverpool, there is a saving of the whole distance from Winnipeg to Montreal by the use of Hudson Bay. This saving amounts to no less than twelve hundred and ninety-one miles by way of Lake Superior, and sixteen hundred and ninety-eight miles *via* Chicago.

The translation of miles into dollars and cents is an easy process nowadays, and it has been estimated that the difference in freight in favor of the Hudson Bay route is at least thirty-two cents on each bushel of grain, or, in other words, means an additional profit of over six dollars an acre to the farmers of the West. When this idea had once fairly taken hold of the public mind, a profound interest was awakened, not only throughout Canada, but also in England, where, at the 1880 meeting of the British Association, Sir J. H. Lefroy, President of the Geological Section, hesitated not to affirm that the natural seaports of that vast interior now thrown open to settlement, Manitoba, Keewatin, and the other provinces yet unborn, must be sought in Hudson Bay. The mouth of the Churchill River would undoubtedly be the future shipping-port for the agricultural products of the Northwest, and the route by which immigrants would enter the country. In Canada the subject was brought before Parliament for the first time in 1878, and thenceforth pressed upon its attention every year, until, finally, after a committee had gathered all available information upon the subject, it was decided, at the session of 1884, to dispatch a fully equipped expedition having for its main object the determination of the one point upon which the whole question rested, namely, whether the bay and strait might be relied upon as safe and serviceable highways of commerce. It was, of course, a matter of general knowledge that these waters had been plowed by keels for two hundred and seventy-four years back; that sailing-vessels of all descriptions, from the pinnace of twenty tons to the seventy-four-gun man-of-war, had passed through the strait and spread their white wings all across the bay; and that Moose Factory had been visited by a supply-ship with unfailing regularity every year since 1735. But facts like these, encouraging as they might be, were not conclusive, because in all cases these vessels had been free to choose their own time for entering and leaving the bay, and they therefore still left the question open as to whether these waters were navigable during a sufficient portion of the year to render possible the development of a great and permanent commerce. In order that there should be successful shipping-ports upon the bay, there must, of course, be railways leading from the interior to these ports, and these railways must be assured of a profitable volume of business during a good long season, or they would never be built. The expedition, therefore, was charged primarily with the duty of affixing the limits of the period of navigation, and at the same time was instructed to gather as much information concerning the climate, resources, flora, fauna, and other features of the region as the limited time at its command would permit.

On the 22d of July last the steamship Neptune, a wooden vessel, built and equipped with special reference to northern navigation in prosecution of the seal-fishery, set forth from the port of Halifax, with the members of the expedition on board. These were some twenty-six in number, Lieutenant Andrew R. Gordon, R. N., of the Meteorological Survey of Canada, being in command, and having with him, in the double capacity of geologist and medical officer, Dr. Robert Bell, whose explorations in the vicinity of Hudson Bay have been already referred to. The rest of the party comprised a photographer, eight observers, three carpenters, and twelve station-men. As the observers and station-men were to be left for the winter, they had each of them been carefully examined by medical authority, and pronounced physically well fitted to withstand the rigors of an Arctic climate.

Sailing up past Capes North and Ray, and thence through the Gulf of St. Lawrence and the Strait of Belle Isle, the Neptune coasted along the Labrador shore until reaching Nain on the 29th, where a pause was made in the hopes of securing fur clothing for those who were to remain out all winter, and also an interpreter. Failing in both objects, but experiencing much kindness at the hands of the Moravian missionaries, one of whose principal stations Nain is, the expedition continued on to Nachvak, arriving there on the 1st of August. On the way icebergs were encountered in great numbers, requiring constant vigilance on board the steamship. At Nachvak, which is a post of the Hudson Bay Company, both the fur clothing and the interpreter were readily obtained. The company's agent informed Lieutenant Gordon that the ice takes over the harbor of Nachvak, which is in latitude 59° 10′ north, and longitude 63° 30′ west, about the middle of November in each year, and, curious to note, has, for the last seven years, at all events broken up within a day of the 26th of June in each year. Off Cape Chudleigh, which is just at the mouth of Hudson Strait, the Neptune was enveloped in a dense fog, which compelled her to lay-to from Sunday until Tuesday morning. Tuesday, however, dawned bright and clear, and, pushing in through Grey Strait, a fine harbor was found that afternoon on the north-western shore of the cape, at the entrance to Ungava Bay. On the shore of this harbor a site was selected for observing station No. 1, and the place named Port Burwell, in compliment to the observer appointed to that station. As the best and briefest method of indicating the precise nature of the duties devolving upon these observers who were to spend a long and dreary winter at their posts, we herewith transcribe the instructions with which each was furnished :

Instructions to Officers in charge of Stations in Hudson Bay and Strait.—As the primary object of the whole expedition is to ascertain for what period of the year the strait is navigable, all attention is to be paid to the formation, breaking up, and movements of the ice.

Each station is supplied with a sun-dial and time-piece, and the clock is to be tested each day when there is sunshine about noon. A table of corrections is supplied for the reduction of apparent time to local mean time ; to this the difference of time will be applied to 75th meridian, all entries being made in the time of this meridian, and observations will be taken regularly at the following times throughout the year, viz., 3h. 08 m., 7 h. 08 m., 11 h. 08 m., A. M. and P. M.

Each morning the sums and means of the observations taken on the previous day will be taken out and checked over ; they will then be entered in the abstract-books supplied for the purpose.

After each observation during daylight the observer on duty will take the telescope and carefully examine the strait, writing down *at* *the time* all that he sees, stating direction and (when possible) velocity of tide, movement of ice, if any ; also describe the condition of the ice, whether much broken up, solid field, etc.

Tidal Observations.—Each day the time and height of high and low water are to be carefully observed, and during the open season the character of the tide will be carefully noted for two days before and three days after the full and change of the moon. For this purpose a post, marked off in feet and fractions of a foot, is to be placed in the water, at low water in some sheltered spot, if any such be available, and the height of the water noted every half-hour during the rise and fall of one tide on each of these days—the height to be noted most carefully every five minutes during the hour of high water and the same at low water ; the five-minute observations will also be taken for one hour during the most rapid portion of the rise. Special observations of barometric pressure are to be taken in connection with these tidal observations.

To check the zero-mark for the tidal-observation post, select a spot on shore from which the horizon line will be projected on the tidal post, and record the reading of this line when seen projected on the post by the observer, whose eye is to be placed at a measured height above the datum-point selected on shore.

All remarks in regard to the movements of birds, fish, etc., and also as to the growth of grasses, will be carefully entered.

As it is impossible to give to the officers in charge of stations detailed instructions which would be of service in every contingency which might arise, the officers are required to observe and enforce the following rules :

(*a.*) Every possible precaution is to be taken against fire, and, as it is anticipated that the temperature can be maintained considerably above the freezing-point inside the houses, two buckets full of water are always to be kept ready for instant use.

(*b.*) As the successful carrying out of the observations will, in a great measure, depend on the health of the party, the need of exercise is strongly insisted on during the winter months, and also that each member of the party shall partake freely of the lime-juice supplied.

(*c.*) Each party is supplied with a boat, but, unless some emergency requires it, it must be a rule that neither afloat nor ashore must any of the party leave the station for a greater distance than they can be sure of being able to return the same day.

(*d.*) As soon as possible after the houses are completed and the stores all in place, the party will set to work collecting sods, grass, or any other non-conducting material, and before the winter sets in the whole house is to be covered with this, boards overlaid, and snow packed over all ; the assistance of the Eskimos should, if possible, be obtained, and the whole house arched over with snow.

As will be gathered from the above, the observers' duties, while not onerous, were sufficiently varied and responsible to impart variety and purpose to the otherwise necessarily monotonous and depressing round of existence.

It was intended to place station No. 2 on the lower Savage Islands, at the northern entrance to the strait, and nearly opposite to station No. 1, but a succession of stormy weather prevented success in doing so. The expedition proceeded up the strait to Big Island, North Bluff, where station No. 3 was established, and the place christened Ashe Inlet. The Eskimos in the neighborhood seemed highly delighted at the prospect of having white men near them. Station No. 4 was established at Stupart's Bay, Prince of Wales Sound, across the strait from Ashe Inlet; station No. 5 at Port de Boucherville, Nottingham Island. Other calls were made at Digges Island, near Cape Wolstenholme; at Marble Island, south of Chesterfield Inlet, which was found marked by the presence of nineteen graves and a monument to six other persons who had been drowned; at Churchill, the future Liverpool of the region; at York Factory, the present commercial metropolis of the bay, whence, after a stay of only one day, the return journey was taken up. The several stations were visited in turn, and the finishing touches were given to the preparations for the long Arctic winter. A second attempt was made to establish a station on Resolution Island. Two bays were examined, in both of which the vessel ran unwarned immediately from deep soundings upon the rocks, and the idea was given up. Finally, the Neptune arrived at Port Burwell, on the 27th of September, where, as at all the other stations, it found the observers well, pleased with their work, and satisfied with their provisioning. Thence the expedition returned to St. John's, Newfoundland, where the Neptune was given up to her owner, while the men took passage for Halifax.

The course of this expedition having thus been briefly outlined, it now remains to examine into the results so far as they have been detailed, and consider their bearing upon the important problem sought to be solved; and, first of all, with regard to the navigation of Hudson Strait and Bay. The ice has hitherto been supposed to be the most formidable barrier to the navigation of these waters, but Lieutenant Gordon assures us that under investigation its terror very largely disappears. The ice met with during the cruise of the Neptune could be divided into three classes—each class having a distinctly separate origin—namely, icebergs from the glaciers of Fox Channel, heavy Arctic ice from the channel itself, and ordinary field-ice, being that formed on the shores of the bay and strait. No icebergs were encountered in Hudson Bay, nor were any reported as having been seen there in the past; but in the strait a good many were seen, principally along the northern shore, where a number were stranded in the coves, while others were met with in mid-channel. Of those seen in the eastern end of the strait, some had undoubtedly come in from Davis Strait, passing between Resolution Island and East Bluff; but all of those met to the westward had come from Fox Channel, as observations made by the observer at North Bluff show that an iceberg coming in sight from the westward will pass out of view to the eastward in from three to four tides, showing an easterly set of upward of ten miles a day. In Lieutenant Gordon's opinion, the icebergs seen in Hudson Strait during August and September would form no greater barriers to navigation than do those met with off the Strait of Belle Isle, nor were they more numerous in the former than they frequently are in the latter waters. The field-ice encountered, although it would have compelled an ordinary iron steamer to go dead-slow, gave no trouble to the Neptune, the vessel running at full speed between the pans, and rarely touching one of them.

In the harbor at Ashe Inlet the ice came in with the flood-tide, and set so fast that the Eskimos were able to walk off to the ship, although she was at least three quarters of a mile from the shore. On the south shore, also, it was much the same; but still no ice was met with through which the steamer could not easily and safely force her way. In the center of the strait, to the east of North Bluff, no field-ice was seen at all, while between Stupart Bay and Salisbury Island long strings of ice were frequently seen; but, as their direction was invariably parallel to the vessel's course, it was only necessary to coast round them. On the homeward voyage none of this field-ice was seen at all. It is a point of no small significance that, upon the testimony of the Eskimos, both at Ashe Inlet and Stupart Bay, the quantity of ice in the strait had been very unusual that year, and the ice had never been known to hang to the shores so late in the season.

After passing the east end of Salisbury Island the ice got heavier and closer, and when off Nottingham Island the pack was so run together that no attempt was made to force the ship through it. Viewed from a hill on Nottingham, the sea in every direction seemed one vast ice-field, in which four vessels could be noted fast prisoners. This ice was of an altogether different type to that which had been hitherto met. In some cases there were sheets of solid blue ice not less than forty feet in thickness, not a mere aggregation of field-ice, but evidently frozen just as it stood. In other places the thickness would be twenty feet, and the general average of the whole field at least five feet. Now, the question as to the origin of this ice, and whether it will be frequently met with in the strait, is one of paramount importance. Lieutenant Gordon does not consider it possible for ice to form in Fox Channel to a greater thickness than ten feet in a single year, and consequently feels convinced that much of the ice encountered was the accumulation of several years. Ice is well known to be a very poor conductor of heat, and therefore, when once a certain thickness has been formed, the subsequent rate of thickening must be very slow.

The depth to which water will freeze has never yet been determined; but measurements of the formation of ice which are to be carefully made at the observing-stations will, no doubt, materially assist in a determination of this important question.

At Churchill the harbor-ice forms, on an average, about the middle of November, and breaks up about the middle of June, and these two dates may therefore be taken as marking the extreme limits of the season during which that harbor may be used.

With regard to the time consumed in making the passage through the strait, it is necessary to note that, had the Neptune gone direct from Cape Chudleigh to Churchill, instead of coasting and working across the strait, there would have been no greater delay on account of the ice than forty-eight hours at the most; but, at the same time, no ordinary iron steamship, built as the modern freight-carrier is, could have got through the heavier ice without incurring serious risk, if not actual disaster.

There is one matter to which Lieutenant Gordon draws attention that will require the serious consideration of mariners navigating these waters, namely, that in working through the strait, especially at the western end, he found the ordinary compass so sluggish as to be practically useless. The Sir William Thomson card, however, worked admirably when properly compensated. The reason of this difficulty with the ordinary compass is that, from the proximity to the magnetic pole, the horizontal directive force of the earth's magnetism, which alone directly affects the compass-needle, is very small compared with the whole magnetic force, and consequently the effect of induced magnetism in the iron of the ship on the compass becomes very large in comparison with the direct action above mentioned, the result being that, in an imperfectly compensated compass, the error due to local attraction is very greatly increased. The means of correcting this error in the Sir William Thomson binnacle are perfect and easily mastered, and the system is such that the compass can, after the first voyage or two, be perfectly compensated by using certain proportions of soft-iron bars and magnets as correctors, the proportion having to be determined by actual observation and experiment on the voyage. All steamships making the voyage through the strait, Lieutenant Gordon therefore concludes, should have one of these compasses as a standard, and the captains should familiarize themselves with the methods of correcting them, and, as opportunity offers, take azimuth observations, both stellar and solar.

Great caution will have to be observed by all vessels approaching the strait in thick weather, owing to the strong southward current there prevailing, which, during the forty-eight hours the Neptune was lying-to, swept her forty miles out of her course by dead-reckoning, showing that the amount of southerly set exceeds that indicated by the Admiralty directions. Then, again, the tides rise to a considerable height, as much as thirty-two feet at springs in some places, and in their fluctuations create tide-races, which have to be taken into consideration and carefully allowed for. Thus at the entrance to Churchill there is a tide-race, the velocity of which was estimated to be not less than seven knots.

In the matter of weather, Hudson Strait would seem to compare very favorably with that great highway of commerce, the Strait of Belle Isle, as the following table, which is for the month of August, clearly indicates :

	Belle Isle Strait.	Hudson Strait.
Number of days on which fog is recorded	13	9
Approximate number of hours of fog	220	102
Days on which snow fell	0	4
Days on which rain fell	10	8
Days on which wind exceeded twenty-five miles per hour, but did not reach forty	6	5
Days on which wind exceeded forty miles	2	1

This is a very favorable showing for Hudson Strait, and it is strengthened by the annexed table, affording a comparison between Station No. 1 at Cape Chudleigh and Belle Isle. This table covers the month of September :

	Belle Isle Strait.	Hudson Strait.
Number of days on which fog is recorded	7	4
Approximate number of hours of fog	82	34
Days on which snow fell	3	8
Days on which rain fell	15	6
Days on which velocity of wind was between twenty-five and forty miles per hour	4	5
Days on which velocity of wind was forty miles or over per hour	11	3

So far as weather is concerned, therefore, Hudson Strait enjoys a decided advantage over Belle Isle Strait, and on that ground, at all events, presents no difficulties of such a character that they can not readily be overcome by experienced, careful navigators.

Those portions of Lieutenant Gordon's report which deal with the resources and trade of the region he visited, interesting and important as they are, must be passed over for the present, while we hasten on to what he has to say concerning its natural history. Before doing so, however, it is worth noting that, although Hudson Bay belongs to Canada, its whale and walrus fisheries have been hitherto enjoyed by the Americans altogether, and the fur-trade has been entirely monopolized by the Hudson Bay Company, so that the Dominion practically obtains no benefit from these vast possessions whatever. Lieutenant Gordon accordingly, very properly, presses upon the Government of Canada the necessity of their turning their attention to this unaccountably neglected field for enterprise and investment, and especially of seeing that its treasures are not prematurely exhausted, but so preserved as to be a permanent source of revenue and profit.

We come now to Lieutenant Gordon's observations upon the natural history of the country, and first of all as to its human inhabitants. These are very scanty, and, with the exception of a few white men at the traders' posts, are solely Eskimos. On the north side of the strait they are quite familiar with the ways of white men, and seem to be highly pleased at the prospect of increased intercourse with them. Occasionally one is met with who has mastered the English tongue, but not often. Many others understand well enough what is said to them in that language, although they can not be persuaded to speak it. They are particularly fond of any article of civilized clothing, and the head-man at North Bluff manifested no small pride at the possession of a stand-up linen collar, which he displayed to the utmost advantage. In character they are docile, amiable, and willing to work. When landing the stores and coal at North Bluff they worked all day along with the men, carrying heavy weights up over the rocks, and toiling away as cheerily and heartily as could be desired, asking no other remuneration than biscuits, of which commodity they are inordinately fond. These people have no farinaceous food of any kind, and, as a consequence, the children are not weaned until they reach the age of three or four years. The families are small, there rarely being more than two or three children, and, although early marriages are the rule, their numbers must be diminishing, because signs of their presence were met with everywhere, while the people themselves were found at only three places along the straits, and there are only some five or six families known to be between Cape Chudleigh and Nachvak. Along the Labrador coast the Eskimos gather in small settlements around the Moravian mission-stations. Nain is considered the largest settlement, and its Eskimo population does not exceed two hundred souls. Those at the stations are all educated, being able to read and write in their own language, and, according to the missionaries, are regular attendants at church, and very fond of music—two excellent and hopeful traits certainly.

Practical prohibition prevails, thanks to the vigilance of the missionaries, and the only liability to temptation that ever falls in the way of an Eskimo is when some unprincipled Newfoundland fisherman offers him a pull out of his flask. This, however, is a rare occurrence, and there is no record of any disturbance or trouble ever having been raised that would elsewhere demand the presence of a policeman for its quelling. The missions are so well managed as to be self-supporting, the *modus operandi* being for the missionaries to supply the Eskimos on loan with the very best traps, fishing-lines, and other gear, and then to purchase from them all their catch, whether it be seals, cod, salmon, furs, or anything else. A vessel which comes out from

London every year transports the stock thus accumulated to London, where it is sold for the benefit of the mission, and in this way a considerable income is secured annually. In reference to the work thus carried on by the missionaries, Lieutenant Gordon pays them a well-deserved compliment by giving it as his opinion that their system of dealing with the natives, when honorably carried out, as it has been, and is on the Labrador coast, is the one which best meets the wants of the natives, and tends to the improvement of their condition.

So much has been said by Arctic explorers about the incorrigible kleptomania of the natives they encountered, that we read with no less surprise than gratification this testimony as to the moral condition of the Eskimos at Hudson Strait: "One word may be said in regard to their honesty. Although scraps of iron and wood possess a value to them which we can hardly appreciate, they would take nothing without first asking permission; not even a chip or broken nail was taken without their first coming to the officer who was on duty at the building for permission to take it."

In the matter of animals, the Hudson Bay region is quite as scantily supplied as it is in human inhabitants, the list of terrestrial mammalia comprising only four species, namely, the polar bear, the fox, the hare, and the reindeer. The skin of the polar bear is quite valuable, a good one bringing twelve dollars with the agents of the Hudson Bay Company. These animals, although reported by the Eskimos to be very savage, will not, as a rule, attack human beings unless first wounded or rendered desperate by hunger, under which circumstances any beast of prey becomes an undesirable neighbor. The Eskimos on the south side of the strait stated that, at certain times of the year, there were large numbers of these animals seen. Their meat is not unpalatable, but the liver is said to be poisonous. Of foxes there are three kinds found, to wit, the white, the blue, and the red. The white species would seem to be very numerous, judging from the number of skins seen with the natives. These skins, however, have no commercial value. The blue fox is properly of a steel-gray color. The skins are in good demand; but the animals are not at all numerous. As to the red fox, its sole value consists in the fact that its presence indicates the possibility of that most precious of all pelts—a black fox's—being somewhere in the vicinity. This species is met with on the south side of the strait, and black foxes are annually shot or trapped in the country south of Cape Chudleigh. The most important and beneficent of all the animals of the country, however, is the reindeer, which furnishes food and clothing, and much more, too, for its Eskimo master. The hare is common over the whole coast, and with game-birds of many kinds—geese, swans, duck, and ptarmigan—will no doubt furnish many a toothsome dish for the tables of the men at the various stations.

Having thus traversed the whole ground sought to be covered by the expedition, Lieutenant Gordon brings his admirable report to a close with some suggestions to the Government as to what should be done during the coming season. While much, no doubt, will be learned from the observations taken during this winter as to the formation and breaking up of the ice and generally in regard to its movements, and also of the other phenomena affecting navigation, it would be manifestly impossible to state definitively from one year's observations what the average period of the navigability of the strait might be. In order to do this, the stations should be maintained for a second or even a third year.

The question, therefore, as to whether the navigable season of the strait is sufficiently long to permit of an extensive commerce growing up and being profitably maintained, remains still an open one, and must do so for perhaps a year or two more. Yet, in view of what has been already ascertained, it certainly seems as if the probabilities were all in favor of the Hudson Bay route being found practicable, and pressed into the world's service at no very distant day.

The era of sailing-vessels is rapidly passing away. The freight-carriers between the continents will ere long be exclusively steamships, and to steamships properly adapted for the work the passage of Hudson Strait has been clearly shown to be perfectly feasible and free from danger. The matter has resolved itself down to this single point: For how many months may a steamship navigate those waters? And even if the answer, deduced from the observations taken at the stations now established, be that these months are too few to make the route pay, Lieutenant Gordon's expedition will not have been undertaken in vain, for it has thrown a flood of light upon a region hitherto comparatively unknown, and has opened Canadian eyes to the fact that here, right in the heart of their own territory, they possess sources of wealth, both in the seas and on the land, requiring nothing but a little enterprise and capital to yield the most satisfactory returns. In the bay and adjacent waters the whale, porpoise, walrus, narwhal, seal, salmon, trout, and cod are ready at the summons of hook and harpoon to make substantial contribution to the national wealth. Upon the shore and throughout the islands minerals without number and forests without limit await the lumberman and the miner.

THE WAYS OF MONKEYS.

By Dr. ALFRED E. BREHM.

SHEIK KEMAL EDIN DEMIRI, who died about A. D. 1405, and was the author of a voluminous treatise on the life of animals, relates the following story as a fact: "The inhabitants of a town called Olila, on the shore of the Red Sea, were in olden times metamorphosed into monkeys, in punishment for their wickedness. They had broken the Sabbath by fishing. Some of their pious fellow-citizens endeavored in vain to convey them back into the path of virtue; and, finally, when all admonitions proved useless, left the town. Returning to their homes three days later, they found, instead of their neighbors, baboons, which met them looking sorrowfully, and expressing by signs and attitude that they recognized the friends whose advice they had scorned with so dreadful a result. In his anger, Allah had inflicted a terrible sentence upon them." The writer carefully insists on the circumstance that the culprits were Jews.

The Prophet and his followers admit this metamorphosis by God's special intervention as a fact, and this fully explains the prominent part assigned to apes in all Arabic fables and tales. The early Egyptians believed religiously that some groups of monkeys were experts in writing, and, by that fact alone, equal if not superior to mankind in general. A number of apes were consequently sheltered and fed in the temples, worshiped during life, and embalmed after death. Those privileged specimens of the four-handed tribe, when first introduced into the temple, were handed a slate and pencil by the chief-priest, and humbly requested to show their right to admission into the sacred asylum by writing. The gamboling and grinning candidates wrote, and nobody ever doubted that the figures traced by their agile hands fully deserved to be classed in the category of hieroglyphs. So highly were they held in respect and veneration, that the holy Sphinx was represented with their hair-dress, and, till to-day, men and women in the country of the Mahdi give their hair the same shape. But the Egyptians never admitted that the priests or Pharaohs were the descendants of monkeys, while, on the contrary, the Hindoos built houses and temples to shelter and worship apes, and venerated the princes of their country as the direct offspring of the holy animals. The Arabs regard the latter as "the descendants of the wicked, to whom nothing is sacred, nothing respectable, nothing too good or too bad; who never feel friendly dispositions for other creatures of the Lord, and are damned by Allah, and carry the likeness of the devil and of man combined on their ill-shaped bodies."

We, the sons of civilization, agree up to a certain point with the Arabs. We also—at least that portion of modern society who have not been given an education or an overtraining in physical science—decline to see in apes anything more than caricatures of ourselves, and repudiate with much aversion the inferences drawn from Darwin's theory. On the other side, highly educated men all over the world have opened the discussion of the relationship between man and monkey, and speaking about the latter nowadays has become a dangerous task, in so far as there is but one alternative left—to offend the ancestry or the offspring! For my own part, I feel no hesitation in approaching the question of relationship to examine its value, and in trying to illustrate the life of that pretended cousin of ours.

The apes have established their homes in every continent, Australia excepted. Warmth seems to be one of the principal conditions of their existence, as they are only found in the warmer regions. In America they are spread from 26° south to Mexico; in Asia, from the Sunda Islands to the Japanese Sea. In Europe there exists but one species of monkeys, and its members live all together in one troop on the rocks of the fort of Gibraltar, under the special care and protection of the garrison. That troop numbered in all twenty-three individuals when I visited Gibraltar in 1881.

The principal thing the monkeys claim from a country, whose clime they are enjoying otherwise, is food, plenty of varied food; and this fact fully explains the predilection they have always shown for places where pious superstition provides for their wants and makes their life comfortable.

Among other mammifers the female element wields the scepter in family life, but in the realm of apes the male is invested with the sovereign power, not by general suffrage, but by the right of force. The oldest and strongest male of a troop proclaims himself chief and leader, after having vanquished all his competitors, viz., the rest of the senior males. The longest teeth and the strongest arms decide in the question of supremacy. All those who show some reluctance to submit are chastised till they come to political reason. To the strongest belongs the crown; in his sharp teeth resides his wisdom.

This ferocious tyrant understands his duty as a leader, and performs the same with dignity. His subordinates flatter and fondle him in every way; the ladies of his harem rival in keeping his dress clean from annoying parasites. As a genuine pasha, he accepts this respect with a kind of languid acquiescence. In return, he watches carefully over his vassals, and shows a continual anxiety for their welfare and security. He orders and directs minute details in daily life, and subdues all opposition—for there exists a Left also in the monkey state—by striking and sharp bodily argumentation. As a general rule, the monkeys go early to bed, rise late, and establish their night encampment on the summit of rocks, if possible. The first thing they do in the morning is to warm themselves, for which purpose they climb to the tops of rocks and trees and turn slowly around in the sun till their hair, wetted by the nightly dew, is entirely dry. This preliminary operation is followed by a thorough cleansing of the skin, and, immediately after, by breakfast. Every eatable thing suits monkeys—fruits, onions, roots, seeds, nuts, leaves, insects, eggs, young birds, snails—and they enjoy generally a copious, free board. Their notions concerning property are very defective. "We plant and the apes harvest," says the Arab of Eastern Soudan, with his natural apathy in the presence of facts and events that he can not prevent. Does not the monkey show in this a pronounced analogy with mankind who, since the existence of the world, though under severe penal legislation, find it so hard a task to observe the difference between mine and thine ?

The hungry crowd of quadrumana infest fields and gardens : neither lock nor bolt, neither fence nor wall is an obstacle for those robbers, who steal and destroy everything in their way, whether it be eatable or not. It is not surprising, to any one who has witnessed such depredations, to see the farmers entertain a mortal hatred against these dark, grinning thieves ; and the Arabs range them in the category of evil spirits. When they are surprised in their mischievous work, they flee like cowards toward the nearest trees or rocks, the mothers carrying their children. Only when flight is impossible do they show fight, and attack men as well as the biggest beasts of prey, and even elephants, with that impetuous temerity which distinguishes the coward in despair.

After a gestation of from seven to nine months, the female monkey gives birth to one young one, very seldom to twins. The new-born monkey is a little ugly creature, bare of hairs, with spindling limbs and a repulsive, senile face. But the mother is passionately fond of her monster, and caresses and nurses it with remarkable devotion. She does not leave it for a single moment, she presses it to her heart, rocks it to and fro, and takes the utmost care to keep it absolutely clean. In the first period of life the baby is apathetic and almost insensible, but begins gradually to play with urchins of its age. The mother is a patient observer of the first steps of her beloved, and watches carefully that no harm may befall it. In the mean time, she trains it ; and the first virtue inculcated in the mind of the youngster is obedience, obedience in the strictest sense of the word. Men have ridiculed the maternal affection of the brute, and speak of "apish love." In our eyes the tenderness exhibited by the monkey may have a ridiculous side, but where is the man who could, without deep emotion, witness the anxiety of a mother-ape nursing her sick child ? I must confess that, to my eye, in such cases she is at least the equal of the human mother. If the young ape dies, the spectacle is a piteous one. The mother can not be separated from the dead body, refuses all food, and frequently perishes from grief. In such crises the ape proves certainly his congeniality with the human race, and in his moral affections could stand as an example to many men.

The intellectual cultivation of which the monkeys are susceptible neither raises them so high above the average of mammifers, nor places them so far beneath the level of mankind, as some people contend. Further on, we find in no order of animals, as far as intellect is concerned, so wide a difference between the highest and the lowest individuals as among the monkeys, while, in inverse proportion, the lowest-gifted human creature hardly differs from the apes whose intelligence is most developed. In many instances the mental and bodily likeness to humanity is so pronounced that the observer feels quite uncomfortable in presence of the evidently small chasm existing between man and beast.

After this general characterization of the whole species, I may be allowed to trace in large outlines the families and some of their principal representatives. Science establishes two families, the *monkeys of the Old World* and *the monkeys of the New World*, and divides the latter into two sub-families, viz., the *claw* or *squirrel apes* and the *howling monkeys*, or scientifically, the *Ouistitis* and the *Alouattes*. The home of the ouistitis extends from Mexico to Brazil. The squirrel-apes are not yet perfect monkeys, though having the same number of identically shaped teeth as the monkeys of the Old World. Their limbs end in true paws, bearing narrow, compressed, and sharp-pointed nails on the four fingers ; the thumbs alone are provided with flat, large nails like human nails. They are the representatives of the transition from the unguiculated quadrupeds to the quadrumana, and rank, physically and intellectually, far below the genuine monkey with heraldic quarters. The easy, bold, and graceful movements of the latter in climbing, jumping, walking, and resting, are above their reach, and in the line of bodily abilities they hardly attain to their model, the squirrel. No one ever saw them walking in erect posture, and they always step on the full flat sole, contrary to the real monkeys, whose feet rest on the outer edge only. The cry of the squirrel-ape sounds like the whistle of mice or the pip of young birds, and its wit does not, by any means, reach the level of the genuine ape. A notorious coward, it shows all the coward's distinctive attributes—a plaintive voice, inability to submit to unavoidable facts and events, and the endeavor to swagger, even in the moment of flight.

The first rank in the family of the apes of the New World belongs incontestably to the howling monkey. Its body is slender, its limbs are proportionately developed, its hands end in five fingers, and each finger shows flat, slightly convex nails. The fur is coarse, and the hair under the chin forms a kind of long, protruding beard. A distinctive feature is to be found in a kind of bony, sixfold drum or barrel formed by an inflation of the hyoid bone, which communicates with the larynx, and gives to the voice an enormous volume and frightful sound. Hence the name of howling monkeys. The long tail is naked, callous, and of great muscular strength at its extremity, and forms a convenient prehensile organ, which might be called a kind of fifth hand, or rather the principal hand of the animal. The alouattes are not poor climbers, but they never take bold jumps, and always keep their hold by the tail till their hands have grasped the next limb, and this makes them slaves to the trees. They seldom venture upon the ground or on rocks. The howling monkeys herd in troops and follow slowly and awkwardly in the steps of their leader, whose slightest movements are imitated by every individual. There is no character in their voice nor in their general behavior: they act like automata and yell and howl like maniacs. In the morning, when all the rest of nature is rejoicing in the new-born daylight, the troop of howling monkeys will descend gravely from the leafy tree where they have passed the night, closely gather in a huddled crowd, and, having secured some breakfast, will proceed to indulge in a kind of social entertainment which is as exempt from frivolity and impropriety as it well can be, but which well reflects the character of the participants. The company make choice of some leafless tree, which they climb with great dignity. Each member takes his place as he pleases, but one large bough is reserved for the exclusive use of the leader, who paces it to and fro, solemnly raising his tail, and begins to utter low sounds, similar to the grunt of a young hog. The prelude grows insensibly louder, the time is quickened, after a few moments the pauses are omitted, and the wretched tune, sinister at first, becomes an uninterrupted, dreadful yelling. Now the crew are thrown into raptures, and all join in one deafening cry and howl in concert. The powerful roar of the jaguar, the terrific growling of the panther, the wild shouting of a crowd of beastly, drunken rustics, lamentations, groans, seem to be combined in this chorus. And, curiously, the artists have no idea of expressing any special feeling. Such entertainments sometimes last several hours. Those long-tailed howlers are tiresome creatures, and I must confess that, in the matter of apes, the Old World takes the lead. Here, also, we find two sub-families—the *Cynopithecini* (dog-apes) and the *Anthropomorpha* (man-shaped apes). The former have perfectly developed teeth, like the quadrupeds, and a tail; the *Anthropomorpha*, on the contrary, have no tail, and their set of teeth resembles that of men, with the exception of the canine teeth, which are stronger and intermediate between those of beast and man.

The *Cynopithecini* present almost all the features in character which distinguish monkeys in general. The leadership is intrusted to the strongest male; he assigns to each member of the troop his duties, and watches for the general welfare. Their well-shaped hands give to these monkeys advantages which other animals do not enjoy, but still it is a question whether the dog could not in justice be placed on the same level with them as regards intelligence and sagacity. Apes and dogs show discernment and exercise restraint on their manner of living; both are aware that every disorderly act on their side is followed by punishment, but the apes believe themselves far above the dogs. Excessively susceptible to reproaches, they want to be praised and fondled, while they themselves tease and insult other animals at every opportunity. They are docile, they eat with knife and fork, drink from the glass, dress, ride on horseback, submit to military drilling, wait on their masters, but only when, where, and as long as they are pleased, and never with the same care and conscientiousness that characterize a well-trained dog. There is no troop in the world so hard to manage as a troop of these monkeys, which peculiarity brings them near the hopeful youth of modern age. Another proof of their superior intellect may be found in the fact that they avail themselves of the means afforded by others to make their life as comfortable as possible.

I had often seen and closely observed individual baboons in captivity, but had never had a chance to meet those interesting animals living the life of liberty in organized troops. That pleasure was in store for me one morning, in the year 1862. I was traveling in Bogosland at the time. On the morning in question I found myself separated for a while from my companions, and had just sat down to take a short rest when I heard a kind of strange barking, coming from a steep cluster of rocks in the vicinity. Some minutes before my attention had been aroused by a number of curiously shaped forms on the summit of the rocks, but I came to the conclusion that they were large blocks of stone. The barking disabused me, inasmuch as the forms, true and genuine baboons, were now starting up. Considering the shouting of the animals as a personal provocation, I hurried up the hill and fired a shot at the troop, which at once took to their heels and were soon out of sight. About half an hour later, after I had joined my friends, we saw the same troop in file on a narrow bridge running at considerable height along a rocky wall. Another gunshot made them disappear once more, but a short distance farther, where the valley turned at a sharp angle, we met them just at the moment when they were crossing to reach the opposite hills. Our hounds, though trained to hunt hyenas, hesitated in bewilderment, but soon gave tongue and made an impetuous rush at the monkeys. At once the old males rallied and faced the dogs, forming a wide semicircle, roaring, grinning, and furiously beating the ground with their hands. Their threatening attitude and spiteful glances frightened the hounds, which recoiled in amazement. The monkeys took advantage of this momentary failure of our animals and retreated in haste. When the latter were rallied and started for a fresh attack, there were only a few more in the valley, and the last of the stragglers was a pug of about six months, which retreated in agonizing terror to the top of a large block of stone where the hounds set it. "That pug will be ours," I shouted, but was thoroughly mistaken. One of the senior males, a strong, powerful individual, started from the other side of the valley, advanced quietly toward the block, pride and mischief shining in his eyes, marched straight to the hounds, which trembled under his vicious glances and threatening gesticulations, climbed the stone, fondled the young one, put it on his back and calmly returned, while we were standing there all startled. Similar acts of self-exposure of a male are only found among monkeys, while among all the other animals, even the lions, it is always the female which risks life to save her cub.

Some time afterward I crossed the same valley in company with

Duke Ernst, of Coburg-Gotha, and near the same place we met the troop moving half-way up on the rocky slope of the hill. On the duke's motion, we resolved to offer them fight. Seven men, armed with patent rifles, opened the attack. At the first volley the females took to flight with the young ones, while the males not only did not flee, but advanced, and in less than no time a formidable hail of stones whistled around our heads. Some of the stones thrown were as large as a man's head. It was full time for us to withdraw, and so we did. The monkeys remained the masters of the battle-field.

On my second voyage to Eastern Soudan we stopped in Khartoum during the rainy season. I suffered much, even more than I am suffering here in New York, from fever and chills. In the long, tedious hours of leisure we made a collection of monkeys, and those animals cheered me up many a time in my physical and mental troubles. We played with them, and at the same time undertook their training, and that in a fashionable manner. So we gave them riding-lessons. An old, fat, lazy donkey had the honor to serve as horse, and, although the apes showed disgust and fear at first, one single lesson was sufficient to initiate them into the secrets of the noble sport, and in a few days they were, in their way, masters in the art. They would mount the donkey three, four, and five at a time, the first one embracing fondly the neck of the trotter with the fore-hands and cramping his hind-hands convulsively in the pelt of the animal's abdomen; the next one taking hold of his comrade, and securing his equilibrium in the same way by means of the hind-hands; and so on in a file. A funnier sight than this, four or five grinning apes closely nestled to the donkey's back, can hardly be imagined. The gray-haired trotter sometimes had to suffer from the mischievous riders, and did not conceal his feelings, to the great amusement of his tormentors. Besides playing, the monkeys were instructed in many little arts and tricks, and on that occasion I learned to appreciate them as smart and most sagacious creatures.

But passion makes them blind—unlike men, as it is said by the monkey-haters—as if men always kept quiet, composed, even-minded, and sober! As well as the apes in general, our baboons were passionately fond of strong liquors, and had a peculiar propensity for merisa, a kind of beer made of the grains of durrah by the inhabitants of the Soudan. Brandy was not to their taste, but, unfortunately, they made an exception one day. After having swallowed copious quantities of merisa, each one of the troop was offered a big glass of date-brandy, which he drank. As a consequence they became completely intoxicated, insolent, passionate, bestial, and grinned and gamboled in a fearful manner; in one word, they offered the hideous caricature of drunken men. The next day thirteen of the drunkards were suffering from the consequences of the spree, and looked sick unto death. All food gave them nausea; they turned away with disgust from merisa and even from wine, a favorite beverage in ordinary time; the only things they accepted were lemons, of which each one ate an average of twenty pieces. In this wretched state they comported themselves like men, and would, doubtless, have enjoyed a sour herring if it had been possible to secure this antidote in the country of the Mahdi. In the evening they felt better, and were all right the next morning. I hoped this hard lesson would teach my pupils the advantages of abstinence, but, alas! I was mistaken once more in my life. They drank and reveled all the same, and from that day drank brandy with predilection. More than that, they claimed their rum every day as a privilege.

I took one of these baboons—it was a female—along to my home in Germany, because she had always proved to be of extraordinary sagacity, and actually exhibited a far greater intelligence than the average of the countrywomen of Thuringia, where I was living. Apes in general like other creatures, provided they submit to their caressing and fondling. My baboon at first concentrated her tenderness upon the children of the village, but, to her great sorrow, found no reciprocity. Then she turned to cats and dogs, and teased and tormented them in every way. A bright pussy, which the most of the time she carried in her arms, was tired one day of her company and attempted to escape. The ape strongly objected, and the kitten, in its struggles, scratched her in the shoulder. Gravely the baboon seized one of the paws of her pet, examined it carefully, and finding, probably, the sharp claws a dangerous superfluity in so small a being, bit them all off, one by one. We sometimes tried a practical joke on her by putting a little powder near the place where she was secured during part of the day, and flashing it by means of burning spunk. When the powder flashed, she screamed and jumped back as far as her chain permitted it. But she had very early found out the connection of things; the next time we threw the burning spunk near the powder, she rushed forward, extinguished it, and quietly ate the explosive, which she probably relished on account of its saltpetrous taste.

The aptitude of the *Cynopithecini* to distinguish between cause and effect is really remarkable. They are aware when they have done wrong, and expect punishment. An old *crowned guenon*, also called *Chinese bonnet*, living in captivity, once assaulted its attendant, lacerated his arm, and cut an artery. The animal being an old offender, the master ordered it to be shot. When the man charged with carrying out the order approached the cage of the ape, the latter, apprehending his fate, retreated to the adjoining shanty serving as bedroom, which communicated with the cage by a door. Neither flatteries nor tempting titbits could move him to come out from there. The man then had dinner brought and placed in the front cage as usual, and walked off. As soon as he was out of sight, the monkey cautiously crawled out, took part of the food, and jumped back to his hiding-place. He went a second time, but found his retreat cut off, the door between the cage and the shanty having been shut. Seeing at the same moment the attendant armed with the dreadful gun reappear, the monkey understood at once that he was lost, jumped furiously at the closed door, tried to escape through every corner, and, finding that flight was impossible, lay down trembling, and awaited the deadly bullet.

The ape holds himself far above the other animals, and endeavors to make them understand it. My baboon showed her superior standing by tormenting every other animal in the house without any reason or the slightest provocation. I had an old dog whose temper had been spoiled by age, and which lived in open war with every creature in the house. My baboon picked it out as an object for her tricks. When the dog was taking its *siesta*, the ape would crawl cautiously near, seize the animal by the tail, and, jumping back, give it an awful jerk. The dog, roused from slumber, flew into a violent passion, and went howling and barking for the ape, who quietly watched him, and aggravated his excitement by patting the floor with her hands. As soon as the dog was near enough to reach her, she made a jump upon his back, and again squeezed his tail. These successive insults made the dog nearly frantic ; he foamed and howled, but, the more excited he grew, the worse the monkey tormented him. Finally, the old hypochondriac, seeing the uselessness of trying to chastise the foe of his rest, marched off with his tail between his legs whenever the monkey showed her face.

The sagacity and docility of the *Cynopithecini*, wonderful as they are, can not be compared with the intelligence of the *Anthropomorpha*, especially the chimpanzee, the gorilla, the orang-outang, and others. I have closely observed several individuals of the family, allowed them to play with my children, and cared for their training and education, and have drawn astonishing results from my studies. These monkeys are creatures which one treats involuntarily like men, or at least like children. The orang-outangs are melancholic and not very sympathetic with men ; the variety of the pongos, to which the chimpanzee belongs, is jovial and by far the most intelligent. Their voice is pure and plain, and, while it can not be denied that the voice of the gibbons sounds more melodious and constitutes a veritable song, that of the chimpanzee is a formal language. All the sounds are fully accentuated, and the observer soon understands the meaning of the different modulations, while children, playing with the animal, catch at once the sense of its utterances.

It is really impossible to treat the chimpanzee like an animal ; his character and general behavior show so much of humanity that men are induced to commune with him in the same way as with their equals. In captivity he is perfectly conscious of his position, and subordinates himself willingly to the superior mental gifts and capacities of mankind, but holds himself better and higher than other animals, especially than other monkeys. Paying in every instance high regard to men, he likes children if they do not tease and molest him. Sportive and humorous, he indulges in joking with men and animals. He is not only inquisitive but eager to acquire knowledge, examines carefully things strange to him, and falls into ecstasy when he has found out their purpose and learned to use them in the right way. While able to understand men and things, he is, nevertheless, modest and kindly, seldom willful, and never stubborn, although he claims what is in right due to him. Of variable temper, he is now good-humored and jolly, now sad and morose, and gives vent to his feelings as men do, but sometimes in a more passionate way.

I was once the owner of a highly educated chimpanzee. He knew all the friends of the house, all our acquaintances, and distinguished them readily from strangers. Every one treating him kindly he looked upon as a personal friend. He never felt more comfortable than when he was admitted to the family circle and allowed to move freely around, and open and shut doors, while his joy was boundless when he was assigned a place at the common table, and the guests admired his natural wit and practical jokes. He expressed his satisfaction and thanks to them by drumming furiously on the table. In his numerous moments of leisure his favorite occupation consisted in investigating carefully every object in his reach: he lowered the door of the stove for the purpose of watching the fire, opened drawers, rummaged boxes and trunks and played with their contents, provided the latter did not look suspicious to him. How easily suspicion was aroused in his mind might be illustrated by the fact that, as long as he lived, he shrank with terror from every common rubber-ball. Obedience to my orders and attachment to my person, and to everybody caring for him, were among his cardinal virtues, and he bored me with his persistent wishes to accompany me. He knew perfectly his time for retiring, and was happy when some one of us carried him to the bedroom like a baby. As soon as the light was put out he would jump into the bed and cover himself, because he was afraid of the darkness. His favorite meal was supper with tea, which he was very fond of, provided it was largely sweetened and mixed with rum. He sipped it from the cup, and ate the dipped bread-slices with a spoon, having been taught not to use the fingers in eating; he poured his wine from the bottle and drank it from the glass. A man could hardly behave himself more gentlemanlike at table than did that monkey.

He was especially engaging in his association with my children, always gentle, obliging, and tender, and they liked him as a good fellow and pretty playmate. When he was first introduced to my little girl, who was then six months old, he seemed perplexed, and observed her with astonishment, as if speculating whether that little bit of a creature was really a human being. At last his mind was made up ; he touched her cheek with one finger and then offered her his hand in friendship. My chimpanzee conversed very little with other animals ; like the apes in general, he was afraid of the big ones and despised the smaller ones. He was always around us, and we, on our side, did not make any difference between him and a man.

The animal fell ill of mumps, followed by pneumonia. I had seen many sick chimpanzees, but never one of them behaved as he did. I engaged two competent physicians to take charge of him. He knew them from the first day, allowed them to feel his pulse, showed his tongue, and directed the hand of the attendant doctor to the painful swelling, which had to be cut open afterward, there being danger of suffocation. The doctors would not use chloroform, out of regard to the affection of the lungs ; but, fearing the chimpanzee would not keep quiet during the operation, engaged four strong men to hold him. The sick animal did not submit to that rough treatment, but excitedly pushed the men aside, and then, without any compulsion whatever, but in compliance with the fondling words of his nurse, in whose lap he was sitting, offered his throat. The operation was performed, the ape never flinching or complaining. He felt afterward much relieved, and expressed his gratitude by pressing fervently the hands of the physicians and kissing his nurse. But his life was not spared ; he died from pneumonia. Meekly and patiently he bore his long agony and died more like a man than an animal. The doctor told me that never in his life, at any death-bed, had he felt an emotion similar to that which seized him at the humble couch of the poor monkey. In Berlin, many beautiful eyes shed tears when the news of the sad end of my widely known and generally petted chimpanzee was spread.

Was the ancestor of the human race a monkey ? That is the vexed question which still raises so much dust.

There is no doubt that man is not more and not less than the chief creature in the animal kingdom, and that the monkeys are his immediate neighbors ; but I can not see why this fact should logically involve the assumption that our great-great-uncles were gamboling in paradise in the shape of apes. The doctrine of gradual evolution may seem trustworthy in the highest degree and beautiful from the scientific standpoint, but it is based upon a simple hypothesis, and a hypothesis is not a proof ; and here I wish not to be misunderstood. Even if the physical and intellectual development and perfection of humanity throughout the succession of thousands of centuries is a fact, there is no authority for the inference that, *eo ipso*, a monkey-nest was the cradle of mankind.

Darwin's treatise on the variation of species gave rise to the ardent controversy of our days. Darwin used the wrong word. It is not "species" he ought to have said, but "varieties" ; for species never interbreed with each other. Man and monkey, though belonging to the same group, represent two distinct species. There is, consequently, a simple and irrefragable natural law refuting peremptorily the thesis of the enthusiastic propugnators of the pedigree rooting somewhere amid a grinning tribe gamboling in the wild forests of Asia or Africa. The criterion that the human race has large, round hands and blunt canine teeth would be sufficient of itself to establish the truth that no monkey-blood is pulsating in our veins; but there are more distinctive features. Men have strong, well-shaped legs, walk constantly in an erect posture, and enjoy the faculty of speech.

The monkeys rank near humanity in the general organization of the world; they show in many instances much likeness with mankind, physically as well as intellectually. But a further concession would be a denial of positive natural laws. Nay! old Adam was not a monkey, not a baboon, not even a chimpanzee!

MOTHS AND MOTH-CATCHERS.

By AUGUSTUS R. GROTE, A.M.

I.

ONE day, in the British Museum, while waiting a moment in a room where entomological specimens were exhibited, I saw two workmen bending over a case containing butterflies and moths.

"There is the Camberwell Beauty," said one, pointing out a particular example to his companion.

"Ay!" was the ejaculatory response, and the tone of that "Ay!" I am not likely to forget. It took me at once to the speaker's probably humble home, stored with treasured specimens in their boxes, pinned down low, labeled and arranged. How many hours of stormy evenings had not been pleasurably spent in sorting and debating, in setting and classifying, these downy bits of Nature's finery! From how much worse employment may not these "little beauties" have saved their owner!

There is no doubt that in England, as well as in France and Germany, the collecting of moths is a very general recreation as compared with the United States. That it is harmless is a negative praise; that a pursuit of its objects is healthful, and takes the man who works in the city out into the fresh country air, is a positive recommendation. But the labor is also instructive. Things have now changed very much since the days of Malpighi, and biology is a respected and necessary study. And throughout the world of animated beings it may be safely said that the growth and changes of life can nowhere be so easily and pleasantly observed as in the rearing of butterflies and moths from the egg. As to butterflies, it may be asserted that they are less interesting than their cousins the moths, who constitute the elder branch of the great natural group of scaly-winged insects, or *Lepidoptera,* to which both belong. The butterflies are less numerous in species, or kinds, and more uniform in habit and appearance. These gaudy and papery-winged day-flies have their own attractions and present their own scientific problems, but in number, diversity, soft and delicate colors, and patterns and unexpected modes of life, they can not hold a candle, to speak both figuratively and appositely, to the foolish but lovely moths.

First, let us assure ourselves that by moths we do not mean clothes-moths. These terrors to the housekeeper are only of two or three kinds, and of small size, belonging to the genera *Tinea* and *Tineola;* while there are over seven thousand species of North American moths already in our catalogues, from the large and gorgeous "Regal Moth" (*Citheronia regalis*) to the "Tiny Gem" (*Lithariapteryx*), of all shades of color from gray to pink, from black to yellow, all innocent of carpet- or clothes-eating in their young larval days. To some general statements as to these, the methods of hunting and preserving them, and those who carry on the fascinating pursuit, I claim the reader's indulgence for a few pages of what I shall try to make easy and instructive reading.

It is, perhaps, unnecessary to state that moths, like plants, bear, each kind, a particular double Latin or Latinized title, as *Actias luna*, the "American Moon-Moth," or "Queen of the Night." The first name is that of the genus, the second of the species. The genus is founded on certain particular points of structure, and usually embraces a number of kinds or species which share in these particular structural features. While the genus *Actias*, for instance, is known by its thinly scaled, pale-green wings, the hind pair furnished with twisted "tails," our species *luna* differs from a number of Asiatic and African species by certain marks and peculiarities of pattern and size.

These Latin names are a source of some difficulty to lay readers and to many amateurs. Some people prefer English names by which to designate their specimens, but our species have not been known for years, as have the European moths; consequently very few have received vernacular names. The "cotton-worm" (*Aletia argillacea*), and the "army-worm" (*Heliophila unipuncta*), are, indeed, two species of moths well known for their ravages in the larval state, and which are consequently provided with vernacular names by which they are distinguished. But we have no English names for the great majority of species, which are really different in kind from their transatlantic brethren.

The introduction of common names for our moths is evidently a matter not to be forced, but to be left to itself. The rule of priority, which Linnæus appointed to govern the Latin names, can not obtain here. Some of our butterflies have received several English names, as the common "milk-weed butterfly." Some of the names for moths in use in England are very pretty, such as the "Arches" and "Wainscots"; others are peculiar and less attractive, as the "Pugs" and "Lackies." English names for our moths will, it is to be hoped, gradually appear in our literature and come into general use. The vernacular names proposed in economic works, such as the reports of State entomologists, are often very ugly, and have nothing to recommend them. They are simple translations from the Latin in many cases, and are then quite often ridiculous. *Dubiosa* is translated *doubtful; fraterna, fraternal*, and so on; it is clear that the Latin names are much better than these. But see what lovely names they have in England for their moths: the "Kentish Glory," the "Peach-Blossom," the "Buff Arches," the "Common Wainscot." About the vernacular names for our moths must come the cooling touch of time; they can not be struck out in the heat which accompanies the coining of a Latin name for a new species. Around their cradle some tutelary divinity must hover; some old tale, like an ancient crone, must be its nurse; out of some melody, dedicate to fields and flowers, must the words be taken which are to serve as the title for the new-comer. Affection for the object, quite distinct from the passion of the scientist, must have its part in the English name, which should also be apposite and express the appearance or habit of the moth. One of the names proposed for a North American species, *Ommatostola Lintneri*, appears to fill these conditions—viz., the "Dune Wainscot." It is a reed-colored moth, found on the sandy ridges (dunes) near the Long Island beaches. Again, another species, vividly colored, black, pink, and yellow, is called the "Spanish moth," as it bears the Spanish colors. Its scientific name is *Euthisanotia timais*. It breeds in Florida, and comes up our Atlantic coast-line in summer, being often beaten into the lighthouses with the birds, during wind-storms, or simply attracted by their light.

Our species of moths east of the Mississippi are pretty well known, and all but the very small ones, the *Tineidæ* or leaf-miners, are described in different publications. What a change during the twenty-five years which have just passed, and which span my own career as a catcher of moths! When, a boy of fifteen, I tried to find out the names of some of our moths, I had great difficulty in ascertaining that there was such a science as entomology at all! At that time, even in Agassiz's museum, at Cambridge, there were not fifty kinds labeled which had been described and named in this country. Now we have about seven thousand names of known species in our catalogues, and from one to two hundred are being added to the list every year. Our new discoveries come chiefly from the West, where wonderfully beautiful species are "turned up." Arizona and New Mexico, as well as Colorado, seem to be perfect paradises for rare and lovely moths.

The reader will have seen that there are two kinds of names, the scientific and the common. Nothing, it seems to me, that will promote popular interest in the study should be neglected; therefore I hope that pretty English names for our moths will appear and lighten the studies of many who find Latin difficult and ugly. It must be remembered, however, that when we wish to designate a certain kind of moth with precision, we are obliged to fall back upon the Latin name, and that there is a good deal of prejudice against common names by scientists, whose opinions are worthy of respect, but whose foible it is to be very exact and precise in their statements about a moth, or any object upon which they have special information, but who are otherwise as fallible as the rest of us when it comes to matters of conduct and art.

The old saying in natural history, that everything comes from an egg, holds good for moths. Nevertheless, modern science has wrought wonderful changes in our ideas on this subject since the days of Ray and Willoughby. The young are now considered as part and parcel of the old—a continuation, to some extent, of the bodies of their parents, whether we consider a moth or a man. The affinity between the seed of a plant and the egg of an animal is indeed illusory, but in some of the lower animals there is a process of reproduction allied to budding in plants. Years ago the poet Chamisso discovered the fact that the young of a lowly organized marine animal called *Salpa* did not resemble their parents. We know now that in some cases several generations intervene before the final form of the species is assumed. When we read of the discoveries in biology of Goethe and Chamisso, we see that there is some justice in the observation that it is the poet who understands Nature best. Perhaps we should rather conclude that the imagination is a quality which the naturalist can by no means dispense with. Goethe's theory of the true structure of the vertebrate skull is now accepted; Chamisso died before Steenstrup, in 1824, vindicated at least the general truth of his particular observations. A curious story is told of the first discoverer of the true nature of the coral-makers. The French Academy of Sciences would not print his essay on the subject, and persisted in the old belief that the coral was a plant.

To return to our moth-eggs. While certain flies reproduce by a sort of budding in the larval state, our moths, so far as known, all come from eggs laid by the female moth on leaves, flowers, or the branches and trunks of trees. Some are inserted in crevices of the wood itself, and the little caterpillars, when they hatch, bore into the heart of the tree upon which they feed. The "peach-borer" (*Ægeria exitiosa*) and the "plum-borer" (*Ægeria pictipes*), Bailey's "goat-moth" (*Cossus centerensis*) are examples of certain kinds of wood-eating caterpillars. The little moth-eggs, usually attached singly, sometimes in belts and clusters, vary in the length of time which elapses before they hatch after they are laid. It is difficult to assert that there is any rule in this respect, and it is certainly hard to tell when they are "addled." When they *are* "bad" and fail to give the little worm, it is often because they are "stung" by minute four-winged flies, parasites upon these tiny objects.

One of the most curious things about the laying of moth-eggs is the botanical knowledge of the mother-moth. In the dark she knows the particular trees upon which her brood flourish, out of a whole forest. The proverb about one man's meat being another man's poison holds good when applied to the caterpillars of moths. They will starve, as a rule, *before* eating, or die *upon* eating, the wrong kind of leaves. The little eggs, sown here and there by the mother-moth in her nocturnal flights, are often very pretty to look at through the microscope, being adorned with delicate traceries. Some kinds are nearly smooth, as those of the *Cecropia*, which are quite easily found on lilac and other leaves, gummed on, with a little brown spot above, over the micropyle, through which the curled-up caterpillar within, a little black, thorny creature, escapes. Some caterpillars eat the empty egg-shell for their first meal, but the practice is far from general. Some which I particularly noticed, those of the "chestnut-stripe" or honeysuckle-leaves, only nibble at the empty egg-shell, and, I thought, were attracted by some of the softer parts which might remain. The caterpillars of this moth (*Homohadena badistriga*) afterward make a rather stout cocoon; I have reared them from eggs found in the back-yard of a house in the heart of New York city. So far do our country friends penetrate.

The bodies of caterpillars and moths are made up of segments, or rings, hardened by a substance called *chitine*, so that it has been said that insects really follow out Sydney Smith's suggestion, given under exceptional circumstances, and "sit in their bones" the whole time. They strike against the outside world with the knobby parts of their anatomy. A child once described a caterpillar as a "jointed tube, filled with soft stuff." I don't know how she found out about the "soft stuff," but the insides *are* soft, and, when carefully examined, show the respiratory canals, opening by little narrow slits in the sides of the segments (for insects do not breathe by the mouth), the nervous and the muscular systems, networks of little whitish threads, as also the central digestive apparatus, which takes up the most room, as our caterpillar is principally a feeding animal. The stiffness of the rings of insects is obviated by their being connected by a highly flexible membrane. The caterpillar increases in size by changing its skin. The old covering becomes too small to hold the food which is retained and transformed by the chemistry of the body into caterpillar-flesh. It splits behind the head, and, with more or less trouble, the caterpillar frees itself from it, stepping out, and leaving its old skin, a thin and almost colorless pellicle, to be blown by the summer winds into Nature's rag-bags which the spiders mostly carry about.

Caterpillars are of all colors, and, within certain limits, of all sizes, variations of the "jointed tube, with soft insides." They are plain and smooth, or ornamented with tufts of hair, or fleshy, colored humps;

when young, the head and tail are somewhat swollen, and in this state one kind has been described as looking like "little animated dumb-bells." When they attain their full size, they prepare to pass into the chrysalis state, and here their methods are equally diverse. A few hang themselves up by threads, like butterflies ; others penetrate the ground, and, without any web, change into a naked, brown-colored pupa, which reposes in a sort of cell, made merely by the movement of the caterpillar pressing back the earth. This is the burial of Psyche. From it a host of oratorical and poetical figures are taken. It affords, in one way, even religious consolation. The human body, buried in the mold, gives to eternity and heaven the soaring soul, as the chrysalis, from its earthy cell, discloses the moth which beats the ether with unquiet wing. Again, many kinds of caterpillars spin thick cocoons, as the "American silk-worm" (*Telea polyphemus*), the "cecropia moth" (*Platysamia cecropia*), and the "sassafras emperor" (*Callosamia Promethea*). Many have been the efforts to utilize the silk thus made by our native moths, and interesting experiments are detailed with that spun by the American silk-worm, as published by Mr. Trouvelot. The silk of all these species can be no doubt used, because the Chinese and Japanese silk-worms belong to the same or nearly related genera. But none of them equal the original Indian or European silk-worm, the *Bombyx mori*, cultivated chiefly in the south of Europe, and which yields the silk of commerce. After several unsuccessful attempts, of late years, the rearing of the cocoons has been profitably undertaken in the United States, probably through the establishment of silk-mills and the protective tariff which stimulates the silk industry.

Everywhere in the country one may find the chrysalides of moths. Under stones, under moss, and beneath the loose bark of stumps, spun fast to branches and wrapped in the dead leaves of autumn, at the foot of the trees which fed the caterpillars, they may be found in all sorts of hiding-places. The duration of the apparently torpid chrysalis-life is different with the season and the species. From a few weeks to sometimes two years, the still nascent insects lie imprisoned. But at length the hour for escape arrives. The brown shell of the chrysalis splits, and the moth, struggling out of all its envelopes, crawls to some near foothold, where it may shake out and expand its feathery wings in safety. And then, when night comes, and the breeze, it gives itself to the darkness, braving all dangers, to deposit its eggs in safety and perpetuate its species, its main object accomplished often at the sacrifice of its own brief life.

While the moths are inseparably connected with the butterflies, we shall know them by their antennæ not being knobbed at the tip, their more downy wings and body, their generally softer colors, and their usual sleepy habit in daytime, when they fold their wings and seek dark places for repose.

Except a few small groups, most of which I can not admit as forming distinct families, our North American moths may be divided into ten groups, to each of which the term "family" is applied, just as we have the same term given to certain similar groups of other animals, such as the birds or fishes. These ten families are: 1. The *Sphingidæ*, or "hawk-moths," of which we have 91 species in our territory; 2. The *Ægeriadæ*, or "clear-wings," of which there are catalogued about 120 sorts; 3. The *Zygænidæ*, or "clear-spots," comprising over 60 kinds; 4. The *Bombycidæ*, or "spinners," of which there are more than 400 species; 5. The *Noctuidæ*, or "owlet-moths," with nearly 1,600 different kinds; 6. The *Geometridæ*, or "spanners," with 500 species; 7. The *Pyralidæ*, or "snout-moths"; and 8. The *Tortricidæ*, or "leaf-rollers," with over 400 kinds of each; 9. The *Tineidæ*, or "leaf-miners"; and 10. The *Pterophoridæ*, or "feather-moths," the former a large family of minute and often brilliantly colored species, the latter a smaller one containing curious slender moths, having the wings split into feathery fingers or rays. These last two groups are very incompletely known.

[*To be continued.*]

CONCERNING KEROSENE.

By Professor S. F. PECKHAM.

A MODERN French writer has said: "In the domain of the useful arts each age reveals characteristic tendencies. In the last century, mankind had need to clothe itself cheaply. . . . The nineteenth century has wished for light." To the development of the petroleum industry the gratification of this wish is mainly due; yet, while the products of petroleum are used in nine tenths of all the dwellings of the land, but few of those who occupy them realize that 60,000 barrels of crude oil flow from the earth every day, that more than 30,000,000 barrels are now stored above-ground in huge iron tanks, and that 15,000 barrels are required to supply each day's demand in the United States alone. Of this vast quantity, by far the largest proportion is consumed as illuminating oil, or kerosene, for the production of which a stream of oil is constantly flowing through six-inch pipes from the oil-region of Western Pennsylvania to Baltimore, Philadelphia, and Jersey City. In each of these cities establishments, constructed for the purpose, convert the crude oil into various products, principally illuminating oil, for the home market and an export trade of vast proportions. In these refineries the oil is first allowed to settle in large tanks, in which a small percentage of water and sediment accumulates. From these tanks the oil is pumped into stills, holding about 1,200 barrels each, beneath which fires may be kindled, and urged by a strong draught until a red-heat is attained.

Petroleum consists of a great many different fluids, which range in volatility from the boiling-point of ether to nearly a red-heat. Such being the case, as soon as the oil is heated at all, the most volatile products begin to come over, at first colorless as water, but very gradually assuming a yellow tinge until the most dense distillate coming over at the last is quite dark brown in color, so that, if all the distillate were allowed to run into a tank together, it would not look very differently from the original petroleum. In the ordinary process of refining petroleum, the distillate is divided into three portions. The first is the lightest, colorless portion, nearly as volatile as ether, and is called crude naphtha, or "benzine." Like the crude petroleum, this crude naphtha may be distilled and divided into gasolene, A, B, and C naphtha, which are used in gas-machines, for mixing paints, and other similar purposes, sometimes also for burning in lamps and stoves.

The middle portion of the distillate, which is neither very light nor very heavy, and having but little color, is the crude illuminating-oil, or kerosene. As it runs from the still it has a very offensive odor, due to the decomposition of certain portions of the petroleum at the high temperature reached in the still. To remove the offensive compounds, the oil is first agitated with about five per cent of strong oil of vitriol. This combines with the offensive oils, forming a black, tarry residue that falls to the bottom of the tank as soon as the oil is brought to rest. This mixture of acid and oil is called "sludge," and is used in large quantities in the manufacture of commercial fertilizers. After the acid is drawn off and the oil washed with water, it is again washed with a strong solution of caustic soda, which removes the excess of sulphuric acid, and also some peculiar acid compounds that exist in the oil. The oil, after another washing with water, is nearly colorless, with the peculiar balsamic odor of kerosene, and possesses the slight opalescence peculiar to these oils. As usually prepared, they belong to the class known as "high-test" kerosenes, and consist almost entirely of oils that exist in the petroleum already formed, being merely separated from the lightest and heaviest portions. Such oils are called the *educts* of the petroleum.

The heaviest portions of the distillate contain paraffine, and are called paraffine-oils. They also are mainly educts of the original oil; they, however, contain a much larger proportion than the kerosene of the products of the decomposition of the oil. A tarry residue remains in the still, called "residuum."

In other establishments the naphtha and illuminating oil are distilled from the petroleum, and the dense oil remaining in the still, called "reduced petroleum," is drawn out and used for lubrication. A large part of this dense oil from which the naphtha and illuminating oil have been removed is "cracked," or destructively distilled, by slacking the fires, and allowing the distillation to proceed so slowly that the dense portions of the vapors are condensed on the dome of the still, and, falling back upon the surface of the hot oil, are heated above their boiling-points, and decomposed into a lighter oil and a carbonaceous residue. By continuing this process for several hours the oil has passed out of the still, leaving a quantity of residuum, as in the first instance. This cracking process is never complete, as a portion of the oil is cracked too much and another portion too little ; but the average gives a burning-oil of the proper density, color, etc., while in other respects it is greatly inferior to the oil that is not cracked. The reader will readily perceive that by mixing these constituent oils of the petroleum suitable for burning-oil, which have been very properly called "normal" burning-oils, with different proportions of the cracked oils, a great variety of products may be obtained ; but I propose in this article to speak of only three classes of burning-oils, and to show that these three classes may furnish oils that meet the demands of legal enactments, while at the same time they may be both very dangerous and very bad.

The first class of oils mentioned that are distilled from the petroleum unchanged consists of compounds of hydrogen and carbon combined in such proportions that the percentage of hydrogen is greater than in any other similar substances. In addition, they are very inert to chemical reagents, in this respect resembling paraffine or India-rubber. They may be washed with sulphuric acid or strong solution of caustic soda, and very completely purified ; but they are not acted on by either of these powerful reagents, and the product is a pure, colorless oil, with the odor of kerosene, and burning with a dazzling, white flame. The wick is burned but little more rapidly than that of an alcohol-lamp. The flame does not smoke, neither does it emit any unpleasant odor. These oils are safe, healthful, and economical ; in fact, they constitute the best and cheapest illuminating agent ever given to man.

When the oils too heavy for illuminating oils are destructively distilled or "cracked," the product is largely contaminated with oils containing less hydrogen in proportion to the carbon, and which are not inert to chemical reagents like those just described. When these oils are treated with sulphuric acid, both the oil and the acid are decomposed. The sulphur and a part of the oxygen of the acid (SO_2) take the place of a part of the hydrogen of the oil, while this hydrogen unites with the remaining oxygen of the acid and forms water. This sulphur and oxygen thus become constituents of the oil, and when the oil is burned they escape into the room as sulphurous oxide identical with the fumes of burned brimstone. But this is not all : the sulphur compounds, and the heavy, imperfectly cracked oils, soon impair the capillary attraction of the wick ; and, the flow of the oil being impeded, the wick becomes charred and coated with unburned carbon.

This imperfect combustion produces smoke and imparts to the atmosphere of the room unpleasant odors, and not infrequently leads to an explosion of the lamp and disastrous conflagrations. The steady flow of the oil through an unencumbered wick keeps the wick burner comparatively cool, and prevents the heating of the lamp and of the oil within it; but, when the capillarity of the wick is impaired, the burner, lamp and oil within it become heated to a temperature that finally produces a distillation of the lighter portion of the oil, in many instances causing the flame to become dense and smoky; sometimes streaming above the top of the chimney; and, if not speedily extinguished, resulting in an explosion and the destruction of the lamp.

When the normal and cracked oils are mixed, the mixture partakes of the mingled characteristics of the constituents. The mixture may be nearly as good as the normal oils, or nearly as bad as the cracked oils. At the present time the *common* kerosene sold is either a "cracked" or a "mixed" oil, while the bulk of the *high-test* kerosene is supposed to consist of "normal" oil; and, while any or all of these oils may be of any required test, they are of very various quality in other respects.

The test of an oil, "high" or "low," represents the temperature to which the oil must be heated in order that a suitable quantity—usually one half-pint—may give off a sufficient amount of inflammable vapor to either flash or burn. The temperatures at which the same oil will flash and burn vary greatly with the character of the oil, being from 10° to 50° apart by Fahrenheit's scale. While it has been repeatedly demonstrated, by several of the most eminent scientific experts now living, that the temperature at which an oil will burn is of no importance as an indication of its safety, this test is still in use in many localities. It is, however, the temperature at which the vapors will flash that is usually understood as the "test" of an oil, and it varies from 70° to 90° Fahr. in low-test oils to 120° to 140° in high-test oils. Experiment has repeatedly demonstrated that an oil that will give off vapors that will flash at 100° Fahr. is safe for any legitimate use. As painful and disastrous accidents are liable to follow the explosion of a lamp, and as the increased danger of explosion where low-test oils are used is obvious to any reflecting person, all efforts to restrict the manufacture or sale of unsafe oils by legislation have been hitherto directed toward the exclusion of very low-test oils from the market. In England such legislation has been based upon very elaborate research, and has been in the main successful; but in the United States no less earnest though less carefully considered measures have been embodied in legislation which has resulted in the enactment of a great variety of statutes—giving to some States laws unreasonably exacting, to others wise provisions, while yet others have no legislative restrictions whatever. Of course, such diverse enactments relating to a single interest and question can not command the respectful consideration that uniform, just, and reasonable legislation would receive from all intelligent persons interested; hence, it may be fairly stated that in this country legislation relating to the testing of petroleum is in in many respects unsatisfactory.

It is not, however, to the generally unsafe character of low-test oils that I wish to call attention, but to those characteristics, not yet generally or fully recognized, that render some oils that come within the legal provisions regarding test unhealthy and unsafe for use.

The petroleum industry, in many of its aspects, is the product of development. This statement is true, not only as respects its vast magnitude, but also as pertaining to many of its details. The process of cracking had been employed in treating the distillates from coal before petroleum became an article of commerce; yet petroleum, for a number of years following its discovery in large quantities, was uniformly distilled into naphtha, normal burning-oil, and paraffine-oil. At that time but few uses were known for naphtha, and it was a drug in the market. At the same time the paraffine-oils were contaminated with more or less of the products of destructive distillation that were unavoidable attendants of even rapid distillation. These oils were consequently very poor lubricators, and, moreover, possessed a very unpleasant odor. They never commanded a good price and were slow of sale, for which reason it was obviously the interest of the manufacturer to put into the burning-oil as large a proportion of the naphtha as possible, for the purpose of holding in solution a maximum quantity of paraffine-oil. This often produced an oil unsafe from excess of naphtha, but it was an oil consisting mainly of normal oil, and almost entirely of the educts of the petroleum. Sulphur had not then been observed as an impurity in burning-oil, although the same process of treatment was then used, but less carefully than now. As the original district of Oil Creek produced, at the end of ten years, a smaller proportion of the entire production of crude oil, the character of the burning-oil on the market in 1875 was different from what it was in 1865. At the former date the "lower country," so called in Butler and Clarion Counties, yielded an oil in some respects different from that of Oil Creek, and unequaled for the manufacture of burning-oil, inasmuch as the percentage of normal oils suitable for burning was found to be considerably greater. In five years the diminished production in the Butler-Clarion field, and the increased production of the Bradford district, together with the mixing of the entire production in huge tanks and pipe-lines without regard to quality, had entirely changed the relation of the amount of normal to that of cracked and mixed oils. The vast production and low price of crude oil had thrown the manufacture of petroleum into the hands of corporations controlling immense capital, and establishments in which the oil is handled in quantities proportionate to the enormous demand. Meantime a method of refining petroleum had been generally introduced, by which a large proportion of the total burning-oil produced consisted of mixed or cracked oils. Such a proportion of high-test oils as were demanded by the market was made, but the great bulk of the distillate had been converted into a cracked or mixed oil. The petroleum was distilled but once, the naphtha was removed, and then the remainder of the oil manipulated to produce such crude burning-oils as were desired, leaving in the still only a small percentage of residuum. These crude burning-oils were treated with sulphuric acid and caustic soda in such a manner as to produce the lightest colored oil possible, and they were further manipulated to bring the test within the legal requirements. As it was much less difficult to bring the mixed or cracked oils within the requirements of a burning rather than a flash test, the burning test has always found strong advocates among a certain class of the manufacturers of petroleum. This method of manufacture was well established, and the markets of the world were well accustomed to handling the various products during that period when the bulk of the crude oil came from the Butler-Clarion district. But gradually, as has been stated, the major portion of the crude oil that flowed into the pipe-lines was no longer from the Butler-Clarion wells, but from those of Bradford. By the end of 1881 more than three quarters of the crude oil was Bradford oil, and the relative proportion has steadily increased. This change in the crude material has been accompanied by a corresponding change in the character of the product. Instead of mixed and cracked oils, consisting largely of normal burning-oil, the products of Bradford crude oil consist largely of the products of destructive distillation, and this is due to the fact that the petroleums of the Butler-Clarion and Bradford districts represent two extremes ; the first contains the smallest proportion and the latter the largest proportion of paraffine-oils of any crude petroleums found in large quantities. The proportion of cracked oils in the distillate from the Butler-Clarion petroleum was too small to injure the general quality of the oil. In the Bradford distillates, on the contrary, the products of destructive distillation give character to the whole. And not only is this statement true, but the proportion of high-test normal oils to be obtained at present from the pipe-line crude oil has gradually become so reduced that the best brands of oil on the market have deteriorated, until it is very difficult, if not impossible, to purchase an article of burning-oil equal in quality to the best offered for sale a few years since. All this time the requirements of law in regard to test have been met, perhaps it may be said, with increased faithfulness.

From the foregoing pages it must be manifest that any improvement in the increasingly bad quality of kerosene can be looked for only from one of two directions. Either it must come from the development of a new field for crude oil of superior quality, or from the introduction of new methods of manufacture. There are no indications at present that warrant any expectation that any material change is imminent in the character of the crude oil. The change must, therefore, come from the introduction of different methods of manufacture. These methods need be neither novel nor unreasonably expensive. Cracked oils of good quality are nothing new, but I have never seen them made by one distillation and one treatment. Cracked oils should be finished by distillation, not treatment. A second distillation would enable the refiner to first remove the two volatile products of cracking and the heavy, uncracked portion of the paraffine-oil, besides destroying the sulphur compounds. But such a technology would so far increase the cost of the oil that those employing it could not compete in the market with those who did not, except by virtue of the superior quality of their oil.

It is in respect to this difficulty that the public weal could be well served by judicious legislation that in its broadest sense might well be considered sanitary legislation. It is a proper subject for physicians to determine, what the precise effects upon the general health may be resulting from the combustion in lamps and stoves of the vast quantities of inferior oils that are daily consumed throughout the country. That the effect must be bad, determining a tendency to certain forms of disease and aggravating others, can not fail to be apparent to the most unreflecting person, especially when it is considered in how few instances any means are employed to remove from the apartment in which these oils are burned the products of combustion. When under such circumstances a pure oil is burned into pure water and carbonic acid, the atmosphere receives a sufficient burden ; but when to these are added vapors of burned sulphur and a variety of irritating vapors with smoke, the eyes, lungs, and nostrils pay a heavy tribute. Added to this is the new source of danger from fire resulting from explosions arising from imperfect combustion—a source of danger not hitherto recognized in legislation, but of not infrequent occurrence.

For the reasons stated, it appears that the health and safety of the public, and the protection of those manufacturers who would make a radical change in the methods of manufacture now employed, alike demand legislation that will exclude from the market not only oils that are unsafe from excess of naphtha, but those which in their general character are unhealthful to use and unsafe from other causes. Such legislation should be based upon an exhaustive scientific examination of the subject, with a view to placing the fewest restrictions upon the manufacture and sale of these oils consistent with the demands of public health and safety. Such an investigation can best be undertaken by the General Government, to be followed by such amendments to the national legislation now in force as the results might justify. Such national legislation, based upon a comprehensive knowledge of the subject, could not fail to be followed by a general revision of State and municipal legislation throughout the country and the enactment of uniform laws that, while securing the adequate protection of the public, would no longer embarrass by needless and unreasonable requirements the manufacture and sale of articles in universal demand.

THE CHEMISTRY OF COOKERY.

By W. MATTIEU WILLIAMS.

LI.—MALTOSE AS A COOKING AGENT.

A FEW years ago the "farmer's friends" were very sanguine on the subject of using malt as a cattle-food, and at agricultural meetings throughout the country the iniquitous malt-tax was eloquently denounced because it stood in the way of the great fodder-reform. The malt-tax was repealed, and the subject fell out of sight and hearing immediately thereafter. Why was this?

The idea of malt-feeding was theoretically sound. By the malting of barley or other grain its diastase is made to act upon its insoluble starch, and to convert it more or less completely into soluble dextrine, a change which is absolutely necessary as a part of the business of digestion. Therefore, if you feed cattle on malted grain instead of raw grain, you supply them with a food so prepared that a part of the business of digestion is already done for them, and their nutrition is thereby advanced.

From what I am able to learn, the reason why this hopeful theory has not been carried out is simply that it does not "pay." The advantage to the cattle is not sufficient to remunerate the farmer for the extra cost of the malted food.

This may be the case with oxen, but it does not follow that it should be so with human beings. Cattle feed on grass, mangel-wurzels, etc., in their raw state, but we can not; and, as I have already shown, we are not even graminivorous as they are—we can not digest raw wheat, barley, oats, or maize.

We can not do this because we are not supplied with such natural grinding apparatus as they have in their mouths, and we have a much smaller supply of saliva, besides a shorter alimentary canal.

We can easily supply our natural deficiencies in the matter of grinding, and do so in our flour-mills; but at first thought the idea of finding an artificial substitute for saliva does not recommend itself. When, however, it is understood that the chief active principle of the saliva so closely resembles the diastase of grain that it has received the name of animal diastase, and is probably the same compound, the aspect of the problem changes.

Not only is this the case with the secretion from the glands surrounding the mouth, but the pancreas, which is concerned in a later stage of digestion, is a gland so similar to the salivary glands that in ordinary cookery both are dressed and served as "sweetbreads," and its secretion, the pancreatic juice, is a liquid closely resembling saliva and containing a similar diastase, or substance that converts starch into dextrine, and from dextrine to sugar. Lehmann says, "It is now indubitably established that the pancreatic juice possesses this sugar-forming power in a far higher degree than the saliva." Besides this there is another sugar-forming secretion, the "intestinal juice," which assists the graminivorous animals in the digestion of raw grain. This being the case, we should, by exercising our privilege as cooking animals, be able to assist the digestive functions of the saliva and the pancreatic and intestinal secretion, just as we help our teeth in the flour-mill; the means of doing this is offered by the diastase of malt.

In accordance with this reasoning I have made some experiments on a variety of our common vegetable foods, by simply raising them (in contact with water) to the temperature most favorable to the converting action of diastase) 140° to 150° Fahr.), and then adding a little malt-extract or malt-flour. This extract may be purchased ready made or may be prepared by soaking crushed or ground malt in warm water, leaving it for an hour or two, or longer, and then pressing out the liquid.

I find that oatmeal-porridge, when thus treated with malt or malt-extract, is thinned by the conversion of the bulk of its insoluble starch into soluble dextrine; that boiled rice is similarly thinned; that a stiff jelly of arrowroot is at once rendered watery, and its conversion into dextrine is demonstrated by its altered action on a solution of iodine. Instead of instantly striking a blue-black color on admixture, only a slight brownish tinge is displayed, and not even this when the temperature has been carefully maintained.

Sago and tapioca are similarly changed, but not so completely as arrowroot. This is evidently because they contain a little nitrogenous matter and cellulose, which, when stirred, give a milkiness to the otherwise clear and limpid solution of dextrine.

Pease-pudding when thus treated behaves very instructively. Instead of remaining as a fairly uniform paste, it partially separates into paste and clear liquid, the paste being the cellulose and vegetable casein, the liquid a solution of the dextrine or converted starch. Turnips, carrots, potatoes, etc., behave similarly, the general results showing that, so far as the starch is concerned, there is no practical difficulty in obtaining a practically sufficient amount of conversion of the starch into dextrine by means of a very small quantity of maltose.

"Hasty-pudding," made of boiled flour, is similarly altered; generally speaking, the degree of visible alterations is proportionate to the amount of starch, but, the smaller the proportion and the greater that of cellulose, the more slowly the change occurs.

I have made a malt-porridge by using ground malt, from which I sifted out as much husk as possible, instead of oatmeal. I found it rather too sweet; but, on mixing about one part of malt-flour with four or more of oatmeal, an excellent and easily-digestible porridge was obtained, and one which I strongly recommend as a most valuable food for strong people and invalids, children and adults.

Further details of these experiments would be tedious, and are not necessary, as they display no chemical changes that are new to science, and the practical results may be briefly stated without such details.

I recommend—1. The production of malt-flour by grinding and sifting malted wheat, malted barley, or malted oats, or all of these, and the retailing of this *at its fair value* as a staple article of human food. Every shopkeeper who sells flour or meal of any kind should sell this.

2. That this malted flour, or the extract made from it as above described, be mixed with the ordinary flour used in making pastry, biscuits, bread, etc.,* and with all kinds of porridge, pea-soup, and other farinaceous preparations, and that when these are cooked they should be slowly heated at first, in order that the maltose may act upon the starch at its most favorable temperature—50 or 60° below the boiling-point.

3. When practicable, such preparations as porridge, pastry, pea-soup, pease-pudding, etc., should be prepared by first cooking them in the usual manner, then stirring the malt-meal or malt-extract into them, and allowing them to remain for some time. This time may vary from a few hours to several days—the longer the better. I have proved by experiments on boiled rice, oatmeal porridge, pease-pudding, etc., that complete conversion may thus be effected. When the temperature of 140° to 150° is carefully obtained, the work of conversion is done in half an hour or less. At 212° it is arrested. At temperatures below 140° it proceeds with a slowness varying with the depression of temperature. The most rapid result is obtained by first cooking the food as usual, then reducing its temperature to 150° and adding the malt flour or extract, and keeping up the temperature for a short time.

4. Besides the malt-meal or malt-flour, which I presume will be preferably made from barley, I recommend the manufacture of what I may call "pearl-malt," that is, malt treated as barley is treated in the manufacture of pearl-barley. This pearl-malt may be very largely used in soups, puddings, and for other purposes evident to the practical cook.

* I have lately learned that a patent was secured some years ago for "malt-bread," and that it is still obtainable from many bakers, who make under a license from the patentee. The "revised formula" for this, which I have just obtained, says: "Take of wheat-meal, six pounds; wheat-flour, six pounds; malt-flour, six ounces; German yeast, two ounces; salt, two ounces; water sufficient. Make into dough (without first melting the malt), prove well, and bake in tins." Malt-flour is also sold, but at fancy prices, absurdly beyond its just value.

It may be found preferable to the malt-flour or meal for some of the above-named purposes, especially for making a *purée* like Rumford's soup. I strongly recommend such a soup to vegetarians, i. e., the Rumford soup No. 1, already described, but with the admixture of a little pearl-malt with the pearl-barley (or malt-meal failing the pearl-malt).

A small proportion of malt flour, one twentieth for example, has a considerable effect, and if a fancy price is to be paid for it such a proportion may be used ; but, if it comes into sufficient demand to be subject to wholesome competition, larger proportions up to one fourth will be desirable.

In my experiments I used the malt-extract in order to render the result visible, but this is not necessary in practice. Either the extract or the flour may be used, as may be convenient. In all cases time should be allowed for the conversion of the starch to take place before raising the temperature to 212°, keeping in view the principles above explained as regards the temperature and time required for conversion.

I have not yet met with any malted maize commercially prepared, but the experiments that I have made on a small scale show that it is a very desirable product. I name it here and now (January 8, 1885) to prevent its becoming patented, as there are so many greedy people who rush to the Great Seal Office with any idea they may pick up, however trivial. Any previous publication of the invention is sufficient to frustrate the monopoly. The same applies to the other uses of malt that I have specified.

I am still unable to speak positively as to the efficiency of vegetable diastase in breaking up or effecting the hydration of cellulose and its conversion into sugar ; but the following facts are promising :

I treated sago, tapioca, and rice with the maltose as above, and found that at a temperature of 140° to 150° all the starch disappeared in about half an hour, as proved by the iodine test. Still the liquid was not clear ; flocculi of cellulose, etc., were suspended in it.

I kept this on the top of a stove several days, the temperature of the liquid varying from 100° to 180°, while the fire was burning, and falling to that of the atmosphere at night. The quantity of the insoluble suspended matter sensibly diminished, but it was not entirely removed.

This has led me to make further experiments, now in progress, on the ensilage of human food, with the aid of diastase. I am packing various kinds of vegetable food in small silos, adding to them varying proportions of malt-flour or malt-extract, and I hereby declare, for the benefit of would-be patentees, that this invention, whether worthless or otherwise, is mine, and can not be secured by them, as I have witnesses of the date of this writing and copy thereof. I shall certainly not patent this or any of the above inventions myself, and will prevent others from interfering with their free use in the improvement and cheapening of our food-supplies. I am also treating such vegetable food material with various acids for the same purpose, and make the same claim in reference to this.

When by these or other means we convert vegetable tissue into dextrine and sugar, as it is naturally converted in the ripening of a pear, and as it has been artificially converted in our laboratories, we shall extend our food-supplies in an incalculable degree. Swedes, turnips, mangel-wurzels, etc., will become delicate diet for invalids, horse-beans better than beef; delicate biscuits and fancy pastry, as well as ordinary bread, will be produced from sawdust and wood-shavings, plus a little leguminous flour.

This may be done now. Long ago I converted an old pocket-handkerchief and part of an old shirt into sugar. Other chemists have done the like in their laboratories. It has yet to be done in the kitchen.

I should add that the sugar referred to in all the above is not cane-sugar, but the sugar corresponding to that in the grape and in honey. It is less sweet than cane or beet sugar, and a better food.

I now conclude this series, with the expression of my firm conviction that the application of chemical science to cookery is capable of vastly extending and improving our food-supplies, and thereby of greatly increasing the numbers of prosperous human beings capable of living on the earth. This, however, demands a great deal of further experimental research.

I have done so little of this in proportion to my suggestions for further research that I fear my readers will liken these papers to those others found by Prince Hal in the pockets of Jack Falstaff: "Oh, monstrous! but one half-pennyworth of experimental bread to this intolerable deal of speculative sack!"

SKETCH OF DR. ALFRED E. BREHM.*

ON the 11th of November last there died a man who is entitled by every consideration to a distinguished place in the pages of a scientific journal. For, whatever Alfred Brehm may have lacked in the systematic formalism of technical zoölogists, it can not be denied that he was really great and even unique in the sympathetic comprehension of animals as living beings. Other works similar to the "Thierleben" ("Animal-Life") exist, and have great merit, but in this sympathetic aspect they are far behind this ten-volumed work. It in no way detracts from his merit that he had to call in specialists to assist him in describing the insects and the lower animals; for these departments are a world in themselves, requiring a whole lifetime for their study,

* We are indebted for the materials of this sketch to an affectionate memoir of Dr. Brehm, published by Dr. Karl Müller in "Die Natur" of December 27, 1884.

and his life was too short to compass everything. But he opened a new door to the vertebrate world; and, if the question be asked how it was possible to give so large and expensive a book permanent currency with the German public, the answer must be found in the sympathetic element of the work, which brought a new world so near to us, and so inspired it that the soul-life of animals is no longer an empty sound.

It was Alfred Brehm's privilege to grow up among the most favorable circumstances conceivable for a nascent naturalist. He was born on the 2d of February, 1829, at Renthendorf, near Neustadt, on the Orla. He could have had no better guide to his future course than his father, the pastor of the parish, who as "Father Brehm" was known among the older ornithologists of his time as indisputably one of the most distinguished observers of the habits of birds. What the no less eminent ornithologist Z. F. Naumann was for Anhalt and its vicinity, Christian L. Brehm was for Thuringia, a favorite region for all lovers of birds, and full of inspiration for youth having a taste for natural history. This inspiration could not fail to work deeply in so receptive a spirit as the son possessed, and he thus grew up literally in an ornithological atmosphere, in which his especial taste and aptitude later took firm root. Thus were early developed in him the future ornithologist and the self-reliant, independent spirit. In 1847 the famous and wealthy African traveler, Baron J. W. von Müller, proposed that he go with him to Africa as his ornithological assistant. It was known that young Brehm was already not only an accomplished ornithologist, who was acquainted with the voices of all the birds, but that he was also a splendid shot, who had himself contributed many precious additions to his father's great collection of European birds, which was estimated to contain nine thousand specimens. Brehm had just passed his abiturient examinations when Müller's invitation came to him; and, as his father had nothing to say in opposition to it, he immediately made his own conditions and decided to go. The journey was to be undertaken at once, and to last five years. Brehm did not return till 1852, after he had explored Egypt, Nubia, and Eastern Soudan, countries that have always had great attractions for zoölogists, especially for ornithologists. Here is the resort of many birds which migrate from Europe to seek a winter home in summer-land, and also the abode of a multitude of African species which never leave that quarter of the world. Naumann also sent his apostles hither at about the same time, and one of them, the youthful Vierthaler, who has long been resting in Nubian soil, described with much spirit, in "Die Natur" for 1852, the kind of a bird-paradise which he found on the banks of the White and the Blue Nile. It was given to young Brehm alone comprehensively to depict this life in his first publication, "Reise Skizzen aus Nordost Africa" ("Travel-Sketches from Northeastern Africa"), three volumes, Jena, 1853. After he had attended the University of Jena, and had subsequently studied the treasures of the Zoölogical Court-Museum at Vienna, under the guidance of the recently deceased Leopold Joseph Fitzinger, its custodian, he became as it were dead for any other than a scientific world, and only the innate energy of his character enabled him to maintain a fixed purpose in life. For every effort to establish himself was defeated in consequence of his having so long lived a wandering life in Africa—as is generally the case with extensive travelers, he had no taste for a sedentary career—and it was, therefore, not strange to see him starting off again in 1856. This time the field of his researches was Spain and its bird-life, which a brother of his had already studied to some extent. Then, in order to study an opposite region to this, he went in 1860 to the North and visited Norway and Lapland. The fruit of this journey was "Das Leben der Vögel" ("The Life of Birds"), Glogau, 1861, and a general fame as a traveler and writer. He soon afterward received an invitation from Duke Ernst of Saxe-Coburg-Gotha to go with him on a hunting-journey to Bogosland and Abyssinia, which was begun in 1862. At the request of the duke, he worked up the collected impressions and observations of this hasty expedition in 1863 into "Ergebnisse einer Reise nach Habesch" ("Results of a Journey to Habesch"), Hamburg, 1863. The physiognomic and sympathetic tastes characteristic of Brehm are also prominent in this book. He was at about the same time appointed director of the Thiergarten in Hamburg, a position which furnished him an excellent opportunity to add to his store of zoölogical observations. It must have been of much value to him, for he had already conceived the idea of publishing an "Illustrirtes Thierleben" on a grand scale. Nevertheless, he surprised the world four years afterward by voluntarily giving up this position and turning his back on Hamburg.

Brehm was also too busy at that time with his own enterprises to be able to devote his whole powers to responsible positions. His "Thierleben" occupied him closely, and required him to review the whole store of observations which he had collected, especially in his later years. What he himself thought of the subject is shown by the following passage of the prospectus which he wrote for the second edition, in 1876: "The activity of science has also worked fruitfully on the public desire for knowledge. The nearer view that is given to it of animals in Nature (in zoölogical gardens), the word spoken from the professorial chairs of the schools, and its multiplied repetition in writing and picture, have—each supplying its part—contributed to spread, with the knowledge of animals, interest in them and appreciation of them. Thus, man's approach to the forms of creation nearest related to him, his recognition of the existence and life of animals, has taught him that this circle of living beings includes its own life within itself, and simply with the entrance into it has much light been shed over the problem of his own origin, which a rigid dogma had long kept in darkness." In this passage he evidently referred to the then still new doctrine of descent of Darwin, but a sure tact preserved him from the mistake of permitting it to have any influence on his great work. The prospectus also gives information on this subject; for he says at the close of it, in the name of the publisher: "The question will come up with every one of what will be the attitude of this work toward the movement of our time which is leaving away behind itself the mark of exact research, and is losing its head in the regions of speculation. On this subject it is proper to remark that the author has not followed this movement in the present work; that he has kept aloof from the strifes of the learned and from brilliant conjectures; and in the well-understood interest of the layman, who will seek instruction through him, he has confined himself to demonstrated facts and established observations. No one, therefore, need fear that his faith or conscience will be damaged, or that he will have reason to be afraid on account of his similarity with monkeys." Brehm was also aware that he must in his treatise abandon the region of the systematic in which all other text-books of zoölogy were cast. "With the abandonment of the sterile domain of the systematic," he says again in his prospectus, "a rich field of observation has opened out before the eye of the naturalist." But he well understood that he could not include everything with this one-sided view, and knew that the naturalist could not be a fast-bound teacher, but must lead the life of a hunter and wanderer, as he himself had done till then. He considers expressly, in the preface to the second series of his "Thierleben," the manner in which readers will have to judge it: "The 'Thierleben' is not afraid of a stringent criticism. Whoever seeks in it what the title and the opening pages will justify him in looking for will not find himself deceived; for, if he will always keep the title in mind, he will not seek there for what he can not find." He was so fortunate as to have the aid, in preparing his first edition, of the gifted animal-painter Robert Kretschmer, of Leipsic. The two men were well acquainted with each other. They had both been attached to the Abyssinian expedition, Kretschmer as its artist; and the water-color illustrations of it, painted on the spot, which he brought home with him, are among the most beautiful of their kind. Brehm was, therefore, quite right in calling his first edition an illustrated "Thierleben"; those fresh, lively pictures, painted with such grasping perception and freedom from restraint, contributed greatly to pave its way to the public; without them, the success of the book, notwithstanding its excellent contents, would have been much smaller. Brehm wrote the first five volumes of his book between 1863 and 1868, while Oskar Schmidt and C. L. Taschenberg prepared the sixth volume, containing invertebrates. A second edition, in ten volumes, was published in 1868, and the following years. The great pains with which the whole work was gradually pushed to completion bore good fruit, and, when we state that the book was translated into most of the living literary languages, it is not necessary to say anything of the appreciation in which it was held by German-speaking people. A popular edition in three volumes was published 1868 to 1872.

During the publication of this great work, Brehm resided in Berlin, where, as in Hamburg, he occupied himself with introducing the public to the forms of life which were described in so masterly a manner in the "Thierleben." A joint-stock company was formed, with a capital of nine hundred thousand marks, for the establishment of a great aquarium, of which Brehm was given the direction. The position, however, did not suit him, for he found himself too closely hedged up for his comfort. The establishment he founded still remains one of the famous sights of the city, but he withdrew from it, to devote himself again to his literary labors, which he varied with lectures in different cities. Among his literary enterprises is a book in two volumes on "Captive Birds," which was published at Leipsic and Heidelberg in 1872.

Brehm again left his country, to pursue zoölogical researches, in 1876, when at the suggestion of Dr. M. Lindermann an expedition to West Siberia was organized in the Bremen Union for Arctic Exploration, the cost of which was defrayed partly by the Union and partly by private contributions and the Russian merchant Michaelovich Sibiriakoff. The expedition consisted of Dr. O. Finsch, Dr. A. Brehm, and Count Waldburg-Zeil-Trauchburg, who joined it as a volunteer. Its route extended over the Ural across the Ischim Steppe, and along the Irtish to Semipalatinsk, to the Arrat Mountains, through the land of the Kirghiz to the Dzungarian Ala-Tau, thence to Nor-Saissan, then over the Chinese Hoch-Altai and through the Altai crownland to the Obi, and lastly across the Tundra to the country of the Ostiaks and Samoyeds, whence Brehm returned home by way of St. Petersburg, where he stayed a short time to deliver lectures. Reaching home safely, he also delivered lectures there, upon the journey he had just performed. In the same year, 1877, he accepted an invitation from the Crown-Prince Rudolph of Austria, to whom he had dedicated the second edition of his "Thierleben," to go with him on an excursion to the forests of the middle Danube, of which the crown prince afterward published a sketch. Two years later, in 1879, he accompanied the crown prince to Spain. In 1880 he, on his own account, visited North America to deliver lectures. This visit had an unfortunate ending; he was attacked by a violent fever; and after he returned home, having gone to Renthendorf, he was prostrated with a disease of the kidneys which soon proved fatal. This premature ending of his life was the more deplorable, because the restless naturalist was engaged on a new natural history of animals, which was to have a very wide scope. In him passed away one of the noblest of Germans, a man to whom the animal world was a world full of spirit and inspiration.

EDITOR'S TABLE.

LIBERTY IN EDUCATION.

DR. McCOSH has published an argument on freedom in the higher education. He had discussed the subject with President Eliot before the Nineteenth Century Club, and he has since issued a pamphlet, entitled "The New Departure in College Education, being a Reply to President Eliot's Defense of it in New York, February 24, 1885." The traditional collegiate system which has descended to us from old mediæval and monastic times, so little impaired in its essential method, is now brought to the test of modern ideas. Not only is it a question of introducing and organizing modern studies in place of the classical studies, that are losing their hold upon the cultivated mind of the age, but this involves an inquiry into the theories and principles of the older and the newer education as to how far we should go in the direction of a more pliant, adaptive, and liberal system, and how far students are to have liberty of choice among the subjects of collegiate study.

Dr. McCosh argues against freedom in the higher education, taking the ground that has ever been taken against the progress of liberty—that it will be abused and run into license. As political liberty was resisted because it would destroy government, and lead to anarchy; as religious liberty was resisted because it would destroy the Church and put an end to religion; and as the liberty of the press was resisted because it would subvert public order—so the liberty of study is now opposed because it will degrade education and destroy the colleges. To all this, the reply dictated by the world's experience is simply that, while there are undoubted objections to liberty, its advantages outweigh its drawbacks. Dr. McCosh maintains that, if the students are left free to elect their subjects, they will choose those which are easiest, and therefore most worthless for purposes of mental cultivation. But this is contrary to both reason and experience. President Barnard, of Columbia College, in a passage appended to this article, testifies that students left free do *not* choose the easier subjects. But the reason of the case is, that what is hard to one student is easy to another; and this fact, with its implications, is the key to the movement in behalf of greater liberty in the choice of studies. Dr. McCosh makes little concession to those rights of individuality which originate in personal aptitudes and diversities of mental constitution, and which impel students to different lines of effort. He would enforce a common method upon all under a theory of mental discipline, rejected by reason and experience, and fortified only by long tradition. Dr. McCosh protests that he is not behind the age or an obstructive, and is "for freedom quite as much as Dr. Eliot is," and he allows "a certain amount of choice of studies," but this is in strict subjection to the classical ideal and the old college practice.

There is talk in this option controversy about a great number of things, but the issue is over compulsory Greek and Latin. It is a fight of the classicists, and, so long as they can force the dead languages, they care very little what else comes or goes. Classical education knows nothing of this modern spirit of liberty. It has ever been closely associated with priestly domination, with religious intolerance, with despotic collegiate authority, and arbitrary state regulation. In the old and powerful English universities the dead languages are the one thing that has been forced for centuries. They have been legislated as the tests of scholarship, the credentials of culture, and the badges of gentility. That the classical spirit should be one of arrogance and tyranny, and adverse to liberty, is sufficiently explained by the history of the old universities. There is much talk about the freedom of the German universities; but, so far as classics are concerned, their policy is one of simple, unmitigated despotism. Students, of course, are left free to attend lectures and recitations or not, as they please, and to study much as they like; but what does that amount to when they can not get into the universities with any chance of success except through the gymnasium, where they are subjected to years of unrelenting classical drill; and, if they do not graduate in conformity to high classical standards, are unable to get places under the state in either the church, the army, or the civil service? The educational system of Germany is an iron despotism of a military state. Dr. McCosh understands this; and, true to his classical instinct, would be willing to concede the utmost option to Harvard University if Massachusetts would but adopt the German plan. He says:

> I know that in Germany they produce scholars without requiring a rigid attendance, and I rather think that in a few American colleges they are aping this German method, thinking to produce equally diligent students. They forget that the Germans have one powerful safeguard which we have not in America. For all offices in church and state there is an examination by high scholars following the college course. A young man can not get an office as clergyman, as teacher, as postmaster, till he has passed by that terrible examining bureau; and, if he is turned by them, his prospects in life are blasted. Let the State of Massachusetts pass a law like the Prussian, and Harvard may then relax attendance, and the State will do what the colleges have neglected to do.

The following passages, from a paper read before the Regents of the University of New York by President Barnard, of Columbia College, is a sufficient answer to the objections urged by Dr. McCosh:

> Every new subject of study which has been admitted in the college course since the century began has been admitted in acknowledged violation of the theory on which the course is assumed to have been originally founded. Chemistry has been admitted, for instance, into the course, on the ground that it is important that every well-educated man should know something about the elementary composition of the matter which surrounds him; anatomy and physiology, because he ought to understand the structure of his own frame and the functions of its several organs; and mineralogy, geology, botany, physics, etc., for similar utilitarian reasons. So great is the multiplicity of subjects at present taught as to destroy altogether, especially in later years, the character claimed for the collegiate course as a system of mental discipline.
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> It is time, as it appears to me, that we should revise our theory of collegiate education, with a view to make it conform a little more nearly to our actual practice; or that we should modify our practice to make it harmonize more nearly with our theory. The most judicious course, apparently, would be to admit, to some extent, both species of change at the same time; and with this would necessarily follow the introduction into the system of instruction of the element of plasticity, permitting it to be varied in its character to accommodate the exigencies of different minds. The doctrine that all varieties of mind may be profitably subjected to the same educational regimen is a doctrine which it is not safe to admit, unless we confine its application to the most elementary stages. The true theory of education is not that theory which aims professedly to secure for all minds identically the same description of development and to force every mind into absolutely the same mold; but that, on the other hand, which anticipates, as inevitable, differences which no external influences can ever compel effectually to disappear, and which adapts its culture to these ineradicable and irrepressible differences.
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> The first business of education is, therefore, to find out what the individual is fit for; the next is to make the most of him in that for which he is fit, and, according to this true theory of a subject which plausible speculation has done very much to obscure, a special system of training, adapted to the idiosyncrasies of the individual, is just as distinctly in-

dicated for the latter years of a liberal educational culture as a general one, equally enforced on all, is for the earliest. And it further follows that, if at this later period the student is permitted to follow the bent which his previous training has served to develop, his choice will fall upon those studies which are in harmony with his bent without any reference to the question whether they are, in the common sense of the word, "easy" studies or "difficult." For these terms "easy" and "difficult" as applied to matters which concern the understanding, admit of two quite different modes of definition.

No mental pursuit is easy if it be distasteful, no matter how small the labors its prosecution demands; and no similar pursuit is difficult if pleasing, even though to follow it may exact the severest and the most persistently sustained exercise of the faculties. And, in corroboration of the truth of this proposition, it may here be stated that, in Columbia College, under the system which permits the members of the senior class to select, for the most part, studies which they prefer to pursue, there is no lack of volunteers for a subject commonly reported to be so difficult and forbidding as the calculus, or as obscure as the metaphysics; nor is there, on the other hand, any observable predominance in the number who select a branch so fascinating as physics, or so practical as technology or chemistry.

The distribution has been, in fact, approximately equal among all the studies presented for option. And this result is one which we may reasonably look for when parallel courses of study are offered to the choice of the student during the later years of the academic course, whatever might be true if the offer were made at the beginning. For the effect of the early years of training is to bring out the character of each individual mind, and to determine what are its native idiosyncrasies, and what it is possible to make of it. And though the doctrine that all the faculties of all minds should be developed as far as possible by appropriate educational exercise and discipline is a true doctrine, yet the doctrine that all faculties of all minds are equally capable of development is a fallacy which no enlightened educator will think of maintaining.

That every faculty should receive its fair amount of fostering attention is certainly just and right, but to expect that this fair amount or that any amount of individual culture, however laborious, will secure to every individual an equal power or chance of success in any given direction—as, for instance, in poetry or mathematical research—is as unreasonable as to expect that every sapling in a nursery may, by proper care, be made equally prolific of fruit. After all that has been said about the desirability and the importance of symmetrical mental development, and of the duty of shaping the educational culture with a view to secure such a development, the simple fact is that all minds develop themselves unsymmetrically, just as certainly as that different minerals crystallize into different geometrical figures; and that it is just as hopeless for the educationist to look for that ideal conformity and perfection of mental proportion among his pupils which has been so much insisted on as the end at which education should aim as it would be for the chemist to attempt by his science to compel all his salts to crystallize into spheres.

The great evil of the invariable curriculum of study in our colleges at the present time is that it makes it impossible, at least after the end of the second year of the course, to teach any subject with satisfactory thoroughness. From an examination of the programme of instruction in Columbia College for the junior and senior years—I select my own college rather than another that my remarks may not seem invidious—it appears that if every student were compelled to take every subject, and if to every subject should be given an equal proportion of the available time, no single subject, if pursued continuously, could occupy a longer period than about a month. How is it possible to expect results satisfactory either to instructor or to learner from such a state of things as this? There is no remedy for the evil but that of permitting the student to concentrate his attention upon those subjects which are most in harmony with his native bent, and to leave the others to those to whom they in turn may be more acceptable.

DE LAVELEYE ON SOCIALISM.

No apology is needed for printing the long article of M. de Laveleye in reply to Herbert Spencer, together with the latter's brief rejoinder. The Belgian state socialist is a man of mark, who believes in the extension of the powers of government for the general purposes of philanthropy; and it was natural that he should see the need of breaking the force of Spencer's argument. But, quite regardless of that result, his paper is of interest as revealing the condition of mind of a man admitted to be strong in politics and economics, but who shows such a want of familiarity with the elements of social science as gives confusion to his exposition. Notwithstanding its merits, looseness and inaccuracy in important parts of his paper must go far to impair our confidence in the integrity of his intellectual work.

What trust, for example, can we have in the information or the thinking of a man who says, "Darwin borrowed his ideas of the struggle for existence and the survival of the fittest from Malthus, from whom he also drew his theories of evolution and transformism"? Now, "the struggle for existence" is certainly not an idea belonging either to Darwin or Malthus, but is far older than both. And so also with the principle of the "survival of the fittest"; it is a formula of Herbert Spencer, adopted by him to represent the same idea that Mr. Darwin expresses by the term "natural selection"; but the conception is found in the writings of the earlier naturalists, and what the modern thinkers have done is simply to work out new and important views of their results.

M. de Laveleye constantly speaks in his article of "Darwin's idea," and constantly misconceives it. What Mr. Darwin did was to show how the ideas or principles or conditions of nature known as the struggle for existence and the survival of the fittest, together with heredity and variation, *give rise to new species* of plants and animals. It was an idea belonging strictly to the sphere of biological science, and aiming to account rationally for the great diversities of kinds among organic beings.

M. de Laveleye not only misapprehends "Darwin's idea," of which he is constantly talking, but speaks of it as something seized upon by Herbert Spencer and applied by him to human society. But, in the first place, Darwin had nothing to apply; and, in the second place, Spencer was in the field long before him. The struggle for existence and the survival of the fittest were ideas which Spencer had developed in their social applications, tracing out their results and assigning their limitations in his book upon human society, of 1851; while "Darwin's idea," belonging in quite another field, was not enunciated till 1859.

But this laxity of thought and misinformation affecting the fundamental conception of his argument go further. Not only does he misapprehend the "Darwinian idea," which is in fact entirely irrelevant to his argument, and not only does he constantly make Spencer the follower of Darwin, where Spencer was the actual predecessor, but he discloses an ignorance of the principles he professes to deal with, in their social bearings, which is somewhat surprising in a man who ventures to take issue with the leading sociologist of the age. He accuses Spencer of borrowing from Darwin, and applying to society an inhuman principle, which reverses all the equities of government and gives license to the worst of crimes. He says, "If it be really advisable that the law of the survival of the fittest should be established among us, the first step to be taken would be the abolition of all laws which punish theft and murder." And does M. de Laveleye really consider that it is optional with anybody whether the principle of the survival of the fittest shall be established in society or not? Are not the principles of the struggle for existence and the survival of the fittest simple demonstrated facts of nature, as old as men's observations of the economy of life upon earth, and no more to be escaped than temperature, the atmosphere, or gravitation? Because the law of gravitation is destructive, and maims and kills people daily, and everywhere, and without remorse, is the question to be raised whether or not it is to be established among us? And will M. de Laveleye maintain that the only way "to establish among us this heartless and cruel law of gravitation" is to give everybody a license to kill? The law of gravitation *is* established, and, with all its deadly results, it is a law of infinite beneficence. Nothing remains for man but to accept it and heed it: if it causes wounds when he stumbles, it is, nevertheless, the condition by which he walks; he is to avoid its injurious effects and secure its useful effects. Nature, of which man is a part, is a mixed system, in which good comes out of evil, and suffering is made tributary to ever-increasing beneficence. The principles of the struggle for existence and the survival of the fittest are inexorable ordinances of Nature, full of violence and death, but through which the progress and improvement and elevation of life upon earth have been accomplished. They were in operation upon a vast scale countless thousands of years before man appeared. They have been in operation in his development many thousands of years before he began to take a conscious and intentional part in the work of his own elevation; and they must continue in operation as long as the present order of natural things prevails, and the movement is upward and onward toward greater good. The sole question is, whether these great laws are to be wisely recognized and made use of by man in furtherance of those ameliorations to which they have already so immensely contributed. Only gross inappreciation of the subject, or sheer intellectual perversity, could assume that these principles require the abolition of the penal restraints of crime in organized society.

LITERARY NOTICES.

Jelly-Fish, Star-Fish, and Sea-Urchins: Being a Research on Primitive Nervous Systems. By G. J. Romanes. New York: D. Appleton & Co. Pp. 323. Price, $1.75.

The main object of this work by Professor Romanes is the description of the investigation of the physiology of the animals lowest in organization, with especial reference to determining the presence of a nervous system in them and its extent and functions. The author at first intended to supplement the accounts of his own work with an exposition of the results which had been obtained by other inquirers, concerning the morphology and development of those animals. He found, however, that he would not be able, within the limits of the contemplated book, to do justice to the labors of others, and has confined himself to giving an account of his own researches. The nervous systems of these animals, as studied by Professor Romanes, are mainly subservient to the office of locomotion, the plan or mechanism of which is completely different in the two classes, and unique in each. The investigations of which this treatise is the result were carried on through six summers spent at the sea-side out of the vacations of twelve years, and were profitable and edifying in more ways than one. On this point, the author makes some remarks which form a fitting introduction to the story of his detailed and technical experiments. "Speaking for myself," he says, "I can testify that my admiration of the extreme beauty of these animals has been greatly enhanced—or, rather, I should say that this extreme beauty has been, so to speak, revealed—by the continuous and close observation which many of my experiments required; both with the unassisted eye and with the microscope numberless points of detail, unnoticed before, became familiar to the mind; the forms as a whole were impressed upon the memory; and, by constantly watching their movements and changes of appearance, I have grown, like an artist studying a face or a landscape, to appreciate a fullness of beauty the *esse* of which is only rendered possible by the *percipi* of such attention as is demanded by scientific research. Moreover, association, if not the sole creator, is at least a most important factor of the beautiful; and, therefore, the sight of one of these animals is now much more to me, in the respects in which we are considering, than it can be to any one in whose memory it is not connected with many days of that purest form of enjoyment which can only be experienced in the pursuit of science. And here I may observe that the worker in marine zoölogy has one great advantage over his other scientific brethren. Apart from the intrinsic beauty of most of the creatures with which he has to deal, all the accompaniments of his work are æsthetic, and removed from those more or less offensive features which are so often necessarily incidental to the study of anatomy and physiology in the higher animals." This book is Volume XLIX of the "International Scientific Series."

Geology and the Deluge. By the Duke of Argyll. Glasgow: Wilson & McCormick. Pp. 47.

This is the substance of a lecture delivered in Glasgow, in which is considered the question whether any scientific evidence exists that there has occurred a deluge, or a great submergence of the land under the sea over a considerable area of the globe; of a temporary character; accompanied with the destruction of animal life; since the birth or development of man; in other words, corresponding with the flood described in the Bible. The author finds evidence of such a flood, not only in universal tradition, but also in many superficial geological facts; among them, the existence of beds of recent marine gravel on mountain-tops in Wales and other countries; the loess, with its abundant land-shells; the extinct mammalian fauna of Europe, of the sudden destruction of which he adduces many evidences; and the masses of mammoths in New Siberia. The evidences of the contemporaneousness of man with the phenomena are discussed, and the question of his antiquity incidentally. The time of the flood in question is believed by the author to have been about the close of the glacial period.

The Rescue of Greely. By Commander W. S. Schley, U. S. Navy, and Professor J. R. Soley, U. S. Navy. New York: Charles Scribner's Sons. Pp. 277, with Illustrations and Maps. Price, $3.

This book gives a plain account of the Greely expedition, of the attempts that failed to relieve it, and of the one that finally succeeded. It has been the aim of the writers to describe the events simply as they occurred, and avoid all criticism of the persons who took part in them. This they have done, in the colorless manner in which all stories ought to be told on which the world is to be called upon to pass an impartial judgment. The relation is begun with a general description of the region in which the search was prosecuted, as "the gateway of the Polar Sea," and an account of the circumpolar stations which were established under the auspices of the International Polar Conference, with which Greely's expedition eventually became connected. Then are given accounts of Greely's Lady Franklin Bay expedition and the unsuccessful relief expeditions of 1882 and 1884, and the detailed account of the expedition under Commander Schley which succeeded in bringing back the survivors of Greely's command. Of the spirit in which the last expedition was prosecuted, the author of the book says that all of the officers and men "knew that the object of the voyage was something above and beyond the ordinary calls of service, and . . . felt an earnestness of purpose which a mere exploring expedition would hardly have called forth. At any rate, whatever may have been their feelings, they certainly evinced a determination to spare no pains, to incur any exposure, to assume any required risk, and to be unflagging in watching for opportunities to gain a mile, a yard, or a foot, on the journey toward Greely and his party."

In the Lena Delta. A Narrative of the Search for Lieutenant-Commander De Long and his Companions, followed by an Account of the Greely Relief Expedition. By George W. Melville. Edited by Melville Philips. Boston: Houghton, Mifflin & Co. Pp. 497, with Maps and Illustrations. Price, $2.50.

Of the world's heroes, the men of the Jeannette Expedition were certainly among the noblest, the sturdiest, and the most enduring. Whether we regard the single incident of the attitude in which Lieutenant De Long's body was found, with the arm frozen stiff in the position in which it was raised and bent to cast his journal to a safer place; or whether we consider the trials and sufferings and pluck of Melville's party, of eleven men, during their trying and lonely journey—we can almost, and when we take note, as well as of these incidents, of the history of the expedition as a whole, we can quite say with Mr. Philips, that "in all the world's history the story has no parallel." This story has already been told by different persons from different points of view; but by none who had a better right to tell it and from whom the world had a better right to ask for it than Engineer Melville, who after De Long's death was the titular commander of the expedition. The earlier part of the expedition, up to the crushing of the Jeannette by the ice, being already familiar, is but lightly dwelt upon. The real interest begins when the men took to the ice, and increases till the end of the search for De Long's party. The book abounds with incidents that help to realize what Arctic life really is. The constant imminence of its dangers was shown when the floe on which the party were encamped split through the center of De Long's tent; "and had it not been for the weight of the sleepers on either end of the rubber blanket those in the middle must inevitably have dropped into the sea." A strong picture of the straits to which men may be reduced for food appears in the observation that walrus-hide may have the solitary advantage over hemp for ropes, in that "upon a pinch it can be eaten. Indeed, fresh walrus-hide, roasted with the hair on, is toothsome at any time, and many members of our company feasted on it after consuming their rations of pemmican." We have views of what traveling on the ice is when we are told that the men did not mind having their toes protruding through their moccasins so long as the soles of their feet were clear of the ice, but they could not keep them clear; and in the incident of their finding—having, in order to keep all their things together, to go thirteen times over each mile—that, after marching from twenty-five to thirty miles a day for two weeks, they had been drifted back twenty-four miles. Finally, at the beginning of winter, on the 6th of August, they were able and glad to take to the sea, in three boats. They kept together till some time after the 10th of September, when they were separated in a furious storm, and one of the boats was never afterward heard from. It was agreed they should all endeavor to land at Cape Barkin, and meet there. How they landed, and what befell either of the two parties that survived the sea-voyage, are graphically told by Engineer Melville, from his own experiences and from the narratives of Nindeman and Noros and the notes left by Captain De Long.

The account of the Greely Relief Expedition is brief, but testifies to the value of Greely's work—that there is no one living competent to criticise his conduct of the expedition on which he was sent, "beyond affirming that he performed the greatest amount of scientific work possible at least expense, and made good his retreat from depot to depot, until he arrived at the point of safety, where our Government had promised to deposit supplies and have a vessel awaiting to carry him and his band away from the 'Land of Desolation.'" Not daunted by what he has seen and experienced of Arctic traveling, Mr. Melville has started again for the north pole, expecting to reach it, and to confirm a theory he has formed of the proper way of getting there. Believing that no vessel can penetrate the ice-barrier much beyond where explorers have gone, he figures to himself a firm or nearly firm ice-cap interspersed with frequent islands, covering the sea from the eighty-fifth parallel to the pole, and that a properly equipped expedition can cross this and return upon it, the whole distance both ways being only a hundred miles greater than his party traversed from the Jeannette to the Lena Delta; and he believes that the results to accrue from reaching the pole will more than pay for all that has been spent in other efforts.

Mind-Reading and beyond. By William A. Hovey. Boston: Lee & Shepard. Pp. 201. Price, $1.25.

An association of gentlemen engaged in scientific investigation was formed in the spring of 1882, under the designation of the Society for Psychical Research, the object of which was stated in its prospectus to be to examine the nature and extent of any influence which may be exerted by one mind upon another, apart from any recognized mode of perception; the study of hypnotism, mesmeric trance, clairvoyance, and allied phenomena; a careful investigation of data regarding apparitions; and an inquiry into the phenomena commonly called spiritual. Among the members of this society were Lord Rayleigh, the Bishop of Carlisle, Professor Sidgwick, Professor Balfour Stewart, William Crookes, and Alfred R. Wallace. They made a considerable number of experiments, in which phenomena were developed that are not yet fully accounted for. From the reports on these experiments made by the several committees to whom the supervision of them was intrusted, Mr. Hovey has prepared the present interesting and suggestive volume.

The Patriarchal Theory, based on the Papers of the late John Ferguson McLennan. Edited and completed by Donald McLennan. London: Macmillan & Co. Pp. 355. Price, $4.

Mr. McLennan, in his book on "Primitive Marriage," and in an essay which he published about fifteen years ago, on "The Worship of Animals and Plants," propounded some original and striking views, and opened up new lines of inquiry into the origins and conditions of primitive society. He was making the investigations of which these publications were the first fruits, his life-work, when his career was cut short, before he was able to perfect anything further, by sickness and death; but not till he had seen his views received respectfully, confirmed in his own mind by new facts and circumstances, and made a part of the light under which the continued study of anthropology would be conducted. It was his purpose, if health and strength had been given him, to undertake a general work on the structure of the earliest human societies. "In particular," says his brother, "he felt that he was able to give a much more consistent and intelligible view of the condition of rude or undeveloped communities than anything that had previously been offered to the public." His research being of a very extensive and far-reaching kind, and involving the use of "a very large apparatus of evidence," he proposed "to prepare the way for his larger work by first issuing a critical essay, by which he hoped to clear out of the way a body of opinion, the prevalence of which seemed to oppose an obstacle to the proper appreciation of his constructive argument." This "body of opinion" was represented by the theory that the family living under the headship of the father was the ultimate social unit, which while it is very old, had recently taken its most important and influential shape in the works of Sir Henry Maine. This "critical essay" he had on hand, assisted by his brother, who now completes it, and had carried out to seven of the nineteen chapters of the present volume, with notes embodying his views as to other parts of the work, when he died. The work is necessarily, by the circumstances of the case, somewhat polemical in form, but not wholly so, for the latter part of it is largely devoted to the buildng up of a theory of the origin of agnation, in the course of which it became necessary to go into the whole question of the Levirate and of the family custom of the Hindoos. "It has appeared at all points," says the editor, "not only that the phenomena dealt with are not intelligible on the patriarchal theory, but that they carry us back to a stage of society prior to the form of the family which has a father at its head, to the stage of polyandry, and to the form of the family founded upon kinship through women only. The argument has been throughout constructive as well as critical, and no slight part of the work is purely constructive."

United States Commission of Fish and Fisheries. Report of the Commissioner for 1882. Washington: Government Printing-Office. Pp. 1,101, with Plates.

The commission having completed the tenth year of its work, the report takes general notice of what it has accomplished. It was formed primarily to investigate the alleged decrease of food-fishes in the United States, but had added to its duties in its second year that of promoting the propagation of fish. It has accomplished much for science by prosecuting, or aiding others to prosecute, researches into the general natural history of marine animals and plants. It has made very large collections of aquatic animals in aid of monographic research, and has given a full series to the National Museum, and sets to several hundred institutions of learning, etc. During 1882 it secured a permanent sea-coast station at Wood's Holl; fitted up the Armory Building as its central Washington station; acquired stations in Maryland and Virginia; furthered the artificial production of oysters, and the production and distribution of the carp; and made inquiries into the extensive destruction of the tile-fish in the North Atlantic. For the future it hopes to extend its general inquiries; to promote improvement in methods and apparatus of fishing, and in fishing-vessels; to determine the extent and general character of the old fishing localities and discover new ones; to improve methods of curing and packing fish for the market; and to continue the work of increasing the supply of valuable fishes in the waters of the United States.

Report of the Operations of the United States Life-Saving Service for the Year ending June 30, 1883. Washington: Government Printing-Office. Pp. 519.

One hundred and ninety-four stations were maintained at the close of the year covered by the report—one hundred and forty-nine on the Atlantic, thirty-seven on the lakes, seven on the Pacific, and one at the Falls of the Ohio. The number of disasters to documented vessels and small boats was 416, in which $7,242,729 of property and 4,040 persons were involved, while $5,671,700 of the property and 4,021 persons were saved, and 651 shipwrecked persons were succored at the stations. Twenty-two other persons were rescued who had fallen from wharves, piers, etc. Ten disasters, involving the loss of lives, took place within the scope of the service. All of the nineteen persons lost were entirely beyond human aid.

Researches on Solar Heat and its Absorption by the Earth's Atmosphere. By S. P. Langley. Washington: Government Printing-Office. Pp. 242, with Plates.

Professor Langley's observations are already quite well known to the scientific world, and their value is universally acknowledged. They were made on the slopes of Mount Whitney, at a height of twelve thousand feet above the sea, and about three thousand feet below the summit of the mountain, with special instruments of the observer's own devising. Notices of some of the results have been given in the "Monthly." The author expresses the opinion that Mount Whitney is an excellent station for such observations, fully equal to any that is possessed by any other nation; and, upon his recommendation, it has been declared a Government reservation, available for purposes of scientific research. Professor Langley records some very interesting facts respecting a dust-cloud which appears to hang in the Sierras at a certain height above the sea, the effects of which he was able to observe from his camp, and which appears to be permanent. Professor Clarence King ascribes its origin to the loess of China. The author also speaks of large logs, which were found to be quite numerous on the mountain-side at a considerable height above the timber-line, as indicating that the region formerly enjoyed a warmer climate than it now has. The relation of the observations which formed the object of the expedition is very important and interesting to men of science, but too technical for the edification of general readers.

The Stars and Constellations. By Royal Hill. New York: Funk & Wagnalls. Pp. 32.

This work is intended to enable students and others, who are interested in the appearance of the heavens, to identify the principal objects of interest without reference to star-maps, which as a general thing are very perplexing to unprofessional readers. The plan adopted by the author is new, and constitutes the main feature of the work. It consists in the employment of two accurately drawn time-charts, giving the exact time of rising and southing for every day in the year, of twenty-five of the brightest stars, which are more distinctly identified in the text. From the positions of these "landmarks of the sky," any other object at all likely to attract the attention of naked-eye observers is so described that it is very difficult for any person of ordinary intelligence to miss the information desired. As each object is identified, the student can learn whatever is of interest concerning it by consulting the separate account that is given of every conspicuous star and constellation visible in this country. The subject is suitably introduced by some interesting information concerning the constellations, the names and numbers of the stars, and the methods adopted by astronomers to designate them. It is illustrated by several very clear maps of the zodiacal constellations, upon which the place of the sun for every day in the year is accurately marked. These maps, which show every star in these constellations to the fifth magnitude, we understand are the first ever published based on the admirable photometric observations of Professor Pickering, the Director of Harvard Observatory. We regard the idea on which the plan is based as a sound one, and the execution of the work as conformed to it. The arrangement is simple, and the directions, in the table, in the charts, and in the text, are clear and accurate.

The "Quincy Methods" illustrated. Pen-Photographs from the Quincy Schools. By Lelia E. Partridge. New York: E. L. Kellogg & Co. Pp. 660. Price, $1.50.

The educational world was startled a few years ago by the report of the great things that were going on in the schools of Quincy, Massachusetts. A new superintendent had been placed over them—Colonel Francis W. Parker—who had dared to break through the shell of formalism and routine within which they were being fossilized, and to infuse into them life, spontaneity, and real progress. The fame of the schools and of the new system—which was not new, however, to many, but too few, teachers of rare genius for their work—spread widely, and Quincy became a place of frequent resort for persons having at heart the interests of real instruction. Among those who went there was Miss Partridge, who recorded what she saw, and now publishes her record. She takes the reader into the school-room and its different classes, day after day, and exhibits, in her printed account, a transcript, exact as it may be, of what occurred there—illustrating how the teacher started, now this subject, now that, and patiently, and with tact, drew out whatever suggested itself to each of the pupils upon it. As the lessons are advanced, they shape themselves into a kind of system, the operation of which is to awaken the minds of the pupils to self-action and independent thinking. The manner in which these accounts are rendered justifies the secondary title of "Pen-Photographs" which the book bears. The author is careful to remind her fellow-teachers that the example-lessons she gives are not to be copied from but are to serve as types, after which teachers must form their own methods according to the bent of their minds and the kind of children they have in charge. The essential features of the Quincy method are flexibility and spontaneity. What is called by that name might, in the hands of a humdrum teacher, become as dead and worthless as any of the stereotyped forms it is intended to supplant. It is its spirit that must be caught, not any of its particular models followed; and the success of its execution will depend most largely upon the power of the teacher to strike out a way of his own.

Mortality Experience of the Connecticut Mutual Life Insurance Company, of Hartford, Connecticut, from 1846 to 1878. Hartford, Conn. Pp. 91.

A series of thirty-seven tables, showing the mortality results of as many kinds of policies or classes of insured, accompanied by a text explaining the table, and calling attention to the more important of the results.

The Vertebrata of the Tertiary Formations of the West. By Edward D. Cope. Washington: Government Printing-Office. Pp. 1,009, with 135 Plates.

This bulky quarto is "Book I" of the fourth volume of the final reports of the Hayden Geological Survey. Its import in paleontological science is of much significance, for it contains a great number of species and genera of vertebrate animals from the fertile tertiary beds of the West, which had not been previously discovered. Some of these fill gaps in the chain of species, and make the connection and the course of development more plain than they were before. The whole collection represents a part only of the results of the researches which the author prosecuted either personally or with the aid of his trained assistants during the exploring seasons of 1872, 1873, 1877, 1878, 1879, 1880 and 1881, and to a lesser extent in some of the intervening years not recorded in this list. The regions in which the explorations were conducted cover portions of the States and Territories included between British America on the north, the western boundaries of Minnesota and Missouri on the east, the northern borders of the Indian Territory and Arizona and the middle of New Mexico on the south, and the Sierra Nevada on the west. The present volume does not include all the results of Professor Cope's researches, for another is to follow. Professor Hayden well says of the whole, in his letter transmitting the report, that "the amount of new matter toward the origin and history of the mammalian groups brought together by the author in these two volumes is most extraordinary, and will probably never be surpassed." In this single volume are given the vertebrata of the Eocene and of the Lower Miocene, less the Ungulata, with descriptions of 349 species, which are referred to 125 genera. The author sums up fifteen important results that have accrued through the researches here set forth in the discovery of new genera and families, among which are the discovery of the phylogenetic series of the *Canidæ*, or dogs, and the same of the ancestors of the *Felidæ*, or cats. As the book was stereotyped in 1883, all conclusions of later date than that are necessarily excluded from it; but the author's final conclusions from the material described are mostly to be found in a series of illustrated articles he has been publishing in the "American Naturalist" in the years 1883–'85.

The Ten Laws of Health; or, How Diseases are produced and prevented. By J. R. Black, M. D. Published by the Author. Baltimore. Price (by subscription), $2.50.

A part of this book was published several years ago. The edition having been exhausted for many years, the matter has been revised to bring it up even with the progress of the age, and an entirely new part has been added, comprising nearly a fourth of the present volume, on thorough disinfection within the sick-room and the sick-bed as the most effective means for preventing the spread of contagious diseases and epidemics. The author is a strong believer in the doctrine that disease is unnecessary and preventable; in his view man is the most sickly of beings, because those—which means most men—"who neither know nor strive to be governed by law in the uses they make of themselves, become victims to hundreds of evils in the various forms of disease." The ten laws of health are taken up in their order and explained; the violations of them are shown, with their attendant results; and the mode of observing them is taught. The first law is, that a pure air must be breathed. To obtain this within the house, supposing that the surroundings are pure, "the great and imperative requirement is air-movement, a decided though gentle current through an occupied room day and night." Second; the food and drink must be adequate and wholesome. The evil to be guarded against in the United States is excess, for inadequateness or a deficiency of food on this continent, although the common sentiment is quite the reverse, is not often a direct cause of disease. As to the quality of our food, as we prepare it, "of the many books published on the subject of cooking, there are few, if any, that have not receipts by the score which can not be excelled for producing indigestion." The effects of tea and coffee and alcoholic stimulants are carefully considered. The third law enforces the necessity and judicious practice of out-door exercise; and the fourth law prescribes adequate and unconstraining covering for the body. The fifth law concerns the exercise of the sexual function. Under the head of the sixth law are considered the effects of changes of climate, and the measures to be taken for safe acclimatization when that step is taken. Regarding changes of climate for the sake of health, the author concludes, from a survey of the available facts on the subject, "that an imprudent change of climate more frequently destroys the health of the healthy than it cures the sickness of the sickly." The seventh law relates to the choice of occupation. Its admonition is to select such pursuits as do not cramp and overstrain any part of the body, or subject it to irritating and poisonous substances; and, of course, to avoid those of an opposite character. Next, we are to keep personally clean, bathing systematically and changing regularly all clothing next to the skin. "Those who for month after month, and even for year after year, do not cleanse and invigorate the skin by frequent baths, followed by brisk friction of the skin, lose the good offices of a very active organ of regeneration, and cause their blood to be in a state very favorable for the production of disease from slight causes." Ninthly, we must preserve the mind in a tranquil state, and secure adequate rest and sleep. "For health, as well as happiness, moderation and diversity of pursuits are essential requisites." Tenth and last law: "No intermarriage of blood relations." The principle is kept in view and enforced by frequent repetition that violations of any of these laws work injury from the beginning, the evil increasing as the violations become habitual, and that for years, perhaps, before the sinner perceives that anything of the kind is taking place; even while he may be boastful of his strength and his superiority to the bad effects of his wrong-doing; and that, when the injury is at last revealed, it is generally past remedy.

The injunctions in the second part of the book, for preventing the spread of infectious diseases by stamping them out within the sick-room, are based on the germ theory of disease. The principles on which they are justified, concisely stated, are, that "persons sick of infectious diseases are the breeding hot-beds from which the germs issue; that these germs make of air, drinks, and foods, mediums by which they are carried into the bodies of others; and, that when they once pervade the air, mix with foods and drinks, they can neither be detected nor destroyed; and, as a corollary, that the only time effectually to destroy them is at the bedside as they pass from the bodies of the sick." To wait, as is too often done, till they have escaped, expecting then by sterner measures to stop the spread of disease, "is like waiting until a fire becomes an alarming conflagration before making systematic efforts to subdue it"—and "even far worse." The directions for enforcing this summary disinfection are plain and practical.

Resultados del Observatorio Nacional Argentino en Cordoba. (Results of the Argentine National Observatory in Cordoba.) By Benjamin A. Gould, Director. Vols. II, III, IV, VII, and VIII. Spanish and English. Buenos Ayres and Cordoba. Pp. (total) 2,243.

We have already (March, 1882) given a sketch of Professor Gould's life and astronomical work, both at home and in Cordoba, and a notice of the first publication of the results of his observations in the southern hemisphere, in the "Uranometria of the Southern Heavens." The present volumes embrace a part of the record of his work at Cordoba as it has been pursued, in considerable but not complete detail. At the beginning, the author entertained the hope of being able to publish all the observations in essentially the same form as they had been made, affixing the instrumental corrections separately. The observations of the years 1872–'73 were prepared for the press in this form, but the impossibility of carrying out the plan became manifest as the number of results increased; and at last anxiety arose lest it might not be possible to secure a prompt publication of the results in any shape whatsoever. The observations for the catalogue have therefore been given in the compact form adapted to the requirements of the case; and those of the zones with only so much detail as seemed needful when a large proportion of the stars had been observed but once. The original observations and all the calculations have been preserved for reference. The zones which have been surveyed in these observations cover a breadth of 52° 20′ in declination, extending from 23° to 80° south. Previous determinations of position by zone-observations have been essentially differential in their character, in one co-ordinate, at least, when not in both; in the present undertaking, Dr. Gould has endeavored to obtain so-called absolute determinations for all the stars observed. During the eight and a half years of work up to the close of 1880, more than 250,000 stellar observations were made with the meridian-circle; and the number of different stars observed is estimated at 35,000—all belonging to the southern hemisphere. Among the special observations was a careful determination, of positions and proper motion, of fifty-four circumpolar stars for determination of the azimuthal errors of the instrument. Vol. II of the present series contains the observations made in 1872; Vols. III and IV, those made in 1873; and Vols. VII and VIII, the zone-observations made in 1875. In making these observations, between declinations 23° and 47°, the normal width of the zone was two degrees, with 10′ additional at each margin and extremity for overlap; from 47° to 75°, their width increased with the declination; until, finally, the last five degrees, 75° to

80°, were comprised in a single belt. The zones were also subdivided, where that seemed best.

The Distribution of Products, or the Mechanism and Metaphysics of Exchange. By Edward Atkinson. New York: G. P. Putnam's Sons. Pp. 303. Price, $1.25.

Mr. Atkinson, a man of business, has spoken so often, so intelligently, and so much to the purpose on financial questions as to give him a right to be heard and weight to his views. The present volume includes three essays—on "What makes the Rate of Wages?" "What is a Bank?" and "The Railway, the Farmer, and the Public." The subject of the first essay is attended with a complication of conditions and relations, and differences of opinion upon it are inevitable. Mr. Atkinson takes an optimistic view of the prospects of a satisfactory settlement of the relations of capital and labor on the conditions set forth in his fundamental proposition. He shows that a high rate of wages does not necessarily signify high cost of production, and *vice versa*, and enforces a distinction, too often overlooked, between rate of wages and sum of wages in the manufacture of a given product. The second essay presents an exposition of the principles on which safe banking is conducted. In the third essay the author shows that the railways have performed a great service in our national economy, and that a large reduction in the costs of transportation has been brought about by the consolidation of the principal lines; and maintains that nearly all the features of our present railway system are working, as a whole, for good.

Paradise Found: A Study of the Prehistoric World. By William F. Warren, LL. D. Boston: Houghton, Mifflin & Co. Pp. 505. Price, $2.

The Count de Saporta, Mr. G. Hilton Scribner, and others, have made our readers familiar with the hypothesis that the cradle of the human race and of all life must be sought at the north pole. The accession of so many men known to be careful observers, imbued with the scientific spirit, and habituated not to express an opinion unless they have reasons at hand with which to fortify it, as have uttered views consistent with this hypothesis, has lifted it up out of the category of speculations to a genuine theory, claiming deliberate investigation. Dr. Warren, who is President of Boston University, has arrived at conclusions nearly coincident with those of Count de Saporta and those who agree with him, through his own independent studies, though not, of course, without having them reenforced by theirs. In the present work, he offers the considerations by which the theory of polar origin is to be supported, carefully worked out, and in their order. Beginning with a survey of the present state of the question of the location of Eden and of the existing theories upon it, he presents in Part Second his own hypothesis, with a definition of the conditions on which it may be admissible; in Part Third, the scientific bearing on it of geogony, geography, geology, prehistoric climatology, paleontological botany, zoölogy, and archæology and general ethnology; in Part Fourth, confirmations of the hypothesis by ethnic tradition—from ancient cosmology and mythical geography, and from Japanese, Chinese, East Aryan, Iranian, Akkadian, Assyrian and Babylonian, ancient Egyptian and Ancient Greek thought; in Part Fifth, further verifications of the hypothesis, based upon a study of the peculiarities of a polar paradise; and in Part Sixth, the significance of the results he has drawn from these considerations.

PUBLICATIONS RECEIVED.

Preliminary Analysis of the Bark of Fouqueria Splendens. By Helen C. DeS. Abbott. Pp. 8.

The Lineal Measures of the Semi-Civilized Nations of Mexico and Central America. By Daniel G. Brinton, M. D. Pp 14.

Proceedings of the Colorado Scientific Society, 1883 and 1884 Denver, Col. Pp. 147, with Plates.

Notes on the Literature of Explosives. By Professor Charles E. Munroe, Annapolis, Md. Pp. 32.

Spiritism: the Origin of all Religions. By J. P. Dameron, San Francisco, Cal. Pp 108.

Elephant Pipes, Davenport, Iowa. By Charles E. Putnam. Pp. 40.

The Fifth-Power. By J. B. Olcott. Pp. 41.

Starling Medical College, Columbus, Ohio. Pp. 16.

Contagiousness of Tuberculosis. By W. H. Webb, M. D., Philadelphia. Pp. 28.

Scriptural Temperance. By W. H. Ten Eyck, D. D. New York: R. Brinkerhoff. Pp. 44.

Light of Comparison Stars for Vesta. Pp. 8. Astronomical Observatory, Harvard College. Report of Director. Pp. 12. Observations of Variable Stars in 1884. Pp. 16. All by Edward C. Pickering.

The Lemuroidea and the Insectivora of the

Eocene of North America. Pp. 16. The Position of Pterichthys. Pp. 6. Evolution of the Vertebrata. Pp. 35. Marsh on American Jurassic Dinosaurs. Pp. 2. The Amblypoda. Pp. 38. All by Professor E. D. Cope.

Standards of Stellar Magnitudes. Report of Committee A. A. A. S. Pp. 2.

Proceedings of the State Board of Health of Kentucky, March, 1885. Pp. 32.

Gold and Silver Conversion Tables. Pp. 8. Elevations in the Dominion of Canada. Pp. 48. Fossil Faunas of the Upper Devonian. Pp. 36. On Mesozoic Fossils Pp. 36. Washington: Government Printing-Office.

Sanitary Council of the Mississippi Valley at New Orleans. Pp. 21.

On Color. By Colonel James W. Abert. Pp. 24.

Ancient Aztec or Mexican Method of computing Time. By Colonel James W. Abert. Pp. 30.

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The Instruments and Work of Astronomy. By Asaph Hall. Pp. 19.

Dictionary of Altitudes in the United States (U. S. Geological Survey). Washington: Government Printing-Office. Pp. 325.

Herbert Spencer's Philosophy as culminated in his Ethics. By James McCosh. New York: Charles Scribner's Sons. Pp 71. Price, 50 cents.

The Diamond Lens, with other Stories. By Fitz-James O'Brien. New York: Charles Scribner's Sons. Pp. 337. Price, 50 cents.

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"Bulletin of the Philosophical Society of Washington, D. C." Vol. VII. Pp. 135.

Osteology of Ceryle Alcyon. By R. W. Shufeldt. Pp. 16, with Plates.

Forests of the Adirondacks. Report of Brooklyn Constitutional Club. Pp. 11.

The Limits of Stability of Nebulous Planets. By Professor Daniel Kirkwood. Pp. 10.

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The Six Nations. By Judge Daniel Sherman. Jamestown, N. Y.: Chautauqua Society of History and Natural Science. Pp. 23.

Ohio Agricultural Experiment Station. Columbus. Report for 1884. William R. Lazenby, Director. Pp. 210.

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Afghanistan and the Anglo-Russian Dispute. By Theodore F. Rodenbough. New York: G. P. Putnam's Sons. Pp. 139, with Map. Price, 50 cents.

Many Drugs, Few Remedies. By George T. Welch, M. D. Pp. 12.

On Oxygen as a Remedial Agent. By Samuel S. Wallian, M. D., New York. Pp 52.

Tableau de Diverses Vitesses (Table of Different Speeds). By James Jackson. 446 Broome Street, New York. Pp. 8.

Geographical Society of Paris. Comptes Rendus, January 23, 1885. Pp. 40.

Recent American Socialism. By Richard T. Ely, Ph. D. Baltimore: N. Murray. Pp. 74. Price, 75 cents.

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Architecture simplified. Chicago: George W. Ogilvie. Pp. 75. Price, 25 cents.

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Descriptive America. Georgia. New York: George H. Adams & Son. Pp. 32, with Maps. Price, 50 cents.

Prehistoric Fishing in Europe and America. By C. Rau, Washington. Pp. 342.

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Origin of Species. Pp. 76. Offices of Electricity in the Earth. Pp. 42. By H. B. Philbrook, 21 Park Row, New York.

Notes from the Physiological Laboratory of the University of Pennsylvania. By N. A. Randolph, M. D., and Samuel G. Dixon. Philadelphia: J. B. Lippincott Company. Pp. 880.

How to drain a House. By George E. Waring, Jr. New York: Henry Holt & Co. Pp. 222. Price, $1.25.

Geology of the Virginias. By the late William Barton Rogers. New York: D. Appleton & Co. Pp. 832, with Charts.

An Introduction to Practical Chemistry. By John E. Bowman. Philadelphia: P. Blakiston, Son & Co. Pp. 248. Price, $2.

The Microtomist's Vade-Mecum. By Arthur Bolles Lee. Philadelphia: P. Blakiston, Son & Co. Pp. 424. Price, $3.

Hegel's Æsthetics. By J. S. Kedney. Chicago: S. C. Griggs & Co. Pp. 302. Price, $1.25.

The Protestant Faith. By D. H Olmstead. New York: G. P. Putnam's Sons. Pp. 77. Price, 50 cents.

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Assyriology; its Use and Abuse in Old Testament Study. By Francis Brown. New York: Charles Scribner's Sons. Pp. 96.

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Insomnia, and other Disorders of Sleep. By Henry M. Lyman, M. D. Chicago: W. T. Keener. Pp. 239. Price, $1.50.

The French Revolution. By H. A. Taine. Vol. III. New York: Henry Holt & Co. Pp. 509. Price, $2.50.

Comstock Mining and Miners. By Eliot Lord (U. S. Geological Survey). Washington: Government Printing-Office. Pp. 451.

POPULAR MISCELLANY.

Schools of Fifty Years ago and of To-Day.—The Rev. Edward Everett Hale, in a recent article on "Half-Time Schools," asserted, among other things, that, on the whole, schools and school-teachers were better fifty years ago, when they turned out an occasional Daniel Webster, than they are now; that all schools are "revolting" to pupils; that the average boy, who has many weeks of vacation per year, is likely to learn the value of time, the necessity of punctuality, and the need of subordination, and to acquire modesty and self-control, order and method, quite as well as he does at school; that the old idea of school, as a place for study in reading, writing, and arithmetic, is the correct one, and all else is to be taught and learned somewhere else; and that such practical affairs as a knowledge of things, tools, and the processes of handicrafts, can not be successfully taught at school, but are learned more quickly and better at home or at work. Professor Woodward, of Washington University, St. Louis, has answered some of Mr. Hale's points. He quotes, from an article of his own, the evidence that the boys in his manual training-school enjoy their school hours with real zest, and remarks on what schools of to-day should teach, as contrasted with the schools of Daniel Webster's day: "When Daniel Webster was a boy, there was not a railroad, nor a telephone, not even a telegraph nor a steamboat, in the land. Our present methods of supplying cities with food, with fuel, with shelter, with clothing, were unknown. There was not an armored ship, nor a breech-loading gun, nor a dynamo, in the world, and one half of the present occupations of men did not exist. Are our schools to be conducted in blissful ignorance of all this?" He adds: "I do not say that schools should teach trades, any more than that they should teach banking, or piano-playing, or telegraphy. They should only teach principles, and methods, and the use of tools and appliances applicable to a majority of the occupations of American civilization; these they should teach for three reasons: 1. Opening the way to an intelligent choice of occupation; 2. Insuring success in the chosen occupation; and, 3. Raising the intellectual and moral standards of manual occupations. It is scarcely necessary to add that three hours per day given to manual training (drawing and tool-work) leave abundant opportunity for literary and scientific training, or that the intellectual development of pupils thus broadly exercised is both wholesome and rapid."

The Medico-Legal Society.—Mr. Clark Bell, in his address on retiring from the presidency of the Medico-Legal Society, points to the high character of the membership of the body as entitling it to that respect and confidence which are now awarded it by students of medical jurisprudence throughout the civilized world. It has three hundred and ninety-four members. Its library has largely increased, by the gift of books from members and honorary and corresponding members, and is now said to be the best single collection of works on medical jurisprudence in this country outside of that embraced in the library of the Surgeon-General's office in Washington. Its list of honorary and corresponding members embraces gentlemen of the highest distinction and eminence in the science of medical jurisprudence, in America and Europe. The constitution of the society has been enlarged so as to admit to active membership persons throughout the United States and Canada. The "Medico-Legal Journal" has a circulation of two thousand copies. The address, after reviewing the progress of the science in Great Britain, France, Belgium, Holland, Scandinavia, Austria, and Hungary, mentions the organization of the Society of Medical Jurisprudence in Philadelphia, and refers to the progress of the work of the Massachusetts Medico-Legal Society. Mr. Bell is succeeded in the presidency of the society by Professor R. O. Doremus.

Cardinal Pitri on Scientific Studies.—Cardinal Pitri, a prelate enjoying high dignities at the papal court, has appeared as a contributor to the Roman scientific journal "Cosmos" of an article, advising the clergy to cultivate science. "It is a good thing," he says, "for those who have in theology the key to all the sciences, not to neglect any of them. We, too, ought to have our specialists who understand and help us to understand the views of men of learning, and are prepared to meet them on their own ground. While they cherish the science of the sanctuary, the clergy should also be familiar with secular knowledge." Not only this, but "ecclesiastics and members of religious orders, especially those addicted to tradition, should be found among the men of bold speculation and research; for tradition is no less necessary for science than for faith." The cardinal recommends those studies, although they at first sight look dry, as sure to afford "a pure and healthy delight, which grows into enthusiasm in proportion as they are perseveringly cultivated." It must be remembered, he adds, that such studies only tend further to establish "those fundamental verities whence flows more or less directly the explanation of whatever can be explained." For the material universe is "a sealed book" to those who acknowledge no Divine Creator and Upholder of the wonderful forces which surround us on every side. But it behooves the young clergy to be careful against coming to too hasty conclusions in their endeavors to harmonize theology and science. "It is neither prudent nor safe to adopt scientific hypotheses too quickly into the domain of theology and hermeneutics." The observation is enforced by incidents in his own experience, that we have had "modern theologians retreating from explanation to explanation, embarrassed between the periods of the anterior creation": and, while the texts that have given occasion to controversy are "equally inspired with the rest of Scripture," it is "dangerous to apply them unreservedly to each passing system"; and is much more prudent "not to be in a hurry to make a theological thesis of a learned hypothesis and commit one's self to it, when no such obligation is imposed on us by the constant teaching or defined dogmas of the Church."

The Soil-Ferment.—It was determined by experiment, a few years ago, that the capacity of earth to purify sewage from organic matters by oxidation could be suspended by treating the earth with chloroform, but that in time the soil would regain its oxidizing quality. The conclusion was reached from this observation, that the oxidation of organic matters in sewage depends, in part at least, on the presence of small living organisms whose activity could be suspended by dosing them with chloroform. This conclusion has been confirmed by subsequent observations, and it is believed now that the oxidizing property of the soil is promoted by the presence of a micrococcus, which acts most efficiently at a temperature about that of the blood, but more feebly at higher or lower temperatures, while its efficiency ceases entirely at near the freezing-point and above 130° Fahr. It appears to be, in dry soils, most abundant in the upper six inches, and to cease to act at depths below eighteen inches. It has been further determined by these experiments that nitrogenous solutions to be acted upon by the ferment must be alkaline, while acid solutions are not affected. Ordinary house-sewage is slightly alkaline and readily acted upon, but this susceptibility is destroyed when acid-manufacturers' wastes are admitted to be mixed with it, or with the soil.

Evolution of Warlike and of Peaceful Races.—The "Pall Mall Gazette" finds in the doctrines of hereditability and modifiability reasons for supposing that the present Continental organizations of military life may ultimately result, by the weeding out of the warlike, in the development of a more peaceful and industrious race of men.

The cloister-life of the middle ages tended to the increase of the warriors by drawing gentle spirits and those skilled in the handicrafts to the convents, and leaving it to the knights and their retinues to do the marrying and the bringing up of posterity. Now the military establishments of the European empires are working in the opposite direction. They tend to draw the brave and the turbulent from married life, and to leave the raising of families to the industrious and those who shun the field of battle. The effect of the system on the population of France after the Napoleonic wars was visible, and has been much remarked upon. Hence it is probable that the warlike nations are destined to decline, and peaceful ones, like Great Britain and the United States, to prevail, and thus will come to pass the prediction in the Sermon on the Mount, that the meek shall inherit the earth.

The Mole a Friend to Man.—A writer in "Land and Water" pleads for the mole as a much-abused animal which really does more good than harm, fulfilling its mission "of ventilating the soil with many-branched tunnels, and of converting insects, worms, etc., into fertile mold. . . . The ingenuity which the mole exhibits in the formation of his covered ways might stimulate—perhaps has done so—agriculturists to improve their drainage systems; the comminuted earth and other material which he leaves behind him might also instigate them to produce the same results on a scale commensurate with their requirements. . . . We cease to be surprised at the work executed by the mole when we examine its structure. The fore-paws, short and very sturdy, are moved by immense muscles, and are supported by a clavicle of great strength; the broad palms are turned outward, the better to form scoops for throwing earth, gravel, soil, etc., behind while the animal is burrowing. The 'fingers' are small, so much so, in fact, as easily to be overlooked, but each is terminated by a nail, long, flat, sharp-edged, and very strong, eminently calculated as a tool for cutting through the soil. The snout, which we have noticed as furnished with a terminal bone, assists in these operations, and the neck is supplied with muscles of extraordinary vigor." But the hinder part of the animal is undeveloped and feeble, and it is said that the creature can progress more swiftly in the ground than on it. Its sense of hearing is very acute, but it has no external ears, and its eyes are barely visible. Its hair is very fine and stands straight out, so that, whichever way the animal goes, it is not "against the grain." The nest or home in which the mole resides, and in which the young are produced, is worthy of notice. A high arched roof is made by the removal of a quantity of earth; here and there pillars—portions of the solid soil—are allowed to remain as supports. The earth, of which the nest is composed, is pressed and beaten, and with it are mingled grass-stalks and roots to give it a greater consistency, and by this means to make it sufficiently compact to throw off heavy rains. Within the dome is erected a small mound, littered with soft grass and leaves. This is the bed, and from its elevated position is secure from whatever drainage may casually make its way below. From this mound lead off, in various directions, the passages excavated by the animals, and these often extend as far as thirty or forty feet from the central hall." The small mounds dotted over the scene of the animal's labors are merely the soil thrown up while in search of worms, etc., and have nothing in them specially worthy of examination. The mole usually seeks to be near the water, or to have access to it.

Obesity.—Obesity, says the "Lancet," may be promoted or relieved, to a limited extent, by the selection of diet and regimen, but it is fundamentally dependent on some inherent state of being or habit of life. For its safe and effectual treatment, provided the case be not of so long standing as to be beyond all remedy, this state must first be understood and regulated. Whatever interferes with oxidation, or with the due metamorphosis of digested food within the tissues, is apt to lead to its storage in the form of fat. It is, therefore, necessary for health that consumption should be limited as nearly as may be to what is necessary for sustenance, and that discharge of waste and tissue demand should be at the same time encouraged by moderate bodily exercise. The limitation of food should, however, be in its quantity rather than in its kind, for, if the requisition of mixed food for the health of the whole body be rudely interfered with, some other function may suffer and become deranged. "While, therefore, we are ready to admit that stout persons should be content with a less rich diet than the spare-bodied, we are careful to preserve its essentially mixed character, to limit its consumption in quantity, and to rely for disposal of the products of digestion mainly on regular and methodical physical exertion. There should be no difficulty about this latter, seeing that it may be taken in different forms suited to various ages and constitutional types."

Comparative Value of Disinfectants.—Dr. W. J. Miller, of Dundee, has contributed to "The Practitioner" the results of studies he has made on the efficiency of various disinfectants, in which he used vaccine as the experimental infectious matter. His preference is decidedly expressed in favor of sulphur. Chlorine was found to be a reliable disinfectant, the practical application of which was, however, attended with considerable inconvenience. Potassic permanganate was declared not certain in its effects. It possesses considerable disinfecting power, but is not as certain as it is reputed; but, as a deodorant, when it can entirely cover the offensive matter, it is of great value in the sick-room. Hydrochloric acid, though not generally in use as a disinfectant, is of very certain efficacy. In acetic acid, we have "a ready, safe, efficient and cheap disinfectant." Sanitas failed to verify the claims that had been set up in its favor. Perchloride of mercury is pronounced decidedly inferior in agency to several other disinfectants; but, as it has been seen that the virtue of infective inflammation is destroyed by considerably weaker dilutions of a disinfectant than vaccine, and in view of the weight of authority by which it has been introduced, the author will not presume to throw doubt on its value in obstetrical and surgical practice. The results with chromic acid, creosote, and eucalyptus-oil do not appear to have been definite. Cupralum, in concentrated solution, immediately destroyed vaccine, and ferralum and terebene appeared to have the same power. Seven days' exposure to air saturated with the vapor of camphor, killed vaccine, while four days failed to do so. Chloralum is uncertain. Boracic acid had little effect on lymph, and salicylic acid in saturated solution was little more satisfactory. Davaine found iodine the most certain disinfectant for malignant pustules. Dr. Miller regards vaccine as one of the most suitable viruses with which to make the experiments, for it exhibits stronger powers of resistance against the action of disinfectants than almost any other contagium. Several general conclusions are drawn from the experiments. Thus, while it is very doubtful whether any efficient disinfection of a sick-room can be practiced while it is occupied, still atmospheric disinfection may be useful to weaken the contagium and impair its power of reproduction. Sulphur is the most efficient and convenient substance to employ for this purpose. The skin of the patient, particularly the scarlet-fever patient, should be sponged several times a day with diluted acetic acid, preferably with the aromatic. For the final disinfection of the sick-room nothing equals sulphur. Clothing is disinfected by being exposed, with the fumes of sulphur, to a temperature of about 250°, for three hours in a specially constructed chamber; excreta of patients, by mixture with hydrochloric acid diluted to 1 to 20. For hand disinfection, carbolic solution 1 in 20, acetic acid, and sulphurous acid, are almost certainly thoroughly effective.

The Value of Recess.—The subject of "recess or no recess in schools" was reported upon at the meeting of the National Council of Education in Madison, Wis., last July, and was remanded to the committee for further investigation, and to be reported upon again, at the next meeting of the Council, in July of this year. The committee, seeking facts of experience, has sent out a circular of questions which it desires answered by all persons connected with schools or interested in them. Among these questions, reaching to the merits of the case, are: What effect has the no-recess plan upon the management of your schools, especially in the matter of the pupils' habits or conduct? Does or does not the no-recess plan affect the duties and privileges of the pupils in such a way as to develop or aggravate in any of them nervous irritation? Does or does not the no-recess plan affect the pelvic organs? Does it or does it not affect the eye-sight? Does it or does it not affect the nasal passages and lungs? How do the physical exercises substituted by the no-recess plan for those of the recess affect relatively the rapidity of the pulse of the pupils, when it is compared to the rapidity developed in the exercises of the out-door recess? Answers may be sent to J. H. Hoose, State Normal School, Cortland, N. Y.

Pacific Coast Panthers.—A correspondent, "Forked Deer," in "Forest and Stream," communicates some notes on the habits of the panther as he has observed them in the Pacific coast region. He expresses surprise that the settlers should have given this animal a different name—California or mountain lion—from the Eastern animal, for the "two panthers are so nearly alike that no one would dream, upon comparing them, of regarding them as distinct species." Yet "the panther of the West coast never indulges, for his own entertainment, in those fierce, cat-like screams with which his Eastern brother occasionally makes night hideous." The correspondent has a growing skepticism in regard to panthers ever willingly attacking a man. "I have known them," he says, "on several occasions to follow persons a short distance, and I have seen wolves do the same thing, especially when I have been packing in freshly-killed meat, but I do not believe that in either case they meditated an attack. In one instance, in the Cascades, near the Hood, I knew a panther to jump at a man as he lay at night in his blankets, but as soon as the man partly arose and shouted for assistance the animal bounded into the brush and disappeared. In talking it over, we all came to the conclusion that the panther had seen the man move under his blankets, and had mistaken him for some less formidable antagonist, and that when the deception was revealed to him he threw up the job at once. . . . That the panther will run from the smallest yelping cur that can be induced to follow his trail is true, but I am satisfied that instinct . . . warns them of the hunter behind the dog, and that it is the latter only which they fear. Panthers ascend the immense trees near the mouth of the Columbia, which are frequently three hundred feet high, and sixty, eighty, or even a hundred feet to the first limb, precisely as a cat would climb them, and when wounded will sometimes go to the very top. Although they may in some places spend the day lying upon the limb of a tree, they are believed to prefer rocky ledges and caverns, where they are accessible, for that purpose."

Cremation of Household and City Refuse.—The ultimate of sanitation, Mr. J. M. Keating, of Memphis, Tenn., argued in his address before the American Public Health Association, last fall, must be by fire. In support of his thesis, he proved by the citation of dozens of instances in the condition of European and American cities, towns, rivers, water-sheets, public institutions, and private houses, that when the people do not complain of polluted water, as they have to do in most cities, they do of sewer-gas; that when resting seemingly secure in an approximately good system of sewerage, they have to complain of the means for and methods of sewage disposal; that by the London method, so exhaustively expensive, the Thames is still nothing better than a wide-open sewer; that the Paris method is only partial, and too expensive, and altogether impossible for large cities; that by the New York method the docks are filled with excreta, and the entrance to the harbor is threatened by bars formed of the street and house wastes, carried out to sea at great expense by barges; that rivers are being destroyed by sewage which kills the fish and make what was once a source of health a permanent nuisance; that as privies and cess-pools are condemned because they saturate the soil, sewers are to be condemned, in some instances, for the same reason, and because they throw off and fill dwellings with sewer-gas, and docks and harbors and rivers with death-dealing sewage; and that all present plans of sewage disposal are defective because they are not final, because they merely contemplate the removal and not the destruction of what is conceded to be the prime factor in promoting and perpetuating, if it is not the original cause of, much of the disease that afflicts country and city alike. "The next step in the line of progress is cremation, and it has already been taken by thousands of households, . . . who cremate all of their household wastes and kitchen garbage, greatly to their comfort and relief. The kitchen-stove is found to be a convenient furnace, and into this everything but excreta is dumped, to be utterly consumed, and thus put beyond the process of fermentation and slow decay." The method of cremation is to be carried out in London on a large scale, in an establishment which has been erected for the purpose by Mr. George Shaw. Its introduction into all cities would relieve them of a multitude of evils, and bring no new ones in.

Early Mention of Maple Sugar.—Messrs. Editors: Professor H. W. Wiley, chief chemist of the Department of Agriculture, has recently published analyses of maple-sugars and sirups ("Chemical News," February 20, 1885), and says he is surprised to find almost no data concerning the composition of maple-sugars in chemical literature.

I can confirm this observation as to the paucity of information, having had occasion to institute a search for such literature.

I have found an early mention of maple-sugar, which seems to me to be of great interest, and append the extract to this note. The references to sugar from maize and from water-melons are curious, and I should like to inquire of your readers whether experiments on manufacturing sugar from water-melons have been made in more recent times. If so, with what success?

Very truly yours,

H. Carrington Bolton.

Hartford, Connecticut, *March* 14, 1885.

Extract from Hon. Robert Boyle's "*Usefulness of Experimental Natural Philosophy*," *Oxford*, *1663*, *Essay iv*, *p. 112.*

"Since the writing of these last Lines, being visited by an ancient *Virtuoso*, Governor to a considerable Colony in Northern *America*, and inquiring of him among other particularities touching his Country, something in relation to the thoughts I had about the making of several kindes of Suger, he assur'd me, upon his own experience, that there is in some parts of *New England*, a kinde of Tree, so like our Wallnut-trees, that it is there so called, whose Juice that weeps out of its Incisions, &c, if it be permitted slowly to exhale away the superfluous moisture, doth congeal into a sweet and saccharine substance; and the like was confirmed to me, upon his own knowledge, by the Agent of the great and populous Colony of the *Masathusets*.

"And very lately demanding of a very eminent and skilful Planter, why, living in a part of *America*, too cold to bare Sugar-Canes, he did not try to make Sugar of that very sweet Liquor, which the Stalks of *Maize*, by many called *Indian* Wheat, affords, when their Juice is expressed; he promised me he would make tryal of it: Adding, That he should do it very hopefully, because that though he had never been solicitous to bring this Juice into a saccharine form, yet having several times, for tryal sake, boild it up to Syrup, and employed it to sweeten Tarts, and other things, the Guests could not perceive that they were otherwise sweetened than with Sugar, and he farther added, That both he and others, had, in *New England* made such a Syrrup with the Juice of Water-melons."

NOTES.

The "Lancet" states that "a marked increase in the death-rate from cancer during the latter part of the present century has for some years occupied the minds of several well-known pathologists in endeavors to reveal its cause." It being generally agreed that the disease is prone to arise out of prior morbid states which do not appear to be directly or necessarily related to it, among which are tissue exhaustion, the "Lancet" adds: "If we admit, therefore, as we consistently may, that tissue-exhaustion, the result of toil, anxiety, or privation, and whether inherited or induced, affords a sufficient basis for the development of cancer, we may not look far into the history of our laborious age to find an explanation of a rise in its death-rate which at first may seem anomalous."

MM. Fol and Sarrazin, of Geneva, have been experimenting on the depth to which light can penetrate the waters of the Mediterranean Sea. They find that at two hundred and eighty metres the effect is about the same as that of a moonless night, and that the chemical rays cease to be felt at four hundred metres. A curious result of their experiments is the discovery that the water of the Lake of Geneva is far less transparent than that of the sea.

Dr. James Paget, of London, has been elected a corresponding member of the French Academy of Sciences in the section of medicine and surgery, replacing M. Bouisson, deceased.

Mr. L. P. Gratacap recently read before the Natural Science Association of Staten Island a paper on chlorides in the rainfall of the island for 1884. The results of his observations on thirty-two rainfalls, or about two thirds of the number that occurred during the year, gave ·228 gramme of chlorine, or ·376 gramme of common salt, as the average amount of those substances that fell with a gallon of water. Taking an average rainfall of 3·5 inches, he was led to the conclusion that, calculated as common salt, the amount of chlorides brought down with the rain in 1884 was 5·10 pounds per acre. Free hydrochloric acid and reactions for sulphates and sulphuric acid were also obtained, probably from neighboring manufactories.

Vaseline has been recommended by some one for shortening in pastry, but M. A. Riche has warned the health authorities of Paris that its use in foods is injurious to health.

An English translation is about to appear of M. Paul Bert's "First Year of Scientific Instruction." The work has had an extraordinary sale in France, amounting to ten editions of fifty thousand copies each in three years, and is used in nearly all the schools.

Platinum has been discovered in New South Wales in connection with gold in the Ophir district; in small grains in the Hunter and Macleay districts; as a nugget, weighing 268 grains, in Wiseman's Creek; and in the sand of the sea-coast near Richmond River.

In a recent United States consular report, the population of Liberia is estimated at 767,500, of whom 750,000 are aborigines not yet enjoying the rights of citizenship, and the remainder are immigrants and civilized aborigines and their descendants. The Cavalla River, navigable for two hundred miles, has great commercial importance, having an agricultural country with some gold-washings upon it.

OBITUARY NOTES.

George Helmersen, the eminent Russian geologist, is dead, at the age of eighty-two years. Having studied at Dorpat, he accompanied his teacher, Engelhart, along the course of the lower Volga and the Ural; then took part in Hofmann's and Humboldt's explorations of the Ural region. Having been appointed to a position in the Mining Institute of St. Petersburg in 1835, he made vacation geological journeys over the Kirghiz Steppe, through Norway and Sweden, the coal districts of Poland and Silesia, the mining districts of Lakes Onega and Peipus, and the bituminous-coal regions of Kherson and Kiev; and explored the gold-mines of Beresovsk. He published numerous memoirs on the results of these investigations.

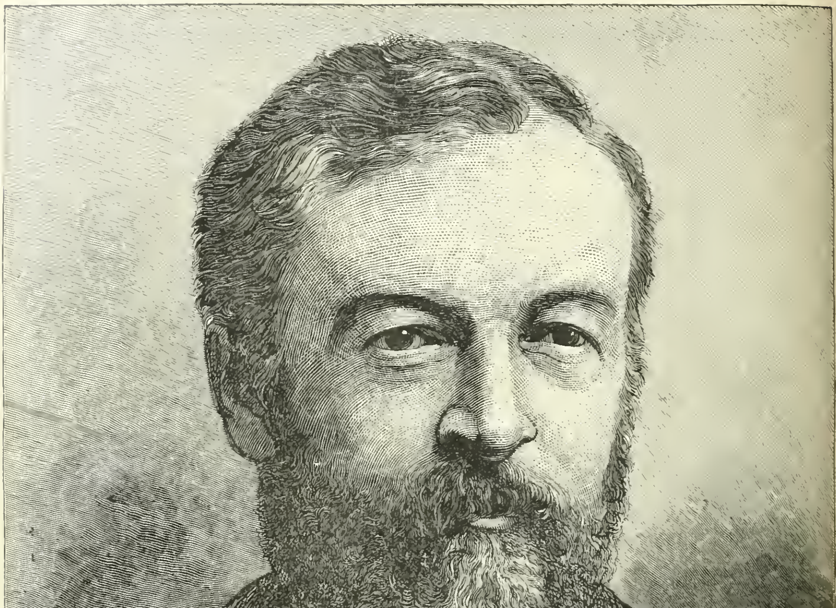
Conchology has lost one of its most industrious students by the death of Mr. Geoffrey Nevill, at Davos Platz, February 10th, in the forty-second year of his age. He was a son of Mr. William Nevill, of Holloway, England, who was interested in mineralogy and had a famous collection of Meteorites. Inspired with some of his father's tastes, he began making collections of shells at an early age. With these, and other collections of his own, he enriched the Museum of Calcutta, with which the most important labors of his life were connected. He contributed many papers on his favorite study to the "Journal" of the Asiatic Society of Bengal, and compiled the valuable "Hand List of Mollusca in the Indian Museum," which, however, he was not able to complete, on account of ill health. During the later years of his life, while an invalid, he was engaged in making collections near Mentone and around the Lake of Como.

The Russian naturalist, Mr. N. Severtsoff, died January 11th, in consequence of the cold following his being plunged into the river Don by his vehicle breaking through the ice. He explored the Thian Shan in 1867, and wrote books on the vertical and horizontal distribution of the animals of Turkistan and on the birds of the Pamir, to which is owing what is known of those subjects outside of Russia.

The death is announced of Mr. Frederick Field, one of the original members of the Chemical Society, who had been vice-consul in Caldera, Chili, and Professor of Chemistry at St. Mary's Hospital and in the London Institution. He contributed to scientific publications numerous papers on various branches of chemistry, especially on topics relating to the mineralogy and metallurgy of South America.

The death is reported of Professor Dunker, mineralogist and paleontologist, of Marburg.

Sir Frederick Palgrave Barlee, who died in Trinidad last summer while serving as governor *pro tem.* of the island, had done considerable official service to geographical and archæological exploration. As Colonial Secretary of Western Australia, he gave encouragement to Mr. John Forrest's explorations, and had the great Lake Barlee named after him. As Lieutenant-Governor of British Honduras, he extended official support in aid of Mr. H. Fowler's journey across the unexplored part of the colony, and also encouraged and assisted the explorations of Dr. Le Plongeon in Yucatan.



S. P. LANGLEY.

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A GREAT WINTER SANITARIUM FOR THE AMERICAN CONTINENT.

By Professor EDWARD FRANKLAND, M. D., F. R. S.,
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THE great importance of a winter sanitarium for patients suffering from or threatened with consumption and other allied diseases has long been recognized and acted upon in Europe. The favorite resort of this description is the valley of Davos, in the Engadine, in Switzerland, where, at an elevation of five thousand four hundred feet above sea-level, the patients enjoy, during the winter months, in a sheltered position, brilliant sunshine, and an early equable sun-temperature from sunrise to sunset.

Dr. Hermann Weber, one of the highest authorities in Europe on chest-diseases, thus summarizes the physiological effects of the climate of Davos:

1. Increased activity of the skin, better nutrition, and invigoration of the skin.

2. Strengthening of the heart and the contractile fibers of the vascular system, with augmented frequency of the heart's contractions at first, but reversion to the normal state after a longer sojourn, together with greater force of each contraction, and thereby increased suction-power.

3. More rapid respiration at first, but return to the normal rate after a few days. Probable increase of depth of inspirations. Strengthening of the respiratory muscles, and probably also of the elastic fibers of the finest bronchial branches. Increased flow of blood through the lungs.

4. Generally a marked increase in the excretion of water through the lungs, and increased and facilitated excretion of carbonic acid.

5. In most cases, transient or continued increase of appetite, ingestion of food, digestion and assimilation.

6. Thereby improved production of blood and nutrition of the organs.

7. Greater energy of nervous and muscular action.

8. In most cases, improvement of sleep.

9. Probable augmentation of tissue-change.

During last fall I became acquainted with an elevated plateau in the United States which rivals if it does not even surpass Davos in the excellence of its winter climatic conditions. I allude to that most interesting tract of territory—the Yellowstone National Park.

The beneficial effects of a winter climate like that of Davos depend upon the concurrence of several conditions which are difficult to secure at a lower elevation than that just indicated. In the first place, the sun's rays are far more powerful at great than at low elevations, and their intensity is much more equable throughout the day; thus the temperature in sunshine observed by me at Davos on the 26th of December was 89·2° Fahr. twenty-five minutes after sunrise, 108·5° Fahr. at noon, and 91·6° Fahr. at thirty-five minutes before sunset. And the intensity of solar radiation at Davos is such that, on the 22d of December, I obtained, in a box lined with padded black cloth and covered with plate-glass, a temperature of 221° Fahr., or 21° above the boiling-point of water at Davos (200° Fahr.).

Besides the intensity of solar radiation and its comparative uniformity during the day, the rarity and calmness of the air are important factors among the causes of the peculiar climate of Davos. With the barometer standing at 615 millimetres, the weight of air in contact with a given surface of the skin is about one fifth less than it is at the sea-level. The excessive dryness of the air at Davos has probably but little special influence upon the sensation of heat and cold, because the maximum proportion of aqueous vapor present in air near the freezing-point is everywhere small, and the specific heats of equal volumes of air and aqueous vapor are not widely different. On the other hand, the absence of suspended watery particles in the air has, no doubt, very considerable influence in preventing the chilling of the skin. Not only are such liquid particles present when there is visible fog, but they often exist in great numbers when the air presents a perfectly transparent appearance. The most important influence upon the sun-temperature, however, is the reflection of solar rays from the snow. The valley of Davos has precipitous sides and a flat sole, and the hotels are situated on the northwest slope of the valley; consequently they receive, in winter, the scattered solar rays reflected from a large area of snow. A considerable proportion of the thermal rays of the sun falling at an acute angle upon a surface of snow is known to be reflected.

It is obvious that this action of extensive reflecting surfaces of snow must exert a powerful influence upon the maximum temperature of places favorably situated for receiving the reflected rays; and, moreover, where the proportion of heat reflected varies (as it has been proved to do in the case of water, and as it doubtless also does in the case of snow) inversely as the angle formed by the incident rays and the reflecting surface, this action must materially contribute, especially in winter, to the maintenance of an approximately uniform sun-temperature throughout the day. At Davos, and similar elevated stations, however, the comparative freedom of the air from suspended particles must, to a great extent, contribute to such a result; for, as pure and dry air is transcalent and reflects heat but very slightly, the horizontal sunbeams, passing through such air, would be nearly as powerful as vertical rays.

The peculiar winter climate of Davos depends, therefore, upon the following conditions:

1. Elevation above the Sea.—This single condition favors a genial and wholesome winter climate in several ways. In the first place, by reducing the weight of cold air in contact with the body, whereby, even with a much lower thermometer, the air, if still, feels warmer at an elevated station than in the lower and denser regions of the atmosphere, in consequence of the slower abstraction of heat from the body. In the second place, the air at great altitudes is more permeable to the heating rays of the sun, owing both to its dryness and to its freedom from dust and suspended particles generally. In illustration of this I have made many experiments, chiefly in England and Switzerland, and an abstract of the results obtained is given in the following table:

PLACE OF OBSERVATION.	Elevation above sea-level.	Sun's altitude.	Sun-temperature.	Air-temperature.
	Feet.	Degrees.	Degs. Fahr.	Degs. Fahr.
Oatlands Park, Surrey	150	60	74·7	86·0
Riffelberg, Zermatt	8,428	60	81·9	76·1
Hörnli, Zermatt	9,491	61	86·6	68·2
Gornergrat, Zermatt	10,289	61	84·6	57·6
Whitby, Yorkshire	60	50	68·0	90·0
Pontresina, Engadine	5,915	49	79·2	79·7
Bernina Hospitz, Engadine	7,644	51	83·5	66·4
Diavolezza, Engadine	9,767	50	107·1	42·8

It is thus evident that, although the air-temperature continually decreases as we ascend, the sun-temperature as regularly augments. The horizontal line in the table divides the observations into two groups, in each of which the sun's altitude was approximately the same. In these, and similar observations described further on, the air-temperature was found by placing an ordinary mercurial thermometer upon a sheet of white paper and shading its bulb with a small arch of similar paper doubled, the sun-thermometer (blackened bulb *in vacuo*) was also placed either upon white paper or upon snow, and the numbers in the column headed "sun-temperature" were obtained by deducting the readings of the air or shade thermometer from those of the sun-thermometer. Thus, on the Diavolezza, the reading of the air-thermometer (42·8°), being subtracted from the reading of the sun-thermometer (149·9°), left the number 107·1° as the sun-warmth, or the temperature, above that of the surrounding air, to which the sun's rays raised the blackened bulb *in vacuo*.

The very high sun-temperature observed on the Diavolezza was recorded at a station surrounded by snow-fields in brilliant sunshine, and the thermometer was placed upon snow.

Not only is solar radiation much more intense at great altitudes, but it is also more equable during the whole day, inasmuch as the comparative absence of suspended matters in the air renders the thermal power of the rising and setting sun more nearly equal to that of the meridional sun. Thus it has been observed that, at or near the sea-level, the sun-temperature increases about 15° Fahr. between 8.30 A. M. and noon, and decreases to the same extent between noon and 3.30 P. M.; whereas on the Riffelberg, 8,428 feet above the sea, the increase and decrease between the same hours are only 9° Fahr. These observations were, however, made in summer; in winter, the difference between the two stations would doubtless be still greater. Moreover, an elevation of 5,000 or 6,000 feet places us, especially in winter, to a great extent above the region of cloud, and thus enables us to enjoy a bright sun at time when clouds effectually cut off his rays from lower altitudes.

Lastly, and this is of the highest importance to invalids, the air at great elevations is characterized by comparatively great freedom from zymotic matters. By numerous and ingenious experiments Pasteur found this to be the case at a height of 6,300 feet, on the slope of Mont Blanc, and Tyndall at an elevation of 6,730 feet, on the Bel Alp, in Switzerland.

2. Reflection from Snow.—Although the air-temperature in midwinter, at elevations of from 5,000 to 10,000 feet, differs but little from that of much lower levels in the same localities, the low temperature prevails for a longer time. Thus the valley of Davos and the surrounding mountains are usually thickly covered with snow from November to the beginning of March, and the solar heat reflected from this snow is an important factor in the production of the genial winter climate of Davos. By laying a sun-thermometer on surfaces of different materials, I have demonstrated the high reflective power of snow. The following summary of the results of these experiments shows the degrees to which the blackened bulb *in vacuo* was raised when laid in the sunshine upon each of the materials experimented with:

White paper	116·6°	Fahr.
White linen	116·1	"
Snow	111·0	"
Metallic mirror	97·5	"
Common mirror	97·5	"
Light-colored soil	96·3	"
Parched grass	95·3	"
Gray rock	88·4	"
Green grass	88·2	"
Black silk	84·0	"
Black caoutchouc	82·2	"
Black merino	80·4	"

White paper and white linen were therefore the most perfect reflectors of solar heat; but the efficiency of snow was but slightly inferior, while it greatly surpassed that of even polished metal.

The relative proportions of direct and reflected solar heat, falling upon a body in sunshine surrounded with snow, has not been determined, although it has been ascertained where water is the reflecting surface. Thus, M. Dufour has measured the proportions of direct and reflected solar heat incident at five different stations on the northern shore of the Lake of Geneva. He found that the proportion of reflected heat was as much as sixty-eight per cent of the heat directly incident from the sun, when the sun's altitude was between 4° 38″ and 3° 34″. At about 70° altitude, the proportion was between 40 and 50 of reflected to 100 of direct heat; and, even at an altitude of 16°, the proportion was between 20 and 30 of reflected to 100 of direct heat; but when the sun was higher than 30° the reflected heat was hardly appreciable. My own observations confirm these results, for I found at Alum Bay, Isle of Wight, that the reflection from a ruffled sea, at 6.45 P. M., in May, added no less than forty-four per cent to the direct solar heat.

It is obvious, therefore, that the Davos sanitarium is much indebted to its snow-covered valley for a winter day-climate which is so genial as to allow the patients to spend nearly the whole of every sunny day in the open air, although the temperature of the air may be 15° or 20° below the freezing-point. Five minutes after sunrise, many of the patients walk in the open air without any special wraps, and some of them even without overcoats. In the brilliant sunshine, one feels comfortably warm sitting in front of the hotel in a light morning coat.

3. Freedom from Air-Currents.—Davos is well sheltered from general atmospheric movements, and, as the surrounding snow can not be warmed above the freezing-point, no local currents or valley-winds can be set up. An almost uniform calm, therefore, prevails during the continuance of snow. This immunity from air-currents is of the highest importance to the patients, for, without it, they would not be able to sit out-of-doors and enjoy the free and comparatively germless air as already described. In still though cold air the skin is less chilled

than in much less cold air which impinges with considerable velocity upon the surface of the body. The effect of motion through the air upon the sensation of warmth and cold at Davos is very striking. Sitting perfectly still in the sunshine, the heat in midwinter is sometimes almost unbearable; on rising and walking about briskly, a delicious feeling of coolness is experienced; but, on driving in a sledge, the cold soon becomes painful to the unprotected face and hands.

Such are the conditions prevailing at Davos, and producing the delightful climate of this winter resort. They may be thus briefly summarized: 1. Great elevation above sea-level; 2. A continuous, and, during winter, permanent covering of snow; 3. A minimum of watery vapor in the air; 4. A clear sun; 5. A clean atmosphere, free from zymotic germs, dust, and fog; 6. A sheltered position, favorable for receiving both the direct and reflected solar rays.

I have been thus particular in describing these conditions in order to make clear the capability of the Yellowstone plateau to provide a similar beneficent winter climate for invalids.

From my own observations, and from inquiries made on the spot, I am of opinion that the Yellowstone National Park possesses, in a high degree, all these essential conditions. In elevation above the sea it surpasses Davos; the great plateau of the park is between 7,000 and 8,000 feet above sea-level, while it is stated that not one of the narrow valleys dips below 6,000 feet. The mountain-ranges, partly surrounding and partly within the park, rise to heights of from 10,000 to 12,000 feet. I should anticipate, therefore, that all the advantages which, as a winter resort for invalids, Davos possesses from its elevated position, would be enjoyed even in a greater degree in the Yellowstone Park. The period of permanent snow is longer, so that invalids could remain there probably until the end of April, whereas the melting of the snow generally compels them to leave Davos early in March, when the climate of the valleys is peculiarly unfavorable for chest-complaints. It is to be expected, from its greater elevation, that a still clearer sky and a larger proportion of sunny days would be experienced in the Yellowstone Park, while the wholesomeness of the air would be still more marked, owing to its comparatively greater freedom from zymotic matter.

The latitude of Davos is 47°, and the Yellowstone Park lies almost entirely between the forty-fourth and forty-fifth parallels. The winter temperature at Davos varies from 32° Fahr. down to 22° Fahr., and that of the park would probably observe nearly the same extremes. The selection of suitable sites for hotels and sanitary dwellings is, of course, of the highest importance. The only hotel at present existing—the Mammoth Hot Springs Hotel—is not favorably situated, but, even in my comparatively limited excursions in the park, I saw numerous most eligible sites for such establishments—sites sheltered from northerly winds, either by abruptly elevated ground or pine-forest, with a wide expanse of prairie to the south. A free horizon southward is of great advantage to a winter climate, not only because the practically unlimited surface of snow secures the most perfect reflection of solar warmth, but also because there is no obstruction to the rays of the rising and setting sun. I consider the want of a free southern horizon to be an important defect in the situation of Davos, for it reduces in winter the daily period of sunshine by more than two hours, or, in other words, it diminishes the length of day available for patients in midwinter by more than one fourth. In respect of daily duration of sunshine, therefore, the advantage of the park over Davos would be considerable.

In order, however, that it may be fitted for the reception of invalids, much will have to be done besides the building of hotels. The lawlessness and extortion which at present prevail throughout the Yellowstone National Park must be made to cease, wholesome food must be substituted for the indigestible material which now does duty for beef and mutton, and the almost impassable roads must be seriously taken in hand.

The one drawback to the park is its great distance from the masses of the American population ; but, in the first place, distances which are almost prohibitive to travelers in Europe are thought little of in America ; and, secondly, the comfortable, not to say luxurious, traveling on American lines would render the transit from the Eastern cities of the United States scarcely more formidable than that from London to Davos, the driving portion of the journey being, in fact, much shorter in the American route.

We are as yet too little acquainted with the chemical composition of the hot springs, geysers, and mineral waters so profusely distributed throughout the park, to form any trustworthy opinion of their medicinal virtues, but the *physical* properties of water are much the same everywhere, and, by a judicious selection of sites, the enormous advantages of an unlimited supply of natural hot water and steam for baths and heating purposes could easily be secured, and this without interfering with the wonders and æsthetic beauties of this most extraordinary and interesting region.

At present, the park, so generously set apart by Congress for the enjoyment of the American people, is utilized only by a very limited number of tourists, in the few months of a very short summer, and it seems a pity that such a magnificent possession should not be much more extensively used. Dedicated during the winter months to the purposes I have here advocated, it would constitute a winter sanitarium unequaled in the world, restoring to health and vigor not only thousands of persons suffering from incipient chest-diseases, but also still greater numbers of the overworked populations of the States and Canada.

RECENT PROGRESS IN AËRIAL NAVIGATION.

By Professor W. LE CONTE STEVENS.

BALLOONING has thus far been a French art: introduced a little over a century ago by a Frenchman, Montgolfier; rapidly developed by another Frenchman, Charles; more practiced in France than anywhere else in the world; and recently improved by Frenchmen to such an extent that it is quite possible now on any fair day to go an hour's journey through the air in any desired direction, even against the wind.

The history of the application of science to art has revealed a number of cases in which practical success was secured by inventors entertaining quite erroneous conceptions of the principles they were applying. Somewhat vague stories are transmitted in regard to Roger Bacon's suggestion, during the thirteenth century, of employing a thin hollow globe of copper, "to be filled with ethereal air or liquid fire and then launched forth from some elevated point into the atmosphere, where it will float like a vessel on water." Bacon gave no recipe for making "liquid fire," nor did he calculate the dimensions of a globe of copper to be filled with it that would have sufficient ascensive power to lift a human being. He assures us "there is certainly a flying instrument, not that I ever knew a man that had it, but I am particularly acquainted with the ingenious person who contrived it." His conception was never reduced to practice. It was merely a fair specimen of current science in his time. He believed that the aërial ocean around our earth had a definite boundary like the liquid ocean, and that a body of sufficient lightness, if it could only be found, would easily rise to this surface as a cork rises to the surface of water.

More than three centuries after the time of Bacon, Father Lana wrote out his idea of a vessel that might be made to rise in the air. Four hollow globes of copper, each having a diameter of about twenty-five feet, were to be carefully exhausted and then attached to a car. Torricelli and Pascal had already proved that the pressure of the atmosphere was nearly fifteen pounds per square inch at sea-level, and Lana's proposed method of exhausting his globes was to be an application of Torricelli's principle. Each globe was to be filled with water and lifted to a height of at least thirty-four feet. Beneath it should be fitted a tube with air-tight connections, which was to dip into water. On opening this tube the contents of the globe would be emptied into the vessel below, leaving a Torricellian vacuum above, while the tube would become a water-barometer. Lana seemed to know nothing about the specific gravity of gases. His copper globes were to be made very thin in order to secure lightness, but he failed to make any correct estimate of the rigidity they must have to sustain either the weight of the water they should hold, or the crushing force of the atmosphere after exhaustion. Unlike the product of Bacon's imagination, his conception was a correct application of demonstrated physical laws; but, had it been tested by experiment, he would at once have found that there were other laws which he had not taken into account. In his view, the only obstacle to success was that "the Almighty would never allow an invention to succeed by means of which civil government could so easily be disturbed." Air-ships floating beyond the reach of missiles, if only capable of being accurately directed, might well have been thought more terrible than dynamite is to-day.

Soon after the discovery of hydrogen gas by Cavendish and Watt in 1766, experiments were made with a view to utilizing it for the purpose of lifting bodies into the air. But, until 1783, nothing more substantial than a soap-bubble could be made thus to ascend. Joseph Montgolfier, who was a successful manufacturer of paper, tried bags of this material; but hydrogen was found to diffuse so rapidly through it that the idea was abandoned by him. Observing that clouds of vapor and smoke remained floating at various heights, he thought that, if they could be confined in bags of paper, these might be made to float in like manner. Since the experiments of Franklin in 1752 had proved the existence of atmospheric electricity, the idea gained currency that the lightness of clouds and of smoke was in some way due to electric charge. A paper bag was made, and, with its opening downward, a fire was kindled, "as well to increase the layer of electric fluid upon the vapor in the vessel as to divide the vapors into smaller molecules and dilate the gas in which they are suspended." The bag was carried up to a considerable height. Montgolfier seems not to have attributed the ascension to the effect of heat in diminishing the specific gravity of the contained air. The first successful experiment in ballooning was thus based on a misconception.

Montgolfier's first public exhibition of his invention was made on June 5, 1783. The news of his success was rapidly spread; and at Paris a balloon was soon constructed under the superintendence of M. Charles, who substituted hydrogen for smoke, confining it in a bag of varnished silk instead of paper and linen. The ascension was successfully accomplished on the 27th of August. Charles at once proceeded to the construction of a new and much larger balloon, in which he ascended with his colleague, Robert, on the 1st of December, making a journey of more than twenty-five miles. This balloon was provided with a safety-valve of Charles's invention, a hoop, to which the car was attached, and netting intended to equalize the distribution of weight upon the balloon. It was in all important particulars the same as the balloon almost universally employed throughout a century afterward. Montgolfier made several exhibitions of his hot-air balloons at Paris, and in one of these, on the 15th of October, M. Pilâtre de

Rozier made the first ascent attempted by a human being. But to Charles is due the credit of making the balloon a moderately safe vehicle in which the aëronaut could ascend or descend at will by varying the relation between the amounts of ballast and of gas retained. Although many thousands of ascents have been made since 1783, the total number of lives recorded to have been lost does not exceed fifty.

It is somewhat remarkable that after the ascents made by Pilâtre de Rozier and others at Paris in the latter part of 1783, the first ascent accomplished elsewhere was in America, a country not only separated by a broad ocean from France, but at that time young in resources, and scarcely beginning to recover from the disastrous effects of the struggle for independence. It is true that in November of that year an Italian, Count Zambeccari, exhibited in London a small hydrogen balloon, which was sent into the air without any living freight; but no one rose from English ground in a balloon until a year after Charles had been successful in France. The news of Montgolfier's experiment of the 5th of June reached Philadelphia about the last of November, and the local newspapers of December 24th contained the accounts just received in regard to Charles's experiment of the 27th of August. David Rittenhouse, the friend of Franklin, and the most distinguished American astronomer of his time, was practicing his profession as a maker of philosophical instruments, and especially of clocks. One of his most intimate associates was Francis Hopkinson, an eminent jurist, whose interest in science was almost as great as in law. Both of these men were members of the American Philosophical Society which had been organized by Franklin. No sooner was the news from France received, than they began to test the use of hydrogen for balloons. On the 28th of December an ascent was made by the first American aëronaut, the account of which is perhaps best given in the language of an eye-witness, François Simonin, whose letter to the "Journal de Paris" was published May 13, 1784. In the "Gentleman's Magazine" of the following month a translation of it appeared, from which the following is an extract: "Messieurs Ritnose [Rittenhouse] and Opquisne [Hopkinson] began their experiments with bladders, and then with larger machines; they joined several together and fastened them round a cage, into which they put animals. The whole ascended, and was drawn down again by a rope. The next day, which was yesterday, a man offered to get into the cage, provided the rope was not let go. He rose about fifteen feet, and would not suffer them to let him go higher. James Wilcox, a carpenter, engaged to go in it for a little money. He rose twenty feet or upward before he made a signal to be drawn down. He then took instructions from Messieurs Ritnose and Opquisne, and after several repetitions on the ground consented to have the rope cut for fifty dollars. Dr. Jaune [Jones], the principal medical person in the city, attended in case of accident. The crowd was incredible, who shouted after the English fashion when they saw

Wilcox rise crowded in the cage, surrounded by forty-seven balloons fastened to it, with astonishing coolness, nodding his head to express his satisfaction and composure. After all, he could not rise above ninety-seven feet, according to the measures taken by two other gentlemen of the Philosophical Academy. He was at least five minutes in the air, but, perceiving the wind to blow from the east and drive him toward the Scoulquille [Schuylkill], he was frightened, and, agreeably to his instructions, made several incisions with a knife in three of the balloons. This was not sufficient, though we saw him descend a little. He pierced three more, and, seeing the machine did not come, his fear increased. He cut five more in the greatest haste, and, unfortunately, all on the same side. He was then seen to tack about (*chavirer*), and, as if he had slid down (*coulé bas*), he fell on the edge of a ditch and a finse [fence], as they call the inclosures. Dr. Jaune ran up ; the poor man had sprained his wrist, but received no other accident."

No sooner was the fact demonstrated that men could safely rise into the air at will, than inventors began to devise plans for directing aërial machines. So long as the balloon is completely at the mercy of the wind, it is practically useless as a means of conveyance. On rising high above the ground the direction of aërial currents is often found to differ greatly from that of the surface-currents. Rising above the clouds, the aëronaut may lose sight of the earth and be carried at a rate of which he is totally unconscious, there being no means of measuring his speed when borne along with a current to which the balloon opposes no sensible resistance. By noting the times and places of ascent and descent, the rate has been estimated to exceed that of our fastest railroad-trains ; and more than one aëronaut has lost his life by being carried out to sea. In the early part of 1784 M. Robert, the colleague of Charles, attempted the propulsion of a balloon by means of oars, but in vain. He subsequently tried artificial wings, but with no better success. M. Blanchard, who crossed the English Channel in 1785 with Dr. Jeffries, tried a variety of similar devices without success.

For the directing of balloons one of the first suggestions based on correct principles was offered by Francis Hopkinson. In a letter to Franklin, dated at Philadelphia, May 24, 1784, he recommends that the balloon shall be made oblong instead of spherical, and provided with a large and light wheel at the stern. "This wheel should consist of many vanes or fans of canvas, whose planes should be considerably inclined with respect to the plane of its motion, exactly like the wheel of a smoke-jack. If the navigator turns this wheel swiftly round by means of a winch, there is no doubt but it would (in a calm at least) give the machine a progressive motion, upon the same principle that a boat is *sculled* through the water." (Sparks's "Life and Works of Benjamin Franklin," vol. x, p. 93.) This remarkable suggestion by Hopkinson shows that he had quite definite views about the application of the principle of the screw-propeller to the direction of aërostatic machines, though in his day screw-propellers had not yet been applied even to surface navigation.

Hopkinson's suggestion did not then find its way into print. Even had it been published, the means were wanting for any experiments on a large scale. It would have been a noteworthy step in the right direction, but the muscular power of his imaginary aëronaut would have been far from sufficient to control the propeller. Nearly seventy years elapsed before his idea, independently evolved by another, was put to the test; and during this interval ballooning was but rarely applied to any other purpose than that of public display. The fruitless attempts to direct balloons were often made the subject of caricature.

In 1852 a young French engineer, who subsequently won the highest distinction, M. Giffard, constructed an elongated balloon (Fig. 1),

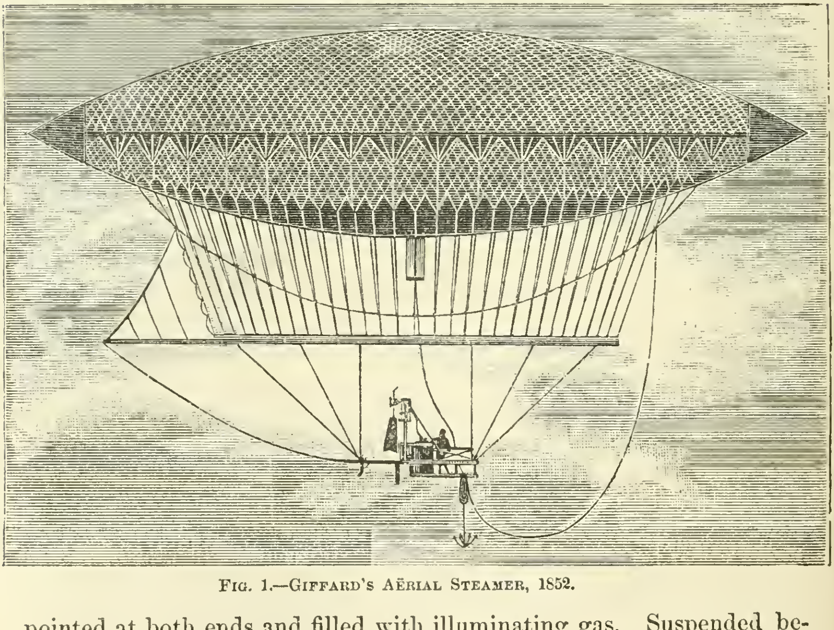


Fig. 1.—Giffard's Aërial Steamer, 1852.

pointed at both ends and filled with illuminating gas. Suspended beneath it by cords was a longitudinal shaft, at the end of which was a triangular sail that could be turned about an almost vertical axis and be made to serve the purpose of a rudder. About twenty feet beneath the shaft was hung a framework of wood, on which rested a small steam-engine, whose piston gave motion to a screw-propeller. The weight of the machine, including furnace, boiler, coal, and water, was not quite fourteen hundred pounds. On the 24th of September Giffard ascended with it over Paris to the height of five thousand feet. The wind was quite strong; but he was able to make very perceptible headway against this, and by the aid of the rudder to turn the machine into any desired direction. He thus proved incontestably that the problem of directing an aërial steamer was by no means insoluble. A second ascent was accomplished by him in 1855, but under unfavorable conditions. He made no further attempts with this machine, the abandonment of these experiments being due chiefly to their danger. A steam-engine, sending forth sparks beneath a mass of thirty thousand cubic feet of inflammable gas contained within an envelope of thin cloth, is a source of peril to which few men would be willing to expose themselves, even if lofty elevations were not reached. Trouble also resulted from the fact that the weight of the balloon could not be kept constant. The loss of the products of combustion and of spent steam made it difficult to preserve the proper relation between the ascensive power and the weight to be sustained.

Not quite twenty years after Giffard's experiments the problem was again attacked by M. Dupuy de Lôme. His immense balloon, containing one hundred and twenty thousand cubic feet of pure hydrogen, was nearly similar in shape to that of Giffard. The car beneath was capable of carrying easily fourteen men, seven of whom at a time were employed in working a capstan which controlled the shaft of the propeller, each of the two blades of this being about ten feet in length. On February 2, 1872, Dupuy de Lôme ascended in this balloon, and attained a speed estimated at 2·8 metres per second, equivalent to about six miles per hour. By means of the rudder he changed the direction through an angle of 12°. Giffard had attained an estimated speed of four metres per second, or nine miles per hour. Muscular power was thus shown to be far too uneconomical, while steam was too dangerous, to be employed in the direction of aërostats.

It was not until 1881, the year of Giffard's death, that electricity was applied as a motive power in the attempt to solve the difficult problem with which he had grappled. His pupil, M. Gaston Tissandier,* had early imbibed a passion for aëronautics, and made many successful ascents with spherical balloons. It was Tissandier who, in company with two friends, ascended in April, 1875, to the height of eight thousand six hundred metres, each of the three swooning on account of the rarefaction of the air, even before this limit was attained. The same aëronaut, in company with Fonvielle, was borne by the wind, in February, 1869, in thirty-five minutes, from Paris to Neuilly-Saint-Front, a distance of fifty miles. Keeping abreast with the progress of electrial science, Tissandier conceived the idea of employing storage-batteries instead of steam or hand power, as the immediate source of energy to actuate the propeller of an elongated balloon. He constructed a small experimental balloon, which was filled with hydrogen,

* The writer takes pleasure in acknowledging his personal indebtedness to M. Tissandier for the full accounts from which the facts set forth in the latter part of this article were obtained.

the effective ascensional force being two kilogrammes. A motor, of the Siemens type (Fig. 2), weighing only two hundred and twenty grammes, was made to turn the propeller, which consisted of a pair of vanes, each ten centimetres long; storage-cell, motor, and propeller being supported on a light platform suspended by netting. This

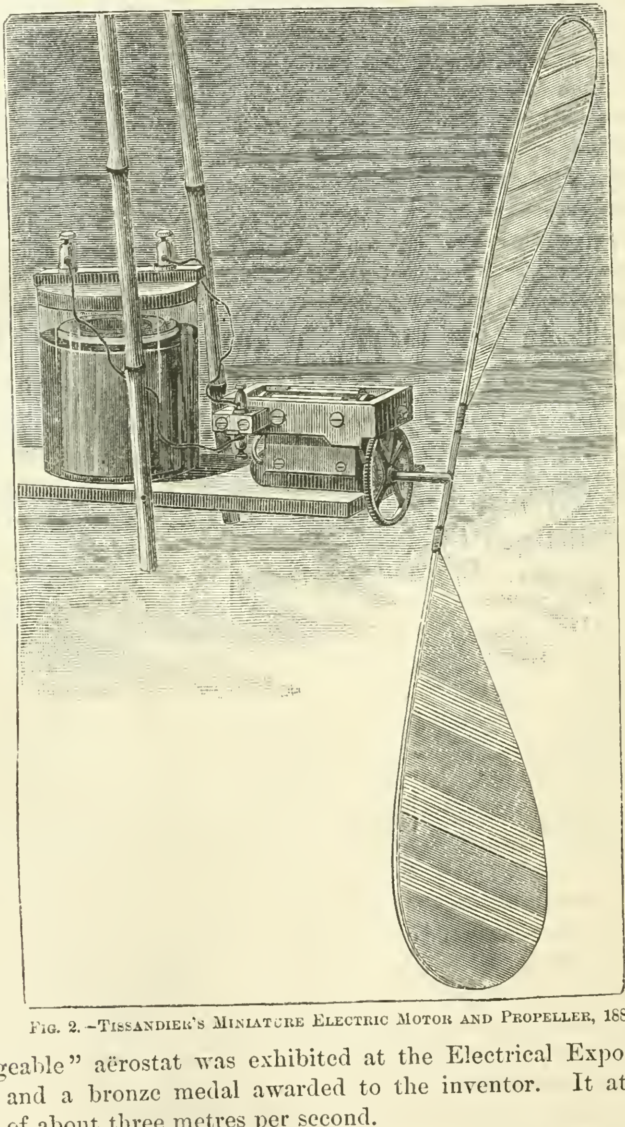


Fig. 2.—Tissandier's Miniature Electric Motor and Propeller, 1881.

"dirigeable" aërostat was exhibited at the Electrical Exposition of 1881, and a bronze medal awarded to the inventor. It attained a speed of about three metres per second.

Encouraged by this success, Tissandier undertook the work of constructing an aërostat large enough to lift two or three persons in addition to the weight of the propelling apparatus and other accessories.

The task was one which involved a heavy expenditure of money, aside from the time, labor, and thought bestowed by the inventor. He sought in vain to organize a company with a capital of two hundred thousand francs for the purpose of constructing an aërostat of three thousand cubic metres capacity ; but the plan was not sufficiently promising of large dividends to be attractive to investors. No fortunes have been made thus far by the navigation of the air, and capitalists have not generally manifested a self-sacrificing spirit in behalf of pure science. The persevering aëronaut could find no one but his brother, M. Albert Tissandier, who was confident enough to join him in laying out capital for the promotion of what was generally regarded as a visionary scheme. The two brothers henceforward worked together, the one continuing to devote himself to the perfection of the electrical appliances on which reliance was to be placed, while the other, who is by profession an architect, gave his attention to the mechanical construction of the aërostat. M. Gaston Tissandier had found by experiments with his small aërostat that better results were to be had from a battery of cells, arranged in series, where a strong acid solution of potassium bichromate was the exciting liquid, than from a storage-battery—the energy evolved during the first few hours being greater in proportion to the weight of the battery. He originated several ingenious contrivances by which great lightness was secured, and the liquid could be conveniently brought into contact with the zinc and carbon plates, or removed at will without disturbing the plates.

A Siemens electric motor was constructed, weighing but fifty-five kilogrammes. When excited by the current from a battery of twenty-four elements weighing one hundred and sixty-eight kilogrammes, this motor was found capable of doing work equivalent to that of twelve or fifteen men, that is, from seventy-five to one hundred kilogramme-metres per second, continued through three hours, the weight of battery and motor together being but little in excess of the weight of three men. Tissandier devised also important improvements in the method of generating pure hydrogen rapidly on a large scale. The ascensive force of this gas when pure is about seventy-five pounds per thousand cubic feet, or eleven hundred and eighty grammes per cubic metre ; while that of coal-gas which has been most generally employed for ballooning purposes is not more than five eighths as much. By the substitution of hydrogen, the size, and consequently the expense, of the balloon is correspondingly diminished.

The aërostat constructed by M. Albert Tissandier is shown in Fig. 3. It is ninety-two feet long, thirty feet in its greatest diameter, with capacity of about thirty-eight thousand cubic feet, and ascensive power of twenty-eight hundred pounds. The propeller, nine feet in diameter, is in the rear of the cage. Above it, and farther back, is a triangular sail, to be manipulated as a rudder. On October 8, 1883, the first ascent was made. The air at the ground was calm, but on reaching a height of sixteen hundred feet the wind was blowing at the rate of rather more than six miles an hour. On putting the propeller into action, with a velocity of three revolutions per second, and turning the head of the aërostat against the breeze, it was kept motionless for some minutes ; but the rudder soon proved to be insufficient to keep the direction constant, flapping like a sail, and at times

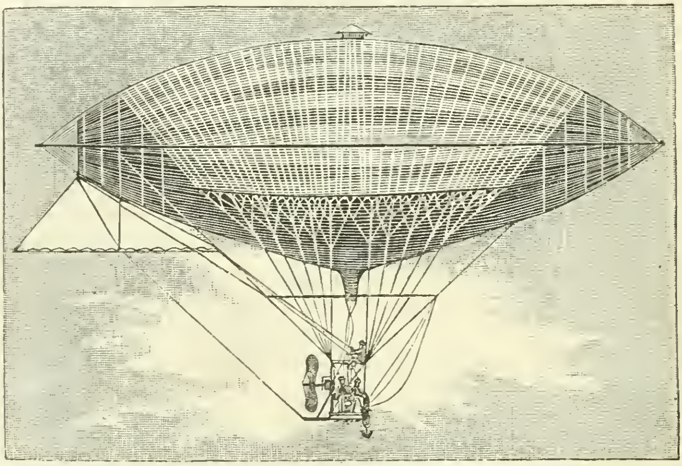


Fig. 3.—Tissandier's Balloon, 1883.

leaving the aëronauts at the mercy of the wind. After stopping the propeller and waiting until the direction of the aërostat coincided with that of the wind, the action was renewed. A marked acceleration in speed was the immediate result, and deviations from the line of the wind were secured by very slight motion of the rudder, the aërostat keeping its stability perfectly. The descent was safely accomplished after remaining in the air a little more than an hour.

This first experiment in the use of electricity in practical aëronautics was about as successful as that of Giffard with steam in 1852, so far as relates to the attainment of speed ; but it showed that such speed could now be secured without danger and without any uncontrollable variation in the weight of the mass propelled. Tissandier did not expect the attainment of complete success in a single trial ; such as he did attain was enough to convince not only him but others that he had opened out a pathway which could be followed with entire confidence. He had not the means at hand sufficient to enable him to keep his aërostat inflated, so as to repeat his experiment on the first favorable day after imposing such modifications as were suggested by the experience of the first ascent. It was not until September 26, 1884, that this opportunity was presented. The velocity of the wind was about the same as during the first ascent, but the aërostat was propelled at a rate about one third greater, so as to make at times very perceptible headway against the wind.

Meanwhile the success achieved by the Tissandier brothers in 1881 and 1883 had inspired MM. Renard and Krebs, officers of the French army, who were stationed at Chalais-Meudon, near Paris. They had for several years been conducting experiments on the conditions requisite for directing balloons, being guided in their studies by the previous work of Dupuy de Lôme. An appropriation of one hundred thousand francs had been granted them, during Gambetta's brief administration, and their investigations were conducted with the utmost secrecy. The pecuniary resources at their command gave them a great advantage over Tissandier, in the ability to construct a balloon much larger than that with which Tissandier's success had been achieved; and this permitted the application of a motor nearly seven times as powerful as the one previously employed. Their balloon (Fig. 4) is one hundred and sixty-six feet long, twenty-eight feet in greatest diameter, its capacity sixty-seven thousand cubic feet, and ascensional power nearly five thousand pounds. The ratio of length to thickness is thus much greater than in Tissandier's balloon. The details of construction of the battery and motor have not been given to the public by Captain Renard. The rudder is almost a parallelogram in form, and thickest in the middle, the cloth being tightly stretched over a light framework so as to present a rigid surface to the air. The propeller is fixed to the extremity of a long shaft, and placed at the front, instead of rear, of the balloon. The front end of the machine is thicker than the rear end. This feature seems rather unaccountable. The balloon is filled with hydrogen, but within it is a subsidiary balloon, connected by a tube with the cage, where air can be pumped in or out at pleasure, thus varying slightly the specific gravity of the mass as a whole and enabling the aëronauts to vary their elevation at will.

On August 9, 1884, an ascent was accomplished with this balloon, the atmosphere being almost perfectly calm. A journey of nearly two miles was made in a southerly direction, then over a mile westward, after which the balloon was turned northward and eastward. Very slight motion of the rudder was needed to execute these curves. Twenty-three minutes after their flight was begun the aëronauts were immediately over their starting-point, having made a trip of not quite five miles. In descending it was necessary to move backward and forward several times in succession, alternately reversing the direction of rotation of the propeller. The return to the ground was at the very spot from which the departure had been made. This remarkable feat was thus accomplished almost exactly one hundred and one years after the ascent of the first hydrogen balloon, sent up by Charles from a point but a few miles distant.

A second ascent was made by Renard and Krebs on the 12th of September, but with only partial success, in consequence of an accident to the motor. On the 8th of November two successive journeys were taken, the balloon returning each time to its point of departure, and attaining a speed of nearly fifteen miles an hour, independently of the wind, which was blowing at the rate of five miles an hour.

In their communication to the French Academy of Sciences, on the 18th of August, Renard and Krebs accord to Tissandier the credit of

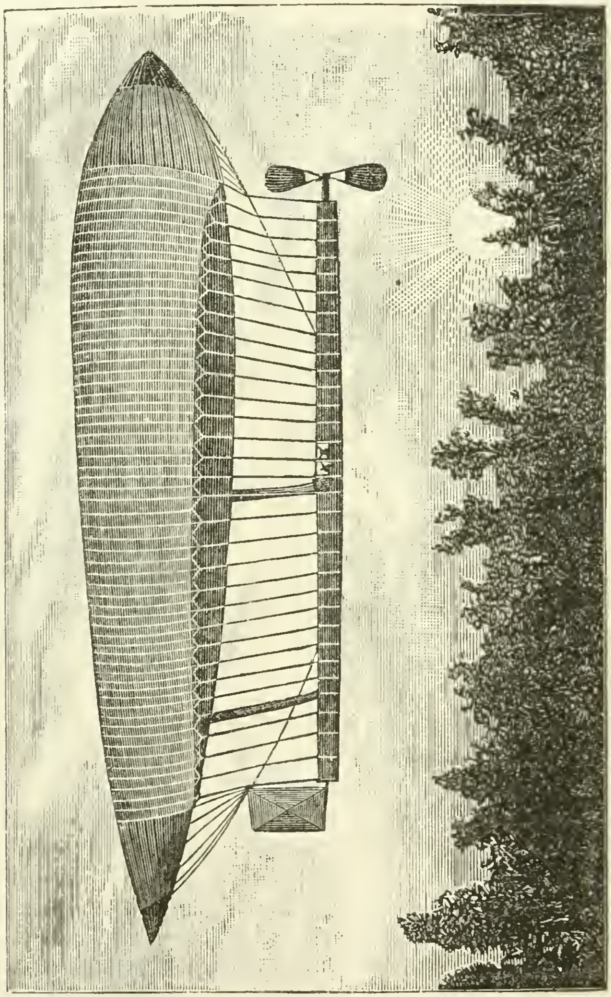


Fig. 4.—Renard and Krebs's Balloon, 1884.

priority in successfully applying electricity to the propulsion of balloons. Tissandier, on the other hand, equally freely accords to them the credit of making a pronounced success of what had been developed to only a limited extent in his hands on account of the want of funds. To each of the group the world must now give praise for the solution of a problem which was theoretically solved long ago, but involved practical difficulties that seemed almost if not quite insurmountable.

At best, however, the balloon as a means of locomotion is of more interest from a scientific than commercial standpoint. Increasing experience will determine the best disposition to be made in relation to a variety of points that are still open to discussion, such as the best methods of reducing resistances and increasing the efficiency of the motor. On the basis of the success already attained, calculations have been made which indicate that it may be quite possible in the near future to construct larger balloons that will travel in calm air at the rate of twenty-five or thirty miles an hour. Such air-ships, capable of ready direction at safe elevations, may serve important purposes in time of war. But for the public their use must long continue to be very limited. The enormous expense attendant upon the construction and manipulation of an aërostat capable of carrying even so few as a score of persons forbids competition with railroads and steamships. The high-tension battery, which is at present the most available source of energy to give motive power, has an effective life of only a few hours; and, even during this time, the cost of zinc and acid is far in excess of that of coal and water. For special purposes, where surface-locomotion is impossible, and expenses can be sustained by great corporations or very wealthy individuals, the "dirigeable" balloon may, perhaps, win for itself an important place. The history of the application of science to art, especially during the last half-century, suggests caution in making sweeping denials, merely because our present knowledge does not enable us to grasp all the details of future development. Dr. Lardner's assertion, that no steamship would ever cross the Atlantic, may well remain fresh in our minds. The present competition between electricity and coal-gas as illuminating agents could scarcely have been foreseen in the days when coal-gas was itself comparatively a novelty. If we continue, as is probable, to attain cheaper methods of generating electricity, the balloon may grow in favor as the electric light has done, but without causing the least commotion in the market for railroad stocks.

But, for the development of aëronautics as an art, we must continue to look to France, its earliest home. If stock companies are formed for the manufacture of air-ships, it must be first among those to whom the recent successes have already become a source of pride. Even as toys and as advertising media, balloons have always been more popular in France than elsewhere. The city of Paris has for years past included one or more large establishments devoted exclusively to the manufacture of them. Should "dirigeable" balloons ever become of commercial importance, enterprising Americans will be quick to imitate their French neighbors, and put upon our market all that the public may demand. The day is perhaps not far distant when at least a favored few in our own country may enjoy the luxury of summer afternoon excursions through the air, free from dust and cinders, and occasionally even vying with the birds in speed.

ARCHÆOLOGICAL FRAUDS.

By CHARLES C. ABBOTT, M. D.

It seems rather hard lines that, even if the archæologist goes personally into the field, and gathers with his own hands specimens of stone implements, he is not quite free from the possibility of being imposed upon.

The cause of this unhappy state of affairs is found in several facts, all of which are of such character that it is well-nigh impossible to avoid being misled by them. In the first place, it requires much less skill and practice than is imagined to artistically shape arrow-heads and other small objects, from fragments of jasper and other minerals having a conchoidal fracture. Many boys, too impatient to gather the relics of the Indians, which requires considerable labor, often practice on broken specimens until they can repoint them, and convert others into handsome examples of scrapers, trimmed flakes, and other forms with which every archæologist is familiar. Unfortunately, the newly-fractured jasper presents a surface scarcely distinguishable from that of objects made centuries ago, so slowly does the process of weathering dull the surface of this flint-like mineral; and the eager collector, who a week before, it may be, charged the boys on various farms to keep all the relics they could find, receives, in his too great eagerness, as genuine, every specimen of known shapes, and is in no wise deceived in the difference in chipping between the ancient and the modern. Indeed, I greatly doubt if any difference can be detected in such simple forms as triangular arrow-heads, scrapers, trimmed flakes, and knives. I have time and again been shown handsome specimens, which I was assured were made by the exhibitors, and, on expressing some doubt, have had other specimens made in my presence. The skill with which one urchin chipped the characteristic beveled edge of a scraper, using only a small quartz pebble as a hammer or chipper, was marvelous, and I have good reason to believe I have been victimized more than once by this same youngster. Still, the prices usually paid for arrow-heads are not such as to warrant boys generally in undertaking the necessary preliminary practice of chipping flint, and the number of modern chipped implements is relatively not large; and being, in all cases, imitations of known patterns, they can not mislead. I do not think any of the Flint Jacks whom I have met ever attempted to design new forms, or copy those found in distant localities, a knowledge of which could only be derived from books. If such should become the case, dire confusion must inevitably arise.

In the case of such implements of stone as were made by pecking away the surface, and subsequently polishing all or portions of the surface, but few attempts to counterfeit have come to my notice. This remark, however, is exclusive of all objects of hematite. So many hundreds of these are manufactured in Cincinnati and other cities, that no object of this material should be admitted into a museum or private cabinet unless its history rendered fraud absolutely impossible. Attempts at making grooved axes have been brought to my notice, but they were so rudely shaped, and so new in appearance, that deception was impossible. The flat pebbles, with two or four notches, known as "net-sinkers," are readily made, but are so abundant that to manufacture them, instead of looking for those made by the Indians, has not yet become profitable.

The Indians were quick to perceive how readily thin, flat sandstone pebbles could be perforated, and so become available as ornaments. Such objects I have gathered by the score from graves and village sites ; and, as a result of calling the attention of collectors to these perforated disks, I find that they are now made in large numbers ; being perforated with flint drills, and the "new" surfaces carefully polished with leather and emory. This gives the appearance of age, and such specimens are readily palmed off upon the unwary. Indeed, detection of the fraud is well-nigh impracticable. A rainy Saturday means mischief, so far as country school-boys are concerned ; for I find that they often congregate in some quiet corner to drill pebbles and repoint arrow-heads ; and then, lying in wait for the professor or the "'Gasy (Agassiz) Club" boys, from town, unload upon them the remarkable "finds" (?) made since their last vist. I do not wish to discourage archæological research, but simply to warn enthusiastic students against dangers to which they are exposed ; for I speak from sad experience.

Of frauds in mound pottery and striped slate, I need not here make other mention than to caution the purchaser of specimens ; for there are abundant counterfeits offered by dealers in curiosities. I do not mean to imply that these dealers are acquainted with the true history of the objects exposed for sale, for they, like the archæologists, are frequently imposed upon.

Unexaggerated as are the dangers of imposition such as I have pointed out, they are really insignificant as compared with that attaching to the purchase of steatite implements. It is well known that the Indians made constant use of this mineral for the manufacture of cooking-vessels, for smoking-pipes, and, to a limited extent, for small ornaments ; but probably never for weapons. As the mineral is so readily worked, the cunning Flint Jacks have long been in the nefarious business of imitating pots, pipes, and trinkets, without number.

Philadelphia has the honor (?) of being the headquarters of steatite frauds ; and it is not long since that one hundred beautiful objects, made by one man, were added to an extensive collection, at a cost of five hundred dollars. Had not the discovery of their origin been made in time, it would have resulted in American archæologists credit-ing the Delaware Indians with far more skill in carving, even steatite, than they ever possessed. As tobacco-pipes have ever been the rarest and most costly of Indian relics, special attention was given to their manufacture, and very remarkable have been some of the specimens which have found their way into private cabinets and public museums. The history of some of these pipes is as intricate and fascinating as a novel, but want of space forbids its publication in this connection. Suffice it to say that the archæologist is only safe when he exhumes, in person, steatite pipes from graves, and finds other objects, either under like circumstances, or sees them plowed up on ancient village sites.

So determined, indeed, are some of these fabricators of frauds, that the following incident is worthy of being published, to show the ingenuity they exercise in their peculiar calling. To discover an Indian grave is, of course, a red-letter day for the archæologist. Now, *Indian graves are manufactured to order*, it would appear. At least the following recently occurred in New Jersey: A Philadelphia Flint Jack secured a half-decayed skeleton from a Potter's field in the vicinity, and placed it in a shallow excavation on the wasting bank of a creek in New Jersey, where Indian relics were frequently found. With it he placed a steatite tobacco-pipe of his own make, a steatite carving of an eagle's head, and beads; with these were thrown numbers of genuine arrow-heads and fragments of pottery. The earth was blackened with powdered charcoal. This "plant" was made in November, and, in the following March, during the prevalence of high waters and local freshets, he announced to an enthusiastic collector that he knew the location of an Indian grave, and offered to take him thither for fifty dollars, the money to be paid if the search proved successful, which of course it did. The cranium of that Philadelphia pauper passed through several craniologists' hands, and was gravely remarked upon as of unusual interest, as it was *a marked dolichocephalic skull, whereas the Delaware Indians were brachycephalic!*

A word, in conclusion, with reference to that much-vexed question, the contemporaneity of man and the mastodon in North America. Constantly objects are being brought to the attention of archæologists as having some bearing upon this question. As to whether the "elephant-pipes," of Iowa, or the "Lenapé-stone," of Pennsylvania, be genuine or not, no opinion is here expressed; but it is unquestionable that many of the remains of the mastodon found in New Jersey and New York are far more recent than some of the relics of man, and it is simply impossible that even so late a comer as the Indian should not have seen living mastodons on the Atlantic seaboard of this continent. Elephant-pipes and carvings should not be condemned, merely because of an impression still prevalent that the mastodon was a creature of an earlier geological epoch than the recent. This is but half the truth: he also shared the forests of the present with the fauna of historic times.

RAILROADS, TELEGRAPHS, AND CIVILIZATION.

By Herr C. HERZOG.

THERE has hardly been a more quiet decade in the political history of the nineteenth century than the one between 1830 and 1840. Yet that decade was the cradle of a new epoch, in which inventions first came into view, or were brought to practical completion, which have had a deeper and more permanent influence than any political event could have upon the shaping of human society. The first steam-railroad in Europe was built in the beginning of this decade, after George Stephenson had solved the problem of the locomotive in 1829. In 1833 Gauss and Weber fixed the first telegraph-wire between the Observatory and the Physical Cabinet in Göttingen, and thereby laid the foundation of electro-magnetic telegraphy, building on which Morse in 1836 invented the writing-telegraph. In this year, 1836, also, the first screw-steamer was built in England, and the transatlantic steam-traffic was opened two years later, or in 1838.

Only a few sharp and enlightened minds could have been able at that time to form a conception of the effects which these discoveries were destined to exercise upon the world ; but their development from those feeble beginnings to the present day has immeasurably surpassed the most sanguine expectations.

The length of the railways, of which three hundred and thirty-two kilometres were in operation in 1830, had risen in 1883 to more than 444,000 kilometres ; and, if the lines were joined one to another, they would have gone around the earth in its longest circumference more than ten times ! Like a net, the meshes of which are continually drawing closer together, their lines are woven over all the countries of Europe ; in both Americas, they have made way into the hitherto pathless wilderness ; they have climbed the Rocky Mountains of the North and the Cordilleras of Peru, and have broken through the nation-dividing walls of the Alps ; the largest streams of the earth wear the yoke of their bridges ; in Southern Africa, in the East Indies, and in Japan, they are pressing unintermittingly into new regions, and even in the Chinese Empire trial-surveys are making for advantageous routes.

Steamship navigation has grown on a similarly grand scale. Nearly ten thousand steamers, with a capacity of seven million tons, traverse the ocean, and connect all parts of the earth with one another. Independent of wind and tide, they maintain communications with a swiftness, security, and regularity rivaling those of the railways, whose complement they are in providing for the world's trade.

More rapidly and extensively than both of these has the telegraph taken possession of the world. The conductor which, in 1833, connected the study-rooms of two German scholars, has in fifty years spread out into a network of wires that incloses the earth. The length of the telegraph lines is estimated now at nearly a million kilometres, and the length of the wires at more than double that number. They stop for no obstacles, but find their way over mountains covered with eternal snow, through deserts, and across rivers. Even the sea does not stop them. More than seven hundred submarine cables bear messages over the bottom of the ocean with a speed outstripping that of the thought in which they originated. Hard as it was fifty years ago even approximately to imagine the impending development of the young discoveries and their influence, it is just as hard now to comprehend them in their fullness. The majority of living people take them for granted, and have no further thought about them. Railroads and telegraphs have been so much a matter of course to them from their childhood up that they can hardly conceive that it was ever different. But he whose memory goes back more than a generation, or whoever has traveled in countries where mules or oxen are the only means of transportation, can realize the difference and appreciate the importance of the progress, and the relations that exist between numerous phenomena of life and those concerns.

The most important and evident of these phenomena are the changes which railroads and telegraphs as means of trade have directly impressed on economical affairs; their influences have also made themselves felt, partly as consequences of those changes, in part directly, in transformations of social conditions, and of manners and customs.

It is common to the means of transportation moved by steam and to the telegraph that they effect changes of place, the former of physical objects and men, and the latter of thoughts, with power, speed, and security, immeasurably surpassing those of the formerly known means.

We will first consider the exchange of goods which composes trade. In his latest "Review of the World's Economy," Dr. Van Neumann-Spallart estimates the weight of the goods which the railroads collectively carried in 1882 at about 1,200,000,000 tons; the freight of the steamers was calculated at about half that weight. By far the greater part of these masses of goods have been set in motion by trade in order to place them where they could be made of use. For this reason, the figure of the weight, although the contemplation of it overtaxes our limited powers of conception, gives quite as little idea of the meaning of this enormous movement as does the knowledge of the weight of the blood circulating in the body, with which it is customary to compare this trade, an explanation of the effect of its flow.

The extension of trade may be considered as to space and as to variety of articles. In the former respect, all parts of the earth have been drawn within the circle of exchanges, even those which formerly lay quite outside of such connections, either because they were thinly inhabited or too difficult of access ; and the trade resources within civilized lands have been greatly expanded as the improvement of transportation facilities has compensated for the difference between the former cost and the present advance. The quantity of the goods used in trade and the variety are increased, or at least become available for whole classes of consumers, to whom their use was formerly forbidden on account of their price. Our daily life affords abundant examples of such articles. They are exemplified in the variety and prices of our food resources, in the fashions of our clothing, in our architecture, and in the warming and lighting of our houses. Coffee, tea, spices, and other products of the tropics, which were formerly rare among the wealthy, are now set upon the tables of the people, and are objects of general use. The European demand for wheat brings into competition steamers from Northern and Western America, Chili, the states of the La Plata, and India.

In clothing, the moderation of price resulting from the cheapened transportation of the raw materials and the wider distribution of the fabrics come more into view than the introduction of new or hitherto unknown or inaccessible materials, of which jute is the only example we now recollect. That silk, which was formerly a mark of wealth, is now worn by women of only moderate means, and cotton goods, which were articles of luxury a hundred years ago, are made into everybody's shirts and bedclothes, are in no small part due to the cheapness and speed of freight-carriage as well as to the increased facilities for manufacturing them afforded by the introduction of steam machinery.

The improvements which railroads and steamers have made possible in our buildings are also obvious, in the use of solid materials in regions far from the quarries. The coals with which we warm our houses and from which we derive our gas-lights, and the petroleum which burns in the lamps of the man of small means, articles which have become indispensable in modern life, but the use of which was formerly forbidden in all but the narrow regions of their productions, are now carried into the most remote mountain-valleys and across oceans, to wherever men live.

As railways and steamers perform the hard, steady, physical work of trade, so the telegraph assists the mental work of its service. Of the more than a hundred million telegrams which the electric wires carry over the earth yearly, by far the greatest part concern affairs of trade. The telegraph is the medium of all important communications in wholesale trade, and speculation could hardly exist without it. A commercial solidarity covering the whole globe has been built upon it, and the present generation for the first time sees a world-trade.

The connection is most evident in transactions in goods of large consumption, and is manifested in the tendency to equalization in prices and in the rates of discount. The price of the staple articles of commerce is fixed in the market of the world. The price of wheat is determined every day by the telegraphic reports to Chicago of the day's transactions in the principal places on the globe where wheat is handled, and the price of cotton in a similar manner at New Orleans and Liverpool; and in all financial transactions the most remote commercial centers respond to one another with a facility and celerity that can hardly be excelled by those with which two houses separated only by the Thames could communicate.

This extension of quick communication over the whole globe has been attended with the further advantages of making commercial products accessible to the largest possible circle of consumers, of making capital, which flows where it can be applied with the most profit, easily available at such spots, and in the acquisition of a number of storage-points whence goods can be dispatched with but little delay to the places where there is a demand for them. Conditioned upon these circumstances are the general decline of interest and the easier avoidance or quicker relief of the distress which may arise in single countries or districts from the temporary scarcity of some particular necessity. Railroads and steamboats have made the prevalence of real famine and the misery associated with it impossible so long as any purchasing power exists in a country or a city. Speculation, so much abused, while it looks out first for its own interests, takes care to compensate for local failures of crops by sending in timely supplies, and has in railroads and telegraphs ready and powerful instruments for its enterprise. That many men still actually suffer from hunger is not to be denied; but it nevertheless appears now to be impossible for the most of the world that a local scarcity of food arising from dearth or any disaster shall not be immediately remedied from without.

This wide community of interests also has its shadows. The ease with which large quantities of goods can be carried from countries where they have accumulated in excess under favoring conditions, to regions where this production is not equally favored, is fraught with disadvantages to the local producers by depreciating the prices of their goods when the circumstances are already hard for them. The depressing competition of American and Indian wheat in the European markets, which the home farmers lament with so much reason, is a striking example of this. Still more serious is the rapidity with which the effects of a commercial crisis occurring anywhere are felt in all markets. But these negative effects of solidarity of interests, hard as they may bear at times upon individuals, are insignificant as compared with the advantages it brings to the general welfare.

Apace with the widening of the trade in goods, has production reached an unprecedented development, and this as regards quantity and variety and quality. If Industry knew what it was doing when in 1829 it offered a prize for a locomotive-engine available as a draught-power, its knowledge has brought it rich fruits. With that invention it gained a basis for increased production, and made it possible to bring together the raw material and the power at points where human skill and the other favorable conditions for production were found. The railroad carried coal and lime to the iron-mines, and cotton to the valleys where men's hands and valuable water-powers were waiting to be used ; blast-furnaces and forges rose here, spinning and weaving establishments there. Industry was released from its bondage to the few spots where all the conditions favorable to its development existed together: and became mobile. It was enough after that if any one of those conditions was given in any place ; what was wanting could be supplied at relatively small expense by means of the railway. Thus have great industries developed themselves mainly under the operation of these agencies. The remarkable phenomena in the economical field connected with these enterprises are the division of labor and the tendency to the equalization of wages, both as between different places and as against fluctuations in the prices of goods ; the former prominently exemplified in the confinement of particular enterprises to special branches of production ; the latter favored by the easy migration of laborers from place to place, and the rapid spread of news of advances in wages, as well as by the possibility of coalitions against uneven scales.

Just as a community of interest has been produced in the world's trade by the operation of railroads and telegraphs, so it has been in industries. Every advance in technics shortly becomes known and common, while those who are backward in taking it up suffer during the transition. On the other hand, local crises are felt by related industries far from the place of their origin, till, in fact, the distance becomes so great that the market is protected against the effects of the shock by the cost of transportation. But here, again, the flexibility and efficiency of the means of communication are of great help in overcoming such crises and equalizing their mischievous consequences.

The movement of persons has undergone quite as important a growth as that of goods. In the "Review of the World's Economy," already named, the number of passengers carried by all the railroads in all parts of the world, in 1882, is estimated at 2,400,000,000, or an average of six and half million a day. The absolute number of passengers carried on steamers is smaller ; but here, as was also the case with goods, they are carried for longer distances, and more days' journeys, than on railroads ; so that, estimated by the mile or the day, the amount both of freight and passenger work the steamers do will appear to much better advantage.

The significance of the facilitation of passenger transportation is derived principally from its effects on social conditions, civilization, and customs. One of the most important of these effects is illustrated in emigration, which has assumed grand dimensions under the operation of the new methods of communication. Of the twelve and a half million emigrants who went to the United States between the recognition of their independence and 1883, not more than a million belong to the time previous to the establishment of regular passenger communication by steamer with Europe, about 1844. As a result of the establishment of this method of communication, and of the building of the railroads that opened the Mississippi Valley and the western part of the continent, emigration assumed colossal proportions. Besides the amelioration of the voyage, which has become an affair of not more than ten or twelve days for emigrant-vessels, the improved fare, the cheaper rate of passage, and the punctuality and increased safety of the transit, may be marked as circumstances contributing to this result.

The difficulties of the land-journey were formerly hardly less formidable to emigrants seeking the interior of the country than were those of the sea-voyage. Weeks and even months might be spent in reaching the end of the journey, while the traveler had to do without everything he could not take along with him, or else to procure it at the expense of great trouble and cost. Now the railroad carries one from the port of arrival, in as many days as months were formerly required, to the extreme West; and, finding himself there, he is no longer lost in the wilderness, with nothing but his own efforts to depend upon; but he has a railroad passing at no very great distance, to keep him in constant communication with civilization. To these great impulses may be added the increased facilities for coming and going within their own country. Formerly the poor man was tied to his threshold by the impossibility of obtaining the means to get away. Now, at an expense of time and money relatively trifling, he is able to go and seek other places where he may find better fields for the exercise of his powers and easier conditions of existence. In this way the condition of the poorer and the laboring classes has been immeasurably altered. Hence we see a streaming of working-men toward the centers of great industries, large towns growing up, labor become scarce in the agricultural districts, and the industrial organizations undergoing a revolution. The labor market has undergone the same kind of extension as the market for goods; and skilled labor has become more and more a thing of merchandise, the price of which is regulated by the larger conjunctures of business. The personal relation between laborer and employer, which formerly, at least in handicraft work, had somewhat the aspect of a family relation, has been dissolved or relaxed.

We have also to speak of the services which the post has rendered. They are by no means limited to the economical field, but they are most evident there. Trade and industry, and all economical life, could hardly be thought of to-day without the co-operation of the post. And that it has surely, effectively, and abundantly contributed to their advancement, to a degree that appears wonderful to us, has again been made possible only by the use of railroads, steamers, and telegraphs. Neither the relatively small postage rate within a single state nor the moderate rate of the Postal Union, the establishment of which represented one of the most remarkable stages in the progress of civilization, would have been possible without these vehicles, as the always ready, cheap, and indefatigable bearers of our correspondence.

So dependent upon one another are all the factors of human life that we should expect to observe the effects of the agencies we have been considering upon all, and we do so observe them, most prominently, perhaps, besides the points on which we have remarked, upon the modern methods of war. The steamer has within the last thirty years taken the place of the sailing-vessel in the navies of all countries to such an extent that the latter is only exceptionally used for warlike purposes. Connected with this change are changes in the form and handling of the guns, armoring, the introduction of turret-ships, and modifications of naval tactics.

While the locomotive has not been made a direct arm, railroads and telegraphs have greatly changed the aspects of war on land. With their help, the mobilization of the army and the concentration of its scattered divisions at the point selected for attack or defense are accomplished in a space of time that is almost as nothing compared with what was required to move troops by the old method. The skillful and energetic use of these helps gives, under some circumstances, an impetus that may be decisive for the issue of the war. They are no less important during the progress of the war, in that they are useful for the forwarding of troops and camp-supplies. The army that controls the railroads is master of the field. It is for the general so to manage the movements of troops by their aid that his forces shall at any given time be superior to those of the enemy at an appointed place, and either compel them to retreat or to fight under unfavorable circumstances. Modern strategy, therefore, consists no little in having knowledge and skill enough to operate with the railroads as the most important factors of movements and the actions, in which, with modern arms, multitudes of men are of more effect than personal bravery, as never to strike except where and when he knows that his forces are superior. It is also an important consideration that provisions and ammunition and re-enforcements can be steadily supplied to the army by means of railroads, so as to keep it constantly effective, even in the enemy's country ; and that the wounded can be carried away from the neighborhood of the battle-field to hospitals far back, or to their homes.

While it is true that wars have in these days become more bloody, it can also be said that they are shorter and, in a certain sense, more humane; the latter, not only in the fact that the victims of battle receive better care, but also that the peaceful population of the country visited by war are, by means of the improved facilities for communication, spared the burden of maintaining the invading army. The greater part of the cruelty and barbarity of former wars arose from the fact that the troops had to be supported by the land in which they were encamped, and the necessity of their taking care of themselves excluded all consideration for the people. War is still a direful scourge; but the arrangements for provisioning and foraging and the system of requisitions which railroads have made possible place the military administration in a condition to spare the country from exhaustive drafts, and to prevent excesses by the soldiers. The influence of modern means of intercourse may also be seen in the peaceful relations of states to one another, and in the inner political life of individual states. We shall make no mistake if we assign to railroads and telegraphs an important part in the present tendency to form large states and to give greater consistency to national organizations. Similarity and community of economical interests are not consistent with separation by arbitrary divisions. Material interests require the widest possible conformity of legislation and administration and a strong civil power able to give them external and internal protection, neither of which can be afforded in the small state. Railroads and telegraphs are a political force of the first order to promote in nascent states the accomplishment of their union, in established states the strengthening of the executive and the growth of the political influence of the government. In all civilized states the telegraph and the railroads together enable the government to be advised of all important events on the instant of their happening, and immediately to take whatever measures may be necessary. It is a further consequence that the central power becomes more concentrated, and the individual prerogative and responsibility of the local officers limited; while in smaller states the administrative organization may be simplified by dispensing with intermediate agents.

The effect of railroads and telegraphs upon the civic structure is also manifested in the more lively participation of the people in political life. This happens both in consequence of the increased ease of personal intercourse and through the quickening and increased extent of the exchanges of thought that are furthered by the press and by correspondence. The freer intercourse of candidates with the people whose votes they are seeking, and of deputies with their constituents, has done much to make the people acquainted with public questions in their varying aspects, and interested in them. Much more is done by the periodical press, which now scatters its issues in numbers and with a speed and cheapness that would have been incredible a half-century ago. Other factors are indeed contributing to this condition, but they would be practically of little value in producing these effects were they not accompanied by correspondingly increased facilities for the diffusion of news. It fails to give an adequate idea of the extent of this influence, to state that two and a half milliard copies of newspapers were circulated in 1882 through the Postal Union, and that only an insignificant proportion of these were carried otherwise than by railroad. Most of these journals being political, the part they have in diffusing political intelligence among the people, who depend almost entirely upon them, and in forming their political culture, may be conceived but can not be measured.

This feature also is attended with disadvantages. The newspapers circulating in all classes of society, the number of persons upon whom the formation of that vague force called public opinion depends has become multiplied many times, and in it many are included who have not the previous knowledge requisite to the formation of an intelligent opinion, or capacity to form a real opinion of their own. Consequently, the quality of public opinion has depreciated. It is more easily led into error, and harder to set right. Furthermore, the rapidity with which the telegraph makes it possible to convey news of all important events—and unimportant ones, too—from all parts of the world to all other parts, has given public opinion a taste and a preference for mere matters of fact. The pressure to learn the latest news is stronger than the desire to know events in their order and connections. Thus interest is rather directed to what is striking and sensational, and, responding to this, the papers give to news of that kind space and conspicuousness out of all proportion to its value. Consequently, we have shallowness of public opinion on the one side, exaggeration and unreliability on the other.

In another aspect, railroads and telegraphs have contributed to the increase of knowledge and the expansion of the ideas and conceptions of the people ; indirectly by assisting in the circulation of journals that carry knowledge on all kinds of subjects through all the channels of their circulation, and directly by making it possible for people of moderate means, and inducing them, to travel and observe for themselves things and phenomena abroad. When I was a boy, the journey of about thirty miles to the capital of the province was an event for children and parents, which was talked about and prepared for for weeks beforehand, and required a whole day of traveling. People seldom went beyond the boundaries of the province, except on business, or on the occasion of important festivals, or of death. Now we can travel to the sea-coast or the mountains in the same time, and with hardly more expense than it then took to go the thirty miles, and we eagerly use the opportunity to change our scene, whether it be to improve the health a shade, for mental relaxation, for instruction, or for pleasure. The attendance at baths, the rise of summer resorts and air-cures, and furloughs for all classes of officers, have become regular institutions, while they were formerly indulged only in cases of sickness; and the excursions of school vacations, the pleasure-trains and the extra trains on holidays, long wedding tours, excursion parties to foreign lands, or around the world, are evidences of the taste for traveling that modern men feel, and of the ease with which it is gratified. Then there are the journeys to meetings of men of a common calling, to scientific congresses or social unions. There is hardly a condition or a professional society that does not feel the need of bringing its members together, and of holding at different but always agreeable places social unions. To these we may add exhibitions, in which fisheries and agriculture, the industries and the fine arts display and compare their efforts, with their culmination in periodical world's fairs. Without railroads this mobility and this releasing of men from their soil, which answer a deep longing of our nature, would be possible only within the narrowest limits.

It can not be denied that with all this are connected a great enrichment, with new views and feelings, a considerable enlargement of mental scope, and a strong stimulus to mental activity, even where no intention of the kind is entertained. Errors are cleared up and prejudices are overcome. Deficiencies at home are revealed by comparison with what is seen abroad, and all that is recognized as better is imitated and improved upon. Habits are also disciplined. Railroads demand an exact account of time, and require all who use them to conform to their regulations. They train people in the most efficient manner to punctuality, to quick decision, and to the omission of formalities.

The forms of intercourse and family relations are also not slightly affected. It can hardly be said that the influence in the former case is always beneficial. Politeness and regard for fellow-travelers, if they happen to interfere with one's own comfort, are not exactly cultivated with zest by railroad-passengers. But we frequently meet polite and interesting traveling-companions, whose intercourse gives us pleasure. Moreover, railroad-traveling brings persons of different degrees of cultivation together, and is fitted to smooth the forms of intercourse, and to have, on the whole, a refining influence, provided cultivated persons set good examples.

I am uncertain whether heart-connections leading to marriage are often formed on railway-journeys. If we may trust the novelists and playwrights, this is the case. At any rate, railway-traveling has an influence on relations of this kind to the extent that it favors the forming of acquaintances between persons living at a distance from one another, out of which family relations may grow. Marriages certainly are negotiated over a much wider scope than formerly, both within the country of residence and as reaching into foreign countries. Distance offers no obstacle to the father's informing himself concerning the circumstances of his daughter's suitor; and the careful mother can consent to let her child go to places which would formerly be considered out of the world, because she can correspond with her daily ; and it only requires a journey of a few hours or days, which also promises a welcome variety to the monotonous life of the parental home, to bring the separated family together again. A change has also come over the course of family life, in which habit and tradition had established fixed customs, whereby the old ways are slowly dissolved and new forms take their place. The prescription of kin, in which the choice of a wife was formerly confined, is relaxed ; the old Frankish courting by the parents for the son is out of fashion ; the wedding-feast is arranged to suit the railroad-train on which the young couple will begin their journey ; fresh blood and strange customs are pressing into the close circle of ancient relationship and stiff usage ; they break up the pride of neighborhood narrowness, and make it first tolerant, then inviting to the foreign better usages, against which it had shut itself up, and which it had despised, merely because they were strange.

On the other side, if modern facilities for moving about furnish opportunities for extending our ideas and knowledge, they also lead to superficiality in observation, which loses in depth and thoroughness what it gains in extent. We travel far in a day, but we see only by glances. Between the beginning of the journey and its appointed end the passenger generally stops only as long as the train, or, at very important stations, only over till the next train. What lies between passes before his vision like a scene in a theatre, or is lost while he sleeps. The guide-books furnish all the information he seeks. For many the number of miles they have traveled over is the most important point. It is evident that nothing useful can come from traveling of this kind. Another undeniable result is the neglect of what is near and around us for what is distant. Many people know more of foreign countries than of their own neighborhoods, consequently their attachment for home is weakened. From indifference to disdain is only a step. On this ground are explained the disappearance of old customs, which gave fixedness to social life in the family and the commune, the dissatisfaction with the narrowness of the home, and a relaxation of regard for persons in authority and for older persons, whose experiences, gathered in the narrow home circle, are not allowed to compete with the assumed versatile and superior knowledge of traveled youth. In a wider circle are thus explained the rapid spread of the fashions and a kind of leveling in life and customs. The new styles, which formerly went out very slowly, now spread quickly through all classes, and the differences between country and city are disappearing.

Returning to the public life of society, we find two features in which there seems to be a connection between changes that are going on and the modern conditions of transportation, viz., the democratic tendencies of society, and the prevalence of materialism. The democratic tendency, which is peculiar to the times, does not limit itself to exhibition in state constitutions, but is penetrating the whole social life. In its wider sense it signifies the mergence of class-differences, the abolition of transmitted privileges and inherited exclusiveness, and the assertion of individuality. It is true that this tendency is older than the railroads and telegraphs, and its origin can not be ascribed to them; but it is also true that they have given it a great impulse, to which compulsory education, universal military obligation, and universal suffrage, have equally contributed. Railroads treat all their passengers alike. All must adapt themselves to the same order and regulations. No one can interfere with the time of arrival or departure, or the speed, or the length of stoppages. Even special trains must not interfere with the time-table. In the case of cars of different classes, the only criterion of distinction is that of price; whoever pays the charge can travel in the corresponding class, whether it pleases his fellow-passengers or not, and he receives the same treatment as they. The ideas suggested by such commingling are very apt to be carried into other fields of intercourse.

With the democratizing of society is flowing a parallel current of a practical materialism, which is manifested in a predominance of material interests over ideal ones, in the recognition of egoism as a leading principle in trade, in the estimation of men's deeds, only according to their visible consequences, and in the rejection of all that transcends realism. This drift is not new in human civilization; but it is a new fact that the masses have been drawn into it, and that they aim to make it potent after they have destroyed or reformed the old civil and social order. Its causes are complicated, and are perhaps only indirectly referable to the expansion of means of communication; but they are connected with the results of increased traffic and intercourse, and their operation is re-enforced by them.

It is too soon to speculate as to what will be the end or the ultimate result of these two parallel movements.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

DIET IN RELATION TO AGE AND ACTIVITY.

By Sir HENRY THOMPSON.

ENOUGH, and more than enough, perhaps, has been uttered concerning the prejudicial effects on the body of habitually using alcoholic beverages. It is rare now to find any one, well acquainted with human physiology, and capable of observing and appreciating the ordinary wants and usages of life around him, who does not believe that, with few exceptions, men and women are healthier and stronger, physically, intellectually, and morally, without such drinks than with them. And confessedly there is little or nothing new to be said respecting a conclusion which has been so thoroughly investigated, discussed, and tested by experience, as this. It is useless, and indeed impolitic, in the well-intentioned effort to arouse public attention to the subject, to make exaggerated statements in relation thereto. But the important truth has still to be preached, repeated, and freshly illustrated, when possible, in every quarter of society, because a very natural bias to self-indulgence is always present to obscure's men views of those things which gratify it. While, in addition to this, an exceedinly clever commercial interest of enormous influence and proportions never ceases to vaunt its power to provide us with "the soundest," "purest," and most to be suspected of all with even "medically certified," forms of spirit, wine, and beer ; apparently rendering alcoholic products conformable to the requirements of some physiological law supposed to demand their employment, and thus insinuating the semblance of a proof that they are generally valuable, or at least harmless, as an accompaniment of food at our daily meals.

It is not, however, with the evils of "drink" that I propose to deal here : they are thus alluded to because, in making a few observations on the kindred subject of food, I desire to commence with a remark on the comparison, so far as that is possible, between the deleterious effects on the body of erroneous views and practice in regard of drinking, and in regard of eating, respectively.

I have for some years past been compelled, by facts which are constantly coming before me, to accept the conclusion that more mischief in the form of actual disease, of impaired vigor, and of shortened life, accrues to civilized man, so far as I have observed in our own country and throughout Western and Central Europe, from erroneous habits in eating, than from the habitual use of alcoholic drink, considerable as I know the evil of that to be. I am not sure that a similar comparison might not be made between the respective influence of those agencies in regard of moral evil also ; but I have no desire to indulge in speculative assertion, and suspect that an accurate conclusion on this subject may be beyond our reach at present.

It was the perception, during many years of opportunity to observe, of the extreme indifference manifested by the general public to any study of food, and want of acquaintance with its uses and value, together with a growing sense on my own part of the vast importance of diet to the healthy as well as to the sick, which led me in the year 1879 to write two articles in this review entitled "Food and Feeding." And since that date fresh experience has, I confess, still enhanced my estimate of the value of such knowledge, which indeed it is impossible to exaggerate, when regarding that one object of existence which I suppose all persons desire to attain, viz., an ample duration of time for enjoying the healthy exercise of bodily and mental function. Few would, I presume, consider length of life a boon apart from the possession of fairly good health; but this latter being granted, the desire for a prolonged term of existence appears to be almost universal.

I have come to the conclusion that a proportion amounting at least to more than one half of the disease which imbitters the middle and latter part of life among the middle and upper classes of the population is due to avoidable errors in diet. Further, while such disease renders so much of life, for many, disappointing, unhappy, and profitless, a term of painful endurance, for not a few it shortens life considerably. It would not be a difficult task—and its results if displayed here would be striking—to adduce in support of these views a numerical statement showing causes which prematurely terminate life among the classes referred to in this country, based upon the Registrar-General's reports, or by consulting the records of life-assurance experience. I shall not avail myself of these materials in this place, although it would be right to do so in the columns of a medical journal. My object here is to call the attention of the public to certain facts about diet which are insufficiently known, and therefore inadequately appreciated. And I shall assume that ample warrant for the observations made here is within my reacn, and can be made available if required.

At the outset of the few and brief remarks which the space at my disposal permits me to make, I shall intimate, speaking in general terms, that I have no sympathy with any dietary system which excludes the present generally recognized sources and varieties of food. It is possible, indeed, that we may yet add considerably to those we already possess, and with advantage; but there appears to be no reason for dispensing with anyone of them. When we consider how varied are the races of man, and how dissimilar are the climatic conditions which affect him, and how in each climate the occupations, the surrounding circumstances, and even the individual peculiarities of the inhabitants, largely differ, we shall be constrained to admit that any one of all the sources of food hitherto known may be made available, may in its turn become desirable, and even essential to life.

To an inhabitant of the Arctic Circle, for example, a vegetarian diet would be impracticable, because the elements of it can not be produced in that region; and, were it possible to supply him with them, life could not be supported thereby. Animal food in large quantity is necessary to sustain existence in the low temperature to which he is exposed. But I desire to oppose any scheme for circumscribing the food resources of the world, and any form of a statute of limitations to our diet, not merely because it can be proved inapplicable, as in the case of the Esquimaux, under certain local and circumscribed conditions, but because I hold that the principle of limiting mankind to the use of any one class of foods among many is in itself an erroneous one. Thus, for example, while sympathizing to a large extent myself with the practice of what is called "vegetarianism" in diet, and knowing how valuable the exclusive or almost exclusive use of the products of the vegetable kingdom may be for a considerable number of the adult population of our own and of other countries in the temperate zones, and for most of that which inhabits the torrid zone, I object strongly to a dogmatic assertion that such limitation of their food is desirable for any class or body of persons whatever. Moreover, an exclusive or sectarian spirit always creeps in sooner or later, wherever an "ism" of any kind leads the way, which sooner or later brings in its train assertions barely supported by fact, the equivocal use of terms, evasion—in short, untruthfulness, unintended and unperceived by the well-meaning people who, having adopted the "ism," at last suffer quite unconsciously from obscurity of vision, and are in danger of becoming blind partisans.

Thus the term "vegetarian," as used to distinguish a peculiar diet, has no meaning whatever unless it implies that all the articles of food so comprised are to be products of the vegetable kingdom; admitting, of course, the very widest scope to that term. In that sense the vegetable kingdom may be held to embrace all the cereals, as wheat, barley, rye, and oats, maize, rice, and millet; all the leguminous plants—beans, peas, and lentils; all the roots and tubers containing chiefly starch, as the potato, yam, etc.; the plants yielding sago and arrowroot; the sources of sugar in the cane and beet, etc.; all the garden herbs and vegetables; the nuts, and all the fruits. Then there are the olive and other plants yielding the important element of oil in great abundance. An admirable assortment, to which a few minor articles belong, not necessary to be specified here. An excellent display of foods, which suffice to support life in certain favorable conditions, and which may be served in varied and appetizing forms. And to those who find their dietary within the limits of this list the name of vegetarian is rightly applicable. But such is by no means the practice of the self-styled vegetarians we usually meet with. It was only the other evening, in a crowded drawing-room, that a handsome, well-developed, and manifestly well-nourished girl—"a picture of health" and vigor—informed me with extreme satisfaction that she had been a "vegetarian" for several months, and how thoroughly that dietary system agreed with her. She added that she was recommending all her friends (how natural!) to be vegetarians also, continuing, "And do you not believe I am right?" On all grounds, one could only assure her that she had the appearance of admirably illustrating the theory of her daily life, whatever that might be, adding, "But now will you tell me what your diet consists of?" As happens in nineteen cases out of twenty, my young and blooming vegetarian replied that she took an egg and milk in quantity, besides butter, not only at breakfast, but again in the form of pudding, pastry, fritter, or cake, etc., to say nothing of cheese at each of the two subsequent meals of the day: animal food, it is unnecessary to say, of a choice, and some of it in a concentrated form. To call a person thus fed a vegetarian is a palpable error; to proclaim one's self so almost requires a stronger term to denote the departure from accuracy involved. Yet so attractive to some, possessing a moral sense not too punctilious, is the small distinction attained by becoming sectarian, and partisans of a quasi-novel and somewhat questioned doctrine, that an equivocal position is accepted in order to retain if possible the term "vegetarian" as the ensign of a party, the members of which consume abundantly strong animal food, abjuring it only in its grosser forms of flesh and fish. And hence it happens, as I have lately learned, that milk, butter, eggs, and cheese are now designated in the language of "vegetarianism" by the term "animal *products*," an ingenious but evasive expedient to avoid the necessity for speaking of them as animal food!

Let us, for one moment only, regard milk, with which, on Nature's plan, we have all been fed for the first year, or thereabout, of our lives, and during which term we made a larger growth and a more important development than in any other year among the whole tale of the life which has passed, however long it may have been. How, in any sense, can that year of plenty and expansion, which we may have been happy and fortunate enough to owe—an inextinguishable debt—to maternal love and bounty, be said to be a year of "vegetarian diet"! Will any man henceforward dare thus to distinguish the source from which he drew his early life? Unhappily, indeed, for want of wisdom, the natural ration of some infants is occasionally supplemented at an early period by the addition of vegetable matter; but the practice is almost always undesirable, and is generally paid for by a sad and premature experience of indigestion to the helpless baby. Poor baby! who, unlike its progenitors in similar circumstances, while forced to pay the penalty, has not even had the satisfaction of enjoying a delightful but naughty dish beforehand.

The vegetarian restaurant at the Health Exhibition last summer supplied thousands of excellent and nutritious meals at a cheap rate, to the great advantage of its customers; but the practice of insisting with emphasis that a "vegetable diet" was supplied was wholly indefensible, since it contained eggs and milk, butter and cheese in great abundance.

It is not more than six months since I observed in a well-known weekly journal a list of some half-dozen receipts for dishes recommended on authority as specimens of vegetarian diet. All were savory combinations, and every one contained eggs, butter, milk, and cheese in considerable quantity, the vegetable elements being in comparatively small proportion!

It is incumbent on the supporters of this system of mixed diet to find a term which conveys the truth, that truth being that they abjure the use, as food, of all animal flesh. The words "vegetable" and "vegetarian" have not the remotest claim to express that fact, while they have an express meaning of their own in daily use—namely, the obvious one of designating products of the vegetable kingdom. It may not be easy at once to construct a simple term which differentiates clearly from the true vegetarian the person who also uses various foods belonging to the animal kigndom, and who abjures only the flesh of animals. But it is high time that we should be spared the obscure language, or rather the inaccurate statement, to which milk and egg consumers are committed, in assuming a title which has for centuries belonged to that not inconsiderable body of persons whose habits of life confer the right to use it. And I feel sure that my friends "the vegetarians," living on a mixed diet, will see the necessity of seeking a more appropriate designation to distinguish them ; if not, we must endeavor to invent one for them.

But why should we limit by dogma or otherwise man's liberty to select his food and drink? I appreciate the reason for abstaining from alcoholic drinks derived from benevolent motive or religious principle, and entertain for it the highest respect, although I can not myself claim the merit of self-denial or the credit of setting an example—abstaining, like many others, solely because experience has taught that to act otherwise is manifestly to do myself an injury.

This brings me to the point which I desire to establish, namely, that the great practical rule of life in regard of human diet will not be found in enforcing limitation of the sources of food which Nature has abundantly provided. On the contrary, that rule is fulfilled in the perfect development of the art of adapting food of any and every kind to the needs of the body according to the very varied circumstances of the individual, at different ages, with different forms of activity, with different inherent personal peculiarities, and with different environments. This may read at first sight, perhaps, like a truism ; but how important is the doctrine, and how completely it is ignored in the experience of life by most people, it will be my object here to show.

I have already alluded to the fact that the young and rapidly growing infant, whose structures have to be formed on the soft and slender lines laid down before birth, whose organs have to be solidified and expanded at one and the same time, in which tissues of all kinds are formed with immense rapidity and activity, requires animal food ready prepared in the most soluble form for digestion and assimilation. Such a food is milk ; and, if the human supply is insufficient, we obtain in its place that of the cow, chiefly ; and during the first year of life milk constitutes the best form of food. After that time other kinds of nourishment, mostly well-cooked wheaten flour in various shapes, begin to be added to the milk which long continues to be a staple source of nourishment to the young animal. Eggs, a still more concentrated form of similar food, follow, and ultimately the dietary is enlarged by additions of various kinds, as the growing process continues through youth to puberty, when liberty arrives more or less speedily to do in all such matters "as others do." On reaching manhood, the individual in ninety-nine cases out of a hundred acquires the prevailing habit of his associates, and he feeds after that uniform prescription of diet which prevails, with little disposition to question its suitability to himself. A young fellow in the fullness of health, and habituated to daily active life in the open air, may, under the stimulus of appetite and enjoyment in gratifying it, often largely exceed both in quantity and variety of food what is necessary to supply all the demands of his system, without paying a very exorbitant price for the indulgence. If the stomach is sensitive or not very powerful, it sometimes rejects an extravagant ration of food, either at once or soon after the surfeit has been committed; but, if the digestive force is considerable, the meals, habitually superabundant as they may be, are gradually absorbed, and the surplus fund of nutrient material unused is stored up in some form. When a certain amount has been thus disposed of, the capacity for storage varying greatly in different persons, an undesirable balance remains against the feeder, and in young people is mostly rectified by a "bilious attack," through the agency of which a few hours of vomiting and misery square the account. Then the same process of overfeeding recommences with renewed appetite and sensations of invigorated digestion, until in two or three, or five or six weeks, according to the ratio existing between the amount of food ingested and the habit of expending or eliminating it from the body, the recurring attack appears and again clears the system, and so on during several years of life. If the individual takes abundant exercise and expends much energy in the business of life, a large quantity of food can be properly disposed of. Such a person enjoys the pleasure of satisfying a healthy appetite, and doing so with ordinary prudence not only takes no harm, but consolidates the frame and enables it to resist those manifold unseen sources of evil which are prone to affect injuriously the feeble. On the other hand, if he is inactive, takes little exercise, spends most of his time in close air and in a warm temperature, shaping his diet nevertheless on the liberal scheme just described, the balance of unexpended nutriment soon tells more or less heavily against him, and must be thrown off in some form or another.

After the first half or so of life has passed away, instead of periodical sickness, the unemployed material may be relegated in the form of fat to be stored on the external surface of the body, or be packed among the internal organs, and thus he or she may become corpulent and heavy, if a facility for converting appropriate material into fat is consistent with the constitution of the individual; for some constitutions appear to be without the power of storing fat, however rich the diet or inactive their habits may be. When, therefore, this process can not take place, and in many instances also when it is in action, the oversupply of nutritious elements ingested must go somewhere, more or less directly, to produce disease in some other form, probably at first interfering with the action of the liver, and next appearing as gout or rheumatism, or to cause fluxes and obstructions of various kinds. Thus recurring attacks of gout perform the same duty, or nearly so, at this period of life, that the bilious attacks accomplished in youth, only the former process is far more damaging to the constitution and materially injures it. In relation to liver derangement and inordinate fat production, we may see the process rapidly performed before our eyes, if we so desire, in the cellars of Strasburg. For the unfortunate goose who is made by force to swallow more nutritive matter than is good for him in the shape of food which, excellent in appropriate conditions, is noxious to the last degree when not expended by the consumer—I mean good milk and barley-meal—falls a victim in less than a month of this gluttonous living to that form of fatty liver which under the name of *foie gras* offers an irresistible charm to the gourmet at most well-furnished tables.* The animal being thus fed is kept in a close, warm temperature and without exercise, a mode of feeding and a kind of life which one need not after all go to Strasburg to observe, since it is not difficult to find an approach to it, and to watch the principle carried out, although only to a less considerable extent, anywhere and everywhere around us. Numerous individuals of both sexes, who have no claim by the possession of ornithological characteristics to consanguinity with the animal just named, may be said neverless to manifest signs of relation in some sort thereto—not creditable perhaps—to the goose, the Strasburg dietary being an enforced one—by their habit of absorbing superfluous quantities of nutriment while living a life of inactivity, and of course sooner or later become invalid in body, unhappy in temper, and decrepit in regard of mental power.

For let us observe that there are two forces concerned in this matter of bountiful feeding which must be considered a little further. I have said that a hearty, active young fellow may eat, perhaps, almost twice as much as he requires to replace the expenditure of his life and repair the loss of the machine in its working without much inconvenience. He, being robust and young, has two functions capable of acting at the maximum degree of efficiency. He has a strong digestion, and can convert a large mass of food into fluid aliment suitable for absorption into the system : that is function the first. But, besides this, he has the power of bringing into play an active eliminating force, which rids him of all the superfluous materials otherwise destined,

* In passing I would strongly commend the condition of those poor beasts to the consideration of the Antivivisection Society, since more disease is artificially produced among them in order to furnish our tables with the "*pâté*" than by all the physiologists of Europe who in the interest, not of the human palate, but of human progress as affected by therapeutic knowledge, sometimes propagate and observe certain unknown forms of disease among a few of the lower animals.

as we have seen, to become mischievous in some shape: and that is function the second. To him it is a matter of indifference for a time whether the quantity of material which his food supplies to the body is greater than his ordinary daily expenditure demands, because his energy and activity furnish unstinted opportunities of eliminating the surplus at all times. But the neglect to adjust a due relation between the "income" and the "output" can not go on forever without signs of mischief in some quarter. A tolerably even correspondence between the two must by some means be maintained to insure a healthy condition of the body. It is failure to understand, first, the importance of preserving a near approach to equality between the supply of nutriment to the body and the expenditure produced by the activity of the latter, and, secondly, ignorance of the method of attaining this object in practice, which give rise to various forms of disease calculated to imbitter and shorten life after the period of prime has passed.

Let it be understood that in the matters of feeding and bodily activity a surplus of unexpended sustenance—here referred to as "the balance"—is by its nature exactly opposite to that which prudent men desire to hold with their bankers in affairs of finance. In this respect we desire to augment the income, endeavoring to confine expenditure within such limits as to maintain a cash balance in our favor to meet exigencies not perhaps foreseen. But, in order to preserve our health when that period of blatant, rampant, irrepressible vigor which belongs to youth has passed away, it is time to see that our income of food and our expenditure through such activity as we have constitute a harmonious equality, or nearly so. It is the balance against us of nutritive material which becomes a source of evil. And it is a balance which it is so agreeable and so easy to form, and which often so insidiously augments, unless we are on our guard against the danger. The accumulated stores of aliment, the unspent food, so to speak, which saturate the system are happily often got rid of by those special exercises to which so large a portion of time and energy is devoted by some people. It is to this end that men at home use dumb-bells or heavy clubs, or abroad shoot, hunt, and row, or perform athletic and pedestrian feats, or sweat in Turkish baths, or undergo a drench at some foreign watering-place—all useful exercises in their way, but pursued to an extent unnecessary for any other purpose than to eliminate superfluous nutrient materials, which are occasioning derangements in the system, for which these modes of elimination are the most efficient cure, and are thus often ordered by the medical adviser. But as we increase in age—when we have spent, say, our first half-century—less energy and activity remain, and less expenditure can be made; less power to eliminate is possible at fifty than at thirty, still less at sixty and upward. Less nutriment, therefore, must be taken in proportion as age advances, or rather as activity diminishes, or the individual will suffer. If he continues to consume the same abundant breakfasts, substantial lunches, and heavy dinners, which at the summit of his power he could dispose of almost with impunity, he will in time certainly either accumulate fat or become acquainted with gout or rheumatism, or show signs of unhealthy deposit of some kind in some part of the body, processes which must inevitably empoison, undermine, or shorten his remaining term of life. He must reduce his "intake," because a smaller expenditure is an enforced condition of existence. At seventy the man's power has further diminished, and the nutriment must correspond thereto if he desires still another term of comfortable life. And why should he not? Then at eighty, with less activity there must be still less "support." And on this principle he may yet long continue, provided he is not the victim of an inherited taint or vice of system too powerful to be dominated, or that no unhappy accident inflicts a lasting injury on the machine, or no unfortunate exposure to insanitary poison has shaken the frame by long, exhausting fever; and then with a fair constitution he may remain free from serious troubles, and active to a right good old age, reaching far beyond the conventional seventy years which were formerly supposed to represent the full limit of man's fruitful life and work on earth.

But how opposed is this system to the favorite popular theory! Have we not all been brought up in the belief that the perfection of conduct consists, truly enough, in temperate habits in youth and middle life, such duty, however, being mostly enforced by the pleasant belief that when age arrived we might indulge in that extra "support"—seductive term, often fruitful of mischief—which the feebleness of advancing years is supposed to deserve? The little sensual luxuries, hitherto forbidden, now suggested by the lips of loving woman, and tendered in the confidence of well-doing by affectionate hands, are henceforth to be gratefully accepted, enjoyed, and turned to profit in the evening of our declining years. The extra glass of cordial, the superlatively strong extract of food, are now to become delicate and appropriate aids to the enfeebled frame. Unhappily for this doctrine, it is, on the contrary, precisely at this period that concentrated aliments are not advantageous or wholesome, but are to be avoided as sources generally prolific of trouble. If the cordial glass and the rich food are to be enjoyed at any time, whether prudently or otherwise, like other pleasures they must be indulged when strength and activity are great, in other words, when eliminating power is at its maximum, assuredly not when the circulation is becoming slow and feeble, and the springs of life are on the ebb. For the flow of blood can not be driven into any semblance of the youthful torrent by the temporary force of stimulants, nor is it to be overcharged by the constant addition of rich elements which can no longer be utilized. And thus it is impossible to deny that an unsuspected source of discomfort, which in time may become disease, sometimes threatens the head of the household—a source which I would gladly pass over if duty did not compel me to notice it, owing as it is to the sedulous and tender care taken by the devoted, anxious partner of his life, who in secret has long noted and grieved over her lord's declining health and force. She observes that he is now more fatigued than formerly after the labors of the day, is less vigorous for business, for exercise, or for sport, less energetic every way in design and execution. She naturally desires to see him stronger, to sustain the enfeebled power which age is necessarily undermining; and with her there is but one idea, and it is practically embodied in one method—viz., to increase his force by augmenting his nourishment! She remonstrates at every meal at what she painfully feels is the insufficient portion of food he consumes. He pleads in excuse, almost with the consciousness of guilt, that he has really eaten all that appetite permits, but he is besought with plaintive voice and affectionate entreaty "to try and take a little more," and, partly to stay the current of gentle complaint, partly to gratify his companion, and partly, as with a faint internal sigh he may confess to himself, "for peace and comfort's sake," he assents, and with some violence to his nature forces his palate to comply, thus adding a slight burden to the already satiated stomach. Or if, perchance, endowed with a less compliant nature, he is churlish enough to decline the proffered advice, and even to question the value of a cup of strong beef-tea, or egg whipped up with sherry, which unsought has pursued him to his study, or been sent to his office between eleven and twelve of the forenoon, and which he knows by experience must if swallowed inevitably impair an appetite for lunch, then not improbably he will fall a victim to his solicitous helpmeet's well-meaning designs in some other shape. There is the tasteless calf's-foot jelly, of which a portion may be surreptitiously introduced into a bowl of tea with small chance that its presence will be detected, especially if accompanied by a good modicum of cream; or the little cup of cocoa or of coffee masking an egg well beaten and smoothly blended to tempt the palate—types of certain small diplomatic exercises, delightful, first, because they are diplomatic and not direct in execution; and, secondly, because the supporting system has been triumphantly maintained, my lord's natural and instinctive objections thereto notwithstanding.

But the loving wife—for whom my sympathy is not more profound than is my sorrow for her almost incurable error in relation to this single department of her duty—is by no means the only source of fallacious counsel to the man whose strength is slowly declining with age. We might almost imagine him to be the object of a conspiracy, so numerous are the temptations which beset him on every side. The daily and weekly journals display column after column of advertisements, enumerating all manner of edibles and drinkables, and loudly trumpeting their virtues, the chief of which is always declared to be the abundance of some quality averred to be at once medicinal and nutritious. Is it bread that we are conjured to buy? Then it is warranted to contain some chemical element; let it be, for example, "the phosphates in large proportion"—a mysterious term which the advertising tradesman has for some time past employed to signify a precious element, the very elixir of life, which somehow or other he has led the public to associate with the nutriment of the brain and nervous system, and vaunts accordingly. He has evidently caught the notion from the advertising druggist, who loudly declares his special forms of half-food, half-physic, or his medicated preparations of beef and mutton, to contain the elements of nutrition in the highest form of concentration, among which have mostly figured the aforesaid "phosphates"—as if they were not among the most common and generally prevalent of the earthy constituents of all our food! Then, lest haply a stomach, unaccustomed to the new and highly concentrated materials, should, as is not improbable, find itself unequal to the task of digesting and absorbing them, a portion of gastric juice, borrowed for the occasion, mostly from the pig, is associated therewith to meet, if possible, that difficulty, and so to introduce the nourishment by hook or by crook into the system. I don't say the method described may not be useful in certain cases, and on the advice of the experienced physician, for a patient exhausted by disease, whose salvation may depend upon the happy combination referred to. But it is the popular belief in the impossibility of having too much of that or of any such good thing, provided only it consists of nutritious food, that the advertiser appeals to, and appeals successfully, and with such effect that the credulous public is being gulled to an enormous extent.

Then even our drink must now be nutritious! Most persons might naturally be aware that the primary object of drink is to satisfy thirst, which means a craving for the supply of water to the tissues—the only fluid they demand and utilize when the sensation in question is felt. Water is a solvent of solids, and is more powerful to this end when employed free from admixture with any other solid material. It may be flavored, as in tea and otherwise, without impairing its solvent power, but when mixed with any concrete matter, as in chocolate, thick cocoa, or even with milk, its capacity for dissolving—the very quality for which it was demanded—is in great part lost. So plentiful is nutriment in solid food, that the very last place where we should seek that quality is the drink which accompanies the ordinary meal. Here at least we might hope to be free from an exhortation to nourish ourselves, when desirous only to allay thirst or moisten our solid morsels with a draught of fluid. Not so; there are even some persons who must wash down their ample slices of roast beef with draughts of new milk!—an unwisely devised combination even for those of active habit, but for men and women whose lives are little occupied by exercise it is one of the greatest dietary blunders which can be perpetrated.

One would think it was generally known that milk is a peculiarly nutritive fluid, adapted for the fast-growing and fattening young mammal—admirable for such, for our small children, also serviceable to those whose muscular exertion is great, and, when it agrees with the stomach, to those who can not take meat. For us who have long ago achieved our full growth, and can thrive on solid fare, it is altogether superfluous and mostly mischievous as a drink.—*Nineteenth Century.*

[*To be continued.*]

AN EXPERIENCE WITH OPIUM.

By S. T. MORTON.

THE subject of the "opium-habit" is one that recurs with ominous frequency in public print. Whenever touched upon, the intensity of interest elicited in the minds of certain readers (alas! how large a number) would be incomprehensible to one not drawn personally to it. That the literature of this subject is mainly very discouraging and unhelpful to this class is perhaps not the fault of its authors; but such is uniformly the case. Of innumerable articles in periodicals and books by the dozen which I have read, it must be said that, while the evils of the "habit" are pictured in burning lines, when the discussion of treatment is reached, the *habitué* is left to believe that, in his case, if it be not impossible of cure, an attempt at total abandonment—with whatever medical skill he could command—would be attended with such hazards, and would inflict such tortures, mental and physical, as would be beyond the average power of endurance.

Unquestionably but a small portion of the general public—of those, too, who know something of its blighting evils—have any adequate idea of the strength of this "habit," and of the great difficulty, or impossibility, in most cases, of unaided cure. The chief responsibility, indeed, with the *habitué* lies in his initiation rather than in his continuance of the "habit." He can not, like the user of alcohol or tobacco, by a strong effort of the will shake off his chains.

A pathetic story has lately come to my knowledge of a young man, an under-graduate in an Eastern college, who had become a victim of the hypodermic use of morphia. He went with his father, who was engaged in the lumbering interest, into the primeval forests of Maine, hoping that during a stay of months with the wood-choppers he would be able to fight out the battle of gradual abandonment successfully. Through a strange fatality, when the party had just arrived at their camping-place, and were transporting their goods across a stream, the case of morphia was broken by an apparent accident and its contents scattered into the water. None but the haggard young man could, at the moment, comprehend the appalling magnitude of the calamity —there, as he was, two hundred miles from the nearest settlement! He survived the terrible ordeal, but no words could express, he has said, the tortures and agony through which he passed during the succeeding weeks. He was closely watched, else, at times, he would have drowned himself or have beaten his brains out upon the rocks. Months afterward he came back to the world a skeleton, worn and haggard, from his terrible contest. It was an experience to which he could never afterward refer without the most painful emotions.

Not the least significant point in this veritable account is the fact that the young man always believed that his father had purposely brought about the catastrophe for the sake of bringing matters to a speedy end! Has the usual treatment of the disease by physicians at this day anything to offer that is much better than this man's summary method? Perhaps no work on the subject has appeared in recent years more careful and thorough in its scientific intention than Dr. Levinstein's "Morbid Craving for Morphia." It is evident that he has brought no common accuracy of observation to bear upon the subject. His clinical notes on a considerable number of cases of the disease treated by him are of absorbing interest to the morphia *habitué*.

There is a striking parallel between the method of the Maine lumberman I have described and that of advanced German science in the treatment of this disease. In both cases the patient suffers from the intense cruelty of ignorance! The best thing to do for the unfortunate victim of morphia, according to this learned work, is to secure him in rooms under charge of a competent keeper or nurse, his person and baggage having been searched, and from the rooms "all opportunities for attempting suicide having been removed. Doors and windows must not move on hinges, but on pivots; must have neither handles, nor bolts, nor keys; being so constructed that the patients can neither open nor shut them. Hooks for looking-glasses, for clothes, and curtains, must be removed." Certainly these are ominous preliminaries to a course of scientific medical treatment! Within this prison the patient is totally deprived at once of morphia in every form, and here he must struggle through the terrible weeks succeeding as best he may. So far as appears, he has but the slightest medical aid. His symptoms are closely watched, however, for the portentous shadow of one special danger looms ever near his bedside—that of a sudden collapse of his vital powers. A few moments' delay in such a contingency may prevent all power of resuscitation; in any case, the situation is very critical. Fortunate will it be if morphia, which is always the immediate resort in such emergencies, have not lost its potency!

I will not recount the story of the tortures through which the patient passes—the days and nights of writhing, the sleeplessness, the restlessness, the thirst, and endless vomitings and purgings; his vain pleadings for liberty, for morphia, for anything which will relieve the intolerable anguish! These clinical notes of Levinstein's, in form cold and terse as a hardware catalogue, are fairly burning with their burden of tragedy. But this treatment he offers as the best known, and its attendant sufferings he evidently believes are inevitable in any cure!

It has happened to me to know, through personal experience, that the unfortunate victim of this "habit" can be freed from his bondage without passing through such an ordeal.

I had been an *habitué* ten years, having reached at the end of that period the daily amount of thirty-six grains of gum-opium, taken only into the stomach. The "habit" had been begun by a very small amount, and its increase had been extremely gradual. I knew not where to turn for help in effecting a cure: one thing seemed certain, it could not be done without help. At a venture merely, I called upon the late Dr. George M. Beard, feeling that, at any rate, I should be free from the risk of charlatanism; and I shall always remember him with gratitude, for it was through his recommendation that I placed myself under the care of another physician, who immediately undertook the treatment of my case.

The gentleman whom, through the good fortune of Dr. Beard's introduction, I thus came to know, I found to be a young man in the prime of good health and spirits, and one who at once inspired me with that confidence so important in such a case. His residence, it was manifest, was no ordinary "institute" or "asylum." I was simply a courteously received guest in a private family. Here were two bright children quietly pursuing their games when I first entered; and I was soon introduced to a pleasant circle embracing the cultivated ladies of the doctor's family, as well as the three who were to undertake the new path simultaneously with myself. Among these good fellows, as I soon found them to be, I was a simple layman in a medical "ring" as it were, for my comrades were young physicians, each under the hypodermic spell, doctors though they were, helpless like myself in the well-riveted chains. In this situation it is in no wise easy to follow the injunction, "Physician, heal thyself."

Placed in these easy and pleasant relations, with every comfort, and—a most important material consideration—an appetizing table, everything outward was calculated to inspire a feeling of freedom and cheerfulness. I speak particularly of these favorable surroundings, for they seem to me to form a very important accessory of the treatment.

This treatment differed in important respects from preconceived ideas, such as are fostered by almost everything written upon the subject. The patient here, for instance, was under no surveillance and restraint. So far from being a prisoner, he was encouraged in taking walks and drives alone, or, with his fellow-patients, in attending evening amusements, etc. It was the doctor's theory that a person of any sensitiveness of nature could not rest under constant suspicion without a sense of resentment which would be prejudicial to the cordial relation which should always exist between physician and patient. "I ask for and extend confidence," he said, "and believe I largely enhance a good result in so doing. Nor do I share in the opinion, largely held, that no reliance is to be placed upon the word of the opium *habitué*." Though he was well aware that this morbid habit in many cases exerts a baneful influence on the moral character, it is manifest that—were the doctor's theory of his patient's reliability and truthfulness altogether erroneous—any plan of treatment based upon it would be entirely impracticable, however agreeable to the patients this view of their character.

Within a week after the beginning of treatment my opiate was all withdrawn. What I had undergone at the end of that period, and, indeed, for a day or two subsequent to the total discontinuance, could scarcely be called suffering ; it was rather a dull, heavy listlessness, as little painful as enjoyable. There was no mental or physical elasticity; exercise was not inviting—nor, indeed, was there the physical ability for it. It became impossible to read or even to think, except in an idle way. There was no pain or nervousness ; but principally a feeling of passive discomfort during this period, when the discontinuance of opium, unaided, would have brought on penal tortures.

Thus "the Rubicon was crossed"—this being the exultant phrase with which the doctor greeted one after the other of our little band, as he passed over that hitherto impassable stream. But the few days succeeding the total deprivation were not so passive. Though I had landed on the other bank of that classic stream, the tug of war was yet to come. That power in the human system which at times seems endowed with a personality of its own—that dual existence, as it were, with its Briarean arms of nerves—revolted. There was a period of disturbance and prostration of strength, with some restlessness. I was for a while the prey of illusions of sight and sound. "Materialized spirits" from the other world seemed at times to hover about my bed, as visible, if not as palpable, as the furniture of my room. But more deceptive still was a loud, sharp voice by which I was addressed occasionally, it seemed, by some person concealed behind the head-board of the bedstead ; no speech of man will ever sound more real to me. These were illusions of my waking hours. But the period of prostration which they accompanied was short ; and within a few days I again took my place at the table with the family.

More or less insomnia is probably inevitable under any circumstances after the discontinuance of opium. In my convalescence—and the experience was parallel with that of my fellow-patients—it was the principal difficulty to overcome. At the worst, however, I passed no night without some sleep. Hypnotics were used at first, but were very soon altogether discontinued; for the sooner the system should discover, so to speak, that no outside aid was to be expected, the better.

The term of my stay under treatment was just four weeks, and the latter half of this may be considered the period of convalescence. There was soon an incoming tide of vitality that transformed the world. This came while my physical strength was still slight, and the amount of sleep to be obtained scanty. But the morning star had arisen above the horizon, and brought an indescribable feeling of renewed hope and courage. Perhaps no after-experience of life will bring again that exquisite sensitiveness to every emotional touch which lasted for two or three days at this early stage of recovery, when the soul was bathed in an atmosphere of joy, and the most commonplace incident would excite a thrill of bliss—when a chance strain of music would bring tears of rapture. This, of course, was not a normal condition, but was the effect of reaction in the newly awakened powers of the system. One main symptom thereafter was a peculiar lassitude—inertia. The will-power seemed to be under some strange thralldom, and one found himself under the greatest difficulty in bringing himself to perform some of the simplest actions. Another symptom—which persisted in some cases much longer than it did in others—was what may be called a dislocation of ideas, or at least a lack of relation between thought and its embodiment in language. The patient would have great difficulty in finding the right expression; he would use words with a most ridiculous misapplication, to his intense mortification. He could not, for the life of him, "call a spade a spade," but would call it almost any other implement or thing imaginable. In my own case, however, this trouble was slight.

At the end of my four weeks' stay I had nearly recovered my regular hours of sleep, and had gained very materially in general tone and strength. With the exception noted above, I had been receiving only tonic treatment; and after leaving my physician's care the only medicines taken were quinine, in tonic doses, and cod-liver oil. It is unnecessary to recount here all the stages of convalescence. Very soon after leaving I had a period of two or three weeks of wonderful elasticity—in fact, of the most perfect health. But this was soon succeeded by a return of the former lassitude and disturbance. There were many such oscillations in the succeeding months; there were periods when the past seemed blotted out in a sense of renewed vigor and strength, followed by weeks when, without any immediate ostensible cause, the tide was at ebb. These were not times of mental despondency, but rather of physical depression and neuralgic disturbance. But there was all the while a steady improvement in general health, with an increasing infrequence of reminders of the "old enemy." During the first three months I gained over twenty pounds in weight.

There is one thing which the *habitué* wishing to be cured would perhaps anticipate with dread; that is, an insatiable craving for the old stimulant, and a consequent prolonged and weary resistance of temptation. I can only say that, greatly to my surprise, I have felt no craving for it at any time since the beginning of my treatment. This may seem a strange statement to any one under the sorcery of the drug, and conscious of its fearful grip. There is of course the knowledge, from experience, of the marvelous potency of opium in annulling all discomfort and distress of body or mind; but this is all. The sense of profound satisfaction, ever present, at the release from its slavery, as well as a lively appreciation of the great danger of again tampering with it, is sufficient to leave the temptation—whatever it may be—from such knowledge, powerless.

The special effect of opium on the system is *functional.* This fact is one great encouragement in attempting a cure from the "habit." The sudden recuperative power manifested, after this paralyzing dead-weight is removed, is a great surprise to the patient. Difficulties which had borne to him the grave aspect of serious organic disease vanish as by magic.

There was no secret about this treatment—there were no wonderful remedies unknown to the world used. The therapeutics included bromide of sodium, hot baths, electricity, and other well-known sedative and tonic medicines. The key-stone of the treatment is in preliminary sedation; that is, while the morphia is being rapidly withdrawn —during a period varying from seven to ten days—the nervous system is, at the same time, as rapidly brought under the influence of an efficient sedative, which reaches its maximum effect at the time of complete opiate withdrawal.

Two years have passed since my escape from the thralldom of opium, and during the far larger portion of that time I could record an experience of renewed vitality—a condition of vigor and elasticity that could only have its origin in perfect health. I use no stimulants whatever, other than tea and coffee; and my health has now been so long fully re-established that I feel the better assured in giving some account of my personal experience. I shall be glad if the narrative be of encouragement to others in the same strait—those who have heretofore believed escape from their situation only possible through prolonged agonies. The inevitable chasm which must be crossed in effecting a cure of the opium-disease can be bridged, as I found. One must know something of the breadth and depth of that chasm, to be able to appreciate the achievement.

SOME SELF-MADE ASTRONOMERS.

By E. LAGRANGE.

OUR purpose is to inquire briefly, illustrating our research by a few eminent examples, how men become astronomers, or, in general, how those who achieve distinction in that profession are directed to it. No one is destined to astronomy from his childhood. No fathers in forecasting the future of their sons ever think of preparing them especially for so unpractical a business, one so far from any of the roads to fortune as the study of the skies. Some particular conditions, independent of parental views of the career their sons are to follow, outside of anything that is contemplated in arranging the course of their studies in school, must contribute to lead a youth to consecrate his life to this pursuit. How, then, we ask again, does one become an astronomer? Well, he begins by taking up some other career—that of watch-maker, for instance, or of writing-master, clergyman, revenue officer, carpenter, bookseller, doctor, or perhaps shepherd, musician, or tradesman; and then, some day, if the thing is to be, some little incident determines it: the die is cast, and he becomes an astronomer. Nothing in particular is done; there are no parental lamentations or reproaches of friends who think you are a fool; you go your way, to the university if you can pay the cost, or straight to the observatory of which you are to become the director, to the disgust of the assiduous students who have been cramming for the examinations. This is the history of Hansen. He was watch-maker, and was called in one day to a scientific man's house to repair a clock. Having to wait a little while in the laboratory till the gentleman came in, he casually picked up a book, which proved to be a geometry. The man of science came in, and, finding him interested in the book, lent it to him. Hansen devoured it; the man lent him other books, and he gave himself up to them as a miss would to a novel she was forbidden to read. Two years after this, Hansen, at thirty years of age, was director of the observatory at Gotha, where he performed his celebrated labors on the motions of the moon.

Mädler was a writing-master till he was forty-five years old, when all at once it came into his head to make an astronomer of himself. He obtained a place at the private observatory of Beer (brother of Meyerbeer), where he drew a map of the moon. Shortly afterward, he was placed by the Russian Government at the head of the Dorpat Observatory, where he continued till his death, at the age of eighty-three years.

Brunhs, director of the Leipsic Observatory, who died a short time ago, was found by Humboldt in a locksmith's shop in Berlin, and obtained through his influence a place in the observatory.

Leverrier, who died Director of the Paris Observatory, and who occupied himself more than any other astronomer with calculations of the motions of the planets, was intended to be an engineer. He was employed in the excise, when he suddenly discovered that the science of the skies was his vocation. It is well known that astronomy owes to him the discovery of the planet Neptune, which was the result of a mathematical calculation.

Olbers, who contributed so much to the theory for determining the orbits of comets, was a practicing physician in Bremen. He was accustomed to spend his evenings at home, after the day's round of calls, in reading for pleasure works on astronomy, to which science he rendered considerable services, while as a doctor he was in no way distinguished from the host of his competitors.

Th. von Oppolzer, to whom science is indebted for some splendid labors, intended first to embrace the career of his father, who was a distinguished physician ; but he had hardly got his first case, when he was seized by the demon of astronomy ; and he forever abandoned his early profession to devote himself to that science.

The great Herschel was a hautboy-player in a Hanoverian regiment, and the thought of being an astronomer never occurred to him till he was forty years old. At that time he wanted to get a telescope, and, as he had no means with which to buy one, he made one himself, and with it discovered Uranus. He was then made a doctor at Oxford, and entered the service of the English Government, with whose aid he was able to build his monster telescope. He afterward explored the sky to very remote depths, discovering nebulæ, and studying double stars and clusters of stars.

The astronomers whose stories have just been told are not exceptions. It must rather be admitted, as a general rule, that all the men who have made epochs in astronomy were deserters, or persons who had left some other profession to engage in astronomy. The academicians may confront me, on this point, with the life of the great Gauss. This celebrated astronomer, one of the greatest of all time, did indeed follow the direct road, but that was only because of his having, when he was young, attracted the attention of the Duke Charles William Ferdinand of Brunswick. It is very probable that, but for this circumstance, he would have become something very different, perhaps a mason, or a fountain-builder, or an employé of the burial-office—three trades which his father carried on together. But it is quite as certain that Gauss would sooner or later have become an astronomer as that Raphael, as Lessing says, would have become a painter, even if he had lost his hands.

Frederick William Bessel, one of the most eminent astronomers of the nineteenth century, had been destined by his father to become a merchant, and the young man, who had a strong distaste for Latin and considerable fondness for mathematics, engaged in his studies with relish, but did not particularly distinguish himself in them. When fifteen years of age, on the 1st of January, 1799, he began his apprenticeship to the merchant's career in a large commercial house of Bremen, with a good-will. No one, and himself least of all, would have dreamed then of his ever becoming celebrated. He was not at all ambitious, and did not even seem to care to put himself in advance of his colleagues. The only thing to remark about him was the conscientiousness with which he did his work. After this was done, he would recreate himself by poring over old books, trying to make himself familiar with all branches of commerce, and studying particularly maritime commerce, in which he was specially interested. He was thinking about his future, and perceived early that, to make his fortune, he would have to try his lot across the sea, for he had no means wherewith to establish himself.

The object of his desire at this time was to be able, as agent of one of the great houses of Bremen or Hamburg, to direct a commercial expedition to the Indies or China. With this purpose he diligently studied English and French, and then bethought himself of what else might be useful to him in the career he wished to embrace. Till this time we see in his conduct no evidence of a disposition toward astronomy. He was simply seeking to become a good merchant, and all his efforts, day and night, were directed to that end. He was in heart a merchant, and in course of becoming one, and yet we can not doubt that there was developing in him at the very time the tendency which was to lead him to the science of the sky.

In the course of the studies of which we have spoken, it occurred to him that a ship-factor, such as he was going to be, undertaking long voyages, and playing so prominent a part on the ship, ought to know a little of the way in which it was to be directed. He had heard that a new art had been discovered—that of sailing in the open sea by observation of the stars, the moon, and the sun. Although the sailors of the period cared to learn nothing of this new art, Bessel hoped that by becoming master of it he might make himself respected by his future captain. It was necessary to procure a sextant; but that was beyond the means of our clerk, so he made one for himself, and assiduously took observations of the stars with it. He determined the latitude and longitude of Bremen, as if he had been on board his vessel. Thus, at nineteen years of age, he had set foot in the astronomical field. He never left it, but delved in it more and more, though without neglecting his commercial studies. He made his astronomical recreations the occupation of his evening hours. It is with astronomy as with love—the smallest spark is enough to kindle a lasting fire, if only the subject is inflammable. This was what happened with Bessel, and the flame that was lighted in his spirit was never extinguished.

The young man had read in his new book how, from the observation of the stars, one might calculate the geographical position of the spot where he happened to be. He sought to know why this was so. For this purpose he had to study mathematics from its rudiments, and was thus led up rapidly to spherical astronomy. He had to be continually introducing the elements of the position of the sun and moon into his calculations, taking them from an astronomical calendar. He desired to calculate these elements for himself. He was thus led to study the laws of the motions of the celestial bodies. The net which astronomical science had cast over him was thus wrapping him closer every day, and in less than a year after he had begun his astronomical studies he undertook the computation of the orbit of the comet of 1607, a work that involved three hundred pages of calculations, and which a skilled astronomer might regard as the task of a year. He was not a little proud of his calculations when he had completed them, and he determined to make the acquaintance of Olbers, who was practicing medicine in Bremen, and was regarded as the first authority in everything that related to comets. Meeting the famous doctor in the street, he timidly told him he had calculated the orbit of a comet, and asked him to have the kindness to examine his work. Olbers granted the request, supposing that he was about to receive the work of an amateur, whom he must treat politely, for fear of discouraging him. But he was greatly surprised when he examined the calculations, and he immediately wrote to Bessel: "I have read your work on the comet of 1607 with very great pleasure. It gives me a very high idea of your astronomical and mathematical knowledge, and of your skill in the most difficult departments of calculation. If I should criticise you on any point, it would be only on your having given more time and care to the ancient observations than they deserve." If we place this praise of Olbers by the side of the fact that Bessel did not know a word of mathematics or astronomy a year before, or hardly that there was such a thing as the mechanics and mathematics of the sky, and if we also recollect that he was occupied from eight o'clock in the morning till night with something entirely different, we can gain a slight idea of the great energy and the rare mental constancy which he must have displayed, and which afterward carried him so far.

Bessel's fate was decided. He was recommended by Olbers to Gauss, who, in the same year, invited him to assist him in the calculations with which he was occupied. Bessel accepted the invitation with enthusiasm, and, according to his habit, made the calculations with more precision than was required. From that time Gauss and Bessel were connected in a lasting scientific friendship. Bessel was to wait another year before giving himself up entirely to astronomy, but early in 1806, warmly supported by Olbers, he was appointed inspector of a private observatory at Lilienthal. He remained there four years, till his reputation brought him a call to the direction of the new observatory at Königsberg. At twenty-six years of age, without ever having been in a university, he took rank as one of the first professors in the University of Königsberg.

We thus see that Bessel was, in the broadest sense of the word, a self-made man. But it can not be said that he was a genius. Ideas did not come to him as the manna to the children of Israel in the desert. He acquired all his knowledge solely by his excessive application and by his indomitable energy in pursuing the end he was aiming at. I do not think that his natural talent exceeded the mean which Nature has given to all. We feel, in reading Bessel, not the sense of a sudden induction—which is frequently given to the mathematician as well as to the astronomer—but rather that of a continuous labor, which draws new and exact conclusions from materials previously accumulated, and knows how to make a practical use of.—*Translated for the Popular Science Monthly from Ciel et Terre.*

ON LEAVES.

By Sir JOHN LUBBOCK.

I.

MR. RUSKIN, in one of his most exquisite passages, has told us that "flowers seem intended for the solace of ordinary humanity: children love them; tender, contented, ordinary people love them. They are the cottager's treasure; and in the crowded town mark, as with a little broken fragment of rainbow, the windows of the workers in whose heart rests the covenant of peace." I should be ungrateful indeed did I not fully feel the force of this truth; but yet it must be confessed that the beauty of our woods and fields is due at least as much to foliage as to flowers.

In the words of the same author, "The leaves of the herbage at our feet take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom, they seem perpetually to tempt our watchfulness and take delight in outstripping our wonder."

Now, why is this marvelous variety, this inexhaustible treasury of beautiful forms? Does it result from some innate tendency of each species? Is it intentionally designed to delight the eye of man? or have the form, and size, and texture some reference to the structure and organization, the habits and requirements, of the whole plant?

I do not propose now to discuss any of the more unusual and abnormal forms of leaves: the pitchers of *Nepenthes* or *Cephalotus*, the pitfalls of *Sarracenia* or *Darlingtonia*, the spring-trap leaves of *Dionæa*, the scarcely less effective though less striking contrivances in our own *Drosera* or *Pinguicula*, nor the remarkable power of movement which many leaves present, whether in response to an external stimulus, as in certain mimosas, oxalises, etc., or as a spontaneous periodic movement, such as the "sleep" of many leaves, or the nearly continuous rotation of the lateral leaflets of *Desmodium*. I propose, rather, to ask you to consider with me the structure, and especially the forms, of the common every-day leaves of our woods and fields.

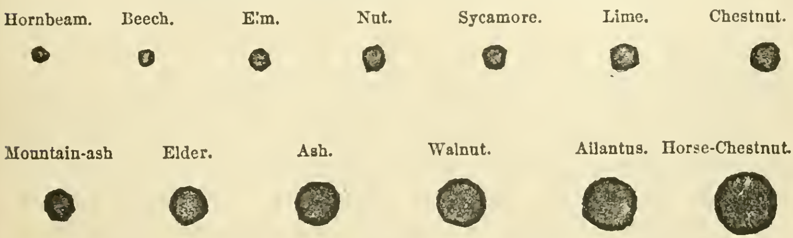
In talking the subject over with friends, I have found a widely prevalent idea that the beauty and variety of leaves are a beneficent arrangement made specially with reference to the enjoyment and delight of man. I have, again, frequently been met by the opinion that there is some special form, size, and texture of leaf inherently characteristic of each species; that the cellular tissue tends to "crystallize," as it were, into some particular form, quite irrespective of any advantage to the plant itself.

Neither of these will, I think, stand the test of careful examination.

In the first place, let us consider the size of the leaf. On what does this depend? In herbs we very often see that the leaves decrease toward the end of the shoot, while in trees the leaves, though not identical, are much more uniform, in size.

Again, if we take a twig of hornbeam, we shall find that the six terminal leaves have together an area of about fourteen square inches, and the section of the twig has a diameter of ·06 of an inch. In the beech the leaves are rather larger, six of them having an area of perhaps eighteen inches, and, corresponding with this greater leaf-surface, we find that the twig is somewhat stouter, say ·09 of an inch. Following this up we shall find that, *cæteris paribus*, the size of the leaf has relation to the thickness of the stem. This is clearly shown in the following table:

Impression of Stalk below the Sixth Leaf.



	Diameter of stem in inches.	Approximate area of six upper leaves in inches.
Hornbeam	·06	14
Beech	·09	18
Elm	·11	34
Nut	·13	55
Sycamore	·13	60
Lime	·14	60
Chestnut	·15	72
Mountain-ash	·16	60
Elder	·18	93
Ash	·18	100
Walnut	·25	220
Ailantus	·3	240
Horse-chestnut	·3	300

In the elm the numbers are ·11 and 34, in the chestnut ·15 and 72, and in the horse-chestnut the stem has a thickness of ·32, and the six leaves have an area often of three hundred square inches. Of course, however, these numbers are only approximate. Many things have to be taken into consideration. Strength, for instance is an important element. Thus the ailantus, with a stem equal in thickness to that of the horse-chestnut, carries a smaller area of leaves, perhaps because it is less compact. Again, the weight of the leaves is doubtless a factor in the case. Thus in some sprays of ash and elder which I examined of equal diameter, the former bore the larger expanse of leaves; but not only is the stem of the elder less compact, but the elder-leaves, though not so large, were quite as heavy, if not indeed a little heavier. I was for some time puzzled by the fact that, while the terminal shoot of the spruce is somewhat thicker than that of the Scotch fir, the leaves are not much more than one third as long. May this not perhaps be due to the fact that they remain on more than twice as long, so that the total leaf area borne by the branch is greater, though the individual leaves are shorter? Again, it will be observed that the leaf area of the mountain-ash is small compared to the stem, and it may, perhaps, not be unreasonable to suggest that this may be connected with the habit of the tree to grow in bleak and exposed situations. The position of the leaves, the direction of the bough, and many other elements would have also to be taken into consideration, but still it seems clear that there is a correspondence between thickness of stem and size of leaf. This ratio, moreover, when taken in relation with the other conditions of the problem, has, as we shall see, a considerable bearing not only on the size, but on the form of the leaf also.

The mountain-ash has been a great puzzle to me; it is, of course, a true *Pyrus*, and is merely called ash from the resemblance of its leaves to those of the common ash. But the ordinary leaves of a pear are, as we all know, simple and ovate, or obovate. Why, then, should those of the mountain-ash be so entirely different? May not, perhaps, some light be thrown on this by the arrangement of the leaves? They are situated some distance apart, and though, as shown in the table, they are small in comparison to the diameter of the stem, still they attain a size of fifteen square inches, or even more. Now, if they were of the same form as the ordinary pear-leaf, they would be about seven inches long by two to three in breadth. The mountain-ash, as we know, lives in mountainous and exposed localities, and such a leaf would be unsuitable to withstand the force of the wind in such situations. From this point of view, the division into leaflets seems a manifest advantage.

Perhaps it will be said that in some trees the leaves are much more uniform in size than in others. This is true. The sycamore, for instance, varies greatly; in the specimen tabulated, the stem was ·13 in diameter, and the area of the six upper leaves was sixty square inches. In another, the six upper leaves had an area of rather over one hundred inches, but in this case the diameter of the stem was ·18.

Another point is the length of the internode. In such trees as the beech, elm, hornbeam, etc., the distance from bud to bud varies comparatively little, and bears a tolerably close relation to the size of the leaf. In the sycamore, maple, etc., on the contrary, the length varies greatly.

Now, if, instead of looking merely at a single leaf, we consider the whole bough of any tree, we shall, I think, see the reason of their differences of form.

Let us begin, for instance, with the common lime (Fig. 1). The leaf-stalks are arranged at an angle of about 40° with the branch, and the upper surfaces of the leaves are in the same plane with it. The

Fig. 1.

Fig. 2.

result is, that they are admirably adapted to secure the maximum of light and air. Let us take, for instance, the second or third leaf in Fig. 1. They are four and a half inches long and very nearly as broad. The distance between the two leaves on each side is also just four and a half inches, so that they exactly fill up the interval. In *Tilia parvifolia* the arrangement is similar, but leaves and internodes are both less, the leaves, say, one and a half inch, and the internodes ·6.

In the beech, the general plane of the leaves is again that of the branch (Fig. 2), but the leaves themselves are ovate in form, and smaller, being only from two to three inches in length. On the other hand, the distance between the internodes is also smaller, being, say, one and a quarter inch against something less than two inches. The diminution in length of the internode is not, indeed, exactly in proportion to that of the leaf, but, on the other hand, the leaf does not make so wide an angle with the stem. To this position is probably due the difference of form. The outline of the basal half of the leaf fits neatly to the branch, that of the upper half follows the edge of the leaf beyond, and the form of the inner edge being thus determined decides the outer one also.

In the nut (*Corylus*), the internodes are longer and the leaves correspondingly broader. In the elm (*Ulmus*, Fig. 3), the ordinary branches have leaves resembling, though rather larger than, those of the beech; but in vigorous shoots the internodes become longer and the leaves correspondingly broader and larger, so that they come nearly to resemble those of the nut.

But it may be said the Spanish chestnut (*Castanea vulgaris*, Fig. 4) also has alternate leaves in a plane parallel to that of the branch, and

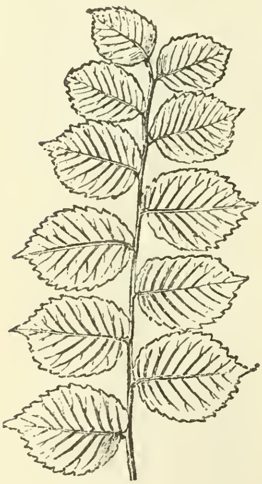


Fig. 3.

Fig. 4.

Fig. 5.

with internodes of very nearly the same length as the beech. That is true; but, on the other hand, the terminal branches of the Spanish chestnut are stouter in proportion. Thus, immediately below the sixth leaf, the chestnut-stalk may be ·15 of an inch in thickness, that of the beech not much more than half as much. Consequently, the chestnut could, of course supposing the strength of the wood to be equal, bear a greater weight of leaf; but, the width of the leaf being determined by the distance between the internodes, the leaf is, so to say, compelled to draw itself out. In Fig. 5 I have endeavored to illustrate this by placing a spray of beech over one of Spanish chestnut. Moreover, not only do the leaves on a single twig thus admirably fit in with one another, but they are also adapted to the ramification of the twigs themselves. Fig. 6 shows a bough of beech seen from above, and it will be observed that the form of the leaves is such that, while but little space is lost, there is scarcely any overlapping. Each fits in perfectly with the rest.

The leaves of the yew (Fig. 7) belong to a type very different from those which we have hitherto been considering. They are long, narrow, and arranged all round the stem, but spread right and left,

Fig. 6.

Fig. 7.

Fig. 8.

so that they lie in one plane, parallel to the direction of the branchlet, and their width bears just such a relation to their distance apart that when so spread out their edges almost touch. Fig. 8 represents a sprig of box. It will be observed that the increase of width in the leaves corresponds closely with the greater distance between the points of attachment.

The leaves of the Scotch pine (*Pinus sylvestris*) are needle-like, one and a half inch in length and one twentieth in diameter. They are arranged in pairs, each pair inclosed at the base in a sheath. One inch of stem bears about fifteen pairs of leaves. Given this number of leaves in such a space, they must evidently be long and narrow. If I am asked why they are longer than those of the yew, I would suggest that the stem, being thicker, is able to support more weight. In confirmation of this, we may take for comparison the Weymouth pine, in which the leaves are much longer and the stalk thicker.

When we pass from the species hitherto considered to the maples (Fig. 11), sycamores, and horse-chestnuts (Figs. 9 and 10), we come to a totally different type of arrangement. The leaves are placed at right angles to the axis of the branch instead of being parallel to it, have long petioles, and palmate instead of pinnate veins. In this group the mode of growth is somewhat stiff ; the main shoots are perpendicular, and the lateral ones nearly at right angles to them. The buds, also, are comparatively few, and the internodes, consequently, at greater distances apart, sometimes as much as a foot, though the two or three at the end of a branch are often quite short. The general habit is shown in Figs. 9 and 10. Now, if we were to imagine six beech or

Fig. 9.

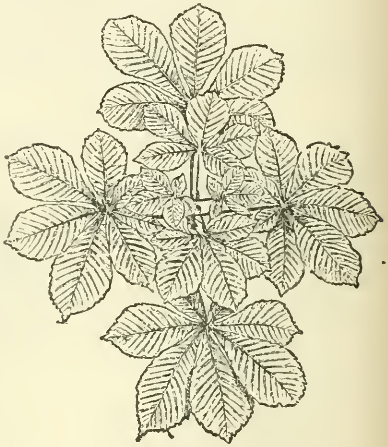


Fig. 10.

elm leaves on these three internodes, it is obvious that the leaf surface would be far smaller than it is at present. Again, if we compare the thickness of an average sycamore-stem below the sixth leaf with that of a beech-stem, it is obvious that there would be a considerable waste of power. Once more, if the leaves were parallel to the branch, they would, as the branches are arranged, be less well disposed with reference to light and air. A glance at Figs. 9, 10, and 11, however, will show how beautifully the leaves are adapted to their changed conditions. The blades of the leaves of the upper pair form an angle with the leaf-stalks, so as to assume a horizontal position, or nearly so ; the leaf-stalks of the second pair decussate with those of the first, and are just so much longer as to bring up that pair nearly, or quite, to a level with the first ; the third pair decussate with the second, and are again brought up nearly to the same level, and immediately to the outside of the first pair. In well-grown shoots there is often a fourth pair on the outside of the second. If we look at such a cluster of leaves directly from in front, we shall see that they generally appear

Fig. 11.

somewhat to overlap; but it must be remembered that in temperate regions the sun is never vertical. Moreover, while alternate leaves are more convenient in such an arrangement as that of the beech, where there would be no room for a second leaf, it is more suitable in such cases as the sycamores and maples that the leaves should be opposite, because, if, other things remaining the same, the leaves of the sycamore were alternate, the sixth leaf would require an inconvenient length of petiole.

Perhaps it will be said that the plane-tree, which has leaves so like a maple that one species of the latter genus is named after it (*Acer platanoides*), has, nevertheless, alternate leaves. In reality, however, I think this rather supports my argument, because the leaves of the plane, instead of being at right angles to the stem, lie more nearly parallel with it. Moreover, as any one can see, the leaves are not arranged so successfully with reference to exposure as those of the species we have hitherto been considering, perhaps because, living as it does in more southern localities, the economy of sunshine is less important than in more northern regions.

The shoot of the horse-chestnut is even stouter than that of the sycamore, and has a diameter below the sixth leaf of no less than three tenths of an inch. With this increase of strength is, I think, connected the greater size of the leaves, which attain to as much as eighteen inches in diameter, and this greater size, again, has perhaps led to the dissection of the leaves into five or seven distinct segments, each of which has a form somewhat peculiar in itself, but which fits in admirably with the other leaflets. However this may be, we have in the horse-chestnut, as in the sycamores and maples, a beautiful dome of leaves, each standing free from the rest, and expanding to the fresh air and sunlight a surface of foliage in proportion to the stout, bold stem on which they are borne.

Now, if we place the leaves of one tree on the branches of another, we shall at once see how unsuitable they would be. I do not speak of putting a small leaf such as that of a beech on a large-leaved tree such as the horse-chestnut; but if we place, for instance, beech on lime, or *vice versa*, the contrast is sufficiently striking.

The lime-leaves would overlap one another, while, on the other hand, the beech-leaves would leave considerable interspaces. Or let us in the same way transpose those of the Spanish chestnut (*Castanea*) and those of *Acer platanoides*, a species of maple. I have taken specimens in which the six terminal leaves of a shoot of the two species occupy approximately the same area. Figs. 4 and 11 show the leaves in their natural position, those of *Castanea* lying along the stalk, while those of *Acer* are ranged round it. In both cases it will be seen that there is practically no overlapping, and very little waste of space. In *Castanea* the stalks are just long enough to give a certain play to the leaves. In *Acer* they are much longer, bringing the leaves approximately to the same level, and carrying the lower and outer ones free from the upper and younger ones.

Now, if we arrange the Spanish-chestnut leaves round a center, as in Fig. 12, it is at once obvious how much space is wasted. On the other hand, if we attach the leaves of the *Acer* to the stalk of *Castanea* at the points from which the leaves of *Castanea* came off, as in Fig. 13,

Fig. 12.

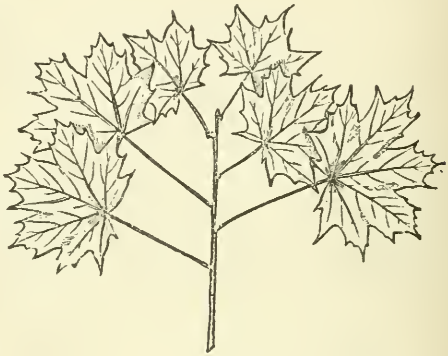


Fig. 13.

we shall see that the stalks are useless, and even mischievous, as a cause of weakness and of waste of space; while, on the other hand, if we omit the stalks, or shorten them to the same length as those of *Castanea*, as in Fig. 14, the leaves would greatly overlap one another.

Once more, for leaves arranged as in the beech the gentle swell at the base is admirably suited; but in a crown of leaves, such as those of the sycamore, space would be wasted, and it is better that they should expand at once as soon as their stalks have borne them free from those within. Moreover, the spreading lobes leave a triangular space (Fig. 11) with the insertion of the stalk at the apex, which seems as if expressly designed to leave room for the pointed end of the leaf within.

Fig. 14.

Hence we see how beautifully the whole form of these leaves is adapted to the mode of growth of the trees themselves and the arrangement of their buds.

Before we proceed to consider the next series of species to which I wish to direct attention, it will be necessary for me to say a few words on the microscopical structure of the leaf. Although so thin, the leaf consists of several layers of cells. Speaking roughly, and as a general rule, we may say that on each side is a thin membrane, or epidermis, underneath which on the upper side are one or more layers of elongated cells known from their form as "pallisade-cells," beneath which is a parenchymatous tissue of more or less loose texture. The leaf is strengthened by ribs of woody tissue. From this general type there are, of course, numerous variations. For instance, some water-plants have no epidermis.

If the surface of the leaf be examined with a tolerably high power, small opaque spots will be observed, resembling a sort of button-hole, with a thick rim or border composed of two more or less curved cells, the concavities being turned inward. When dry, they are nearly straight, and lie side by side; but when moistened they swell, become somewhat curved, and gape open.

It is difficult to realize the immense number of these orifices or "stomata" which a single bush or tree must possess when we remember that there are sometimes many thousand stomata to a square inch of surface. In a large proportion of herbs the two sides of the leaf are under conditions so nearly similar that the stomata are almost equally numerous on the upper and on the lower side. In trees, however, as a general rule, they are found exclusively on the under side of the leaf, which is the most protected; they are thus less exposed to the direct rays of the sun, or to be thoroughly wetted by rain, so that their action is less liable to sudden and violent changes.

There are, however, some exceptions; for instance, in the black poplar the stomata are nearly as numerous on one side of the leaf as on the other. Now, why is this? If we compare the leaves of the black and white poplar, we shall be at once struck by the fact that, though these species are so nearly allied, the leaves are very different. In the white poplar (*Populus alba*), the upper and under sides are very unlike both in color and texture, the under side being thickly clothed with cottony hairs. In the black poplar (*P. nigra*, Fig. 15), the upper and under surfaces are, which is not frequent, very similar in color and texture. The petioles or leaf-stalks, again, are unlike; those of *P. nigra* presenting the peculiarity of being much flattened at the end toward the leaf. The effect of the unusual structure of the petiole is that the leaf, instead of being horizontal as in the *P. alba* and most trees, hangs vertically, and this again explains the similarity of the two surfaces, because the result is that both surfaces are placed under nearly similar conditions as regards light and air. Again, it will be observed that, if we attempt to arrange the leaves of the black poplar on one plane, they generally overlap one another; the extent is larger than can be displayed without their interfering with one another. In foliage arranged like that, for instance,

Fig. 15.

of the beech, elm, sycamore, or, in fact, of most of our trees, this would involve a certain amount of waste; but in the black poplar, as Fig. 15 shows, the leaves when hung in their natural position are quite detached from one another.

Another interesting case of a species with vertical leaves is the prickly lettuce (*Lactuca scariola*), while those of *L. muralis* and *L. virosa* are horizontal. With this position of the leaves is connected another peculiarity, especially well marked in the so-called "compass" plant of the American prairies (*Silphium laciniatum*), a yellow composite not unlike a small sunflower, which is thus named because the leaves turn their edges north and south. This has long been familiar to the hunters of the prairies, but was first mentioned by General Alvord, who called Longfellow's attention to it, and thus inspired the lines in "Evangeline":

> "Look at this delicate plant, that lifts its head from the meadow,
> See how its leaves are turned north, as true as the magnet;
> This is the compass-flower, that the finger of God has planted
> Here in the houseless wild to direct the traveler's journey
> Over the sea-like, pathless, limitless waste of the desert."

The advantage of this position, and consequently the probable reason for its adoption, is that in consequence of it the two faces of the leaf are about equally illuminated by the sun; and in connection with this we find that the structure of the leaf is unusual in two respects. The stomata are about equally abundant on both surfaces, while pallisade-cells, which are generally characteristic of the upper surface, are in this species found on the lower one also.

The leaves of the *Lactuca scariola* have also, when growing in sunny situations, a tendency to point north and south. Under such circumstances also they have a layer of pallisade-cells on each side.

Hitherto I have dealt with plants in which one main consideration appears to be the securing as much light and air as possible. Our English trees may be said as a general rule to be glad of as much sun as they can get. But a glance at any shrubbery is sufficient to show that we can not explain all leaves in this manner, and in tropical countries some plants at any rate find the sun too much for them. I will presently return to the consideration of the general characteristics of tropical vegetation. In illustration, however, of the present point, perhaps the clearest evidence is afforded by some Australian species, especially the eucalypti and acacias. Here the adaptations which we meet with are directed, not to the courting, but to the avoidance, of light.

The typical leaves of acacias are pinnate, with a number of leaflets. On the other hand, many of the Australian acacias have leaves (or, to speak more correctly, phyllodes) more or less elongated or willow-like. But if we raise them from seed we find, for instance, in *Acacia salicina*, so called from its resemblance to a willow, that the first leaves are pinnate (Fig. 16), and differ in nothing from those characteristics of the genus. In the later ones, however, the leaflets are reduced in number, and the leaf-stalk is slightly compressed laterally. The fifth or sixth leaf, perhaps, will have the leaflets reduced to a single pair, and the

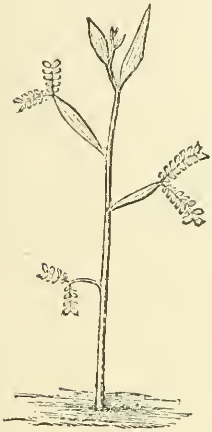


Fig. 16.

Fig. 17.

leaf-stalk still more flattened, while, when the plant is a little older, nothing remains except the flattened petiole. This in shape, as already observed, much resembles a narrow willow-leaf, but flattened laterally, so that it carries its edge upward, and consequently exposes as little surface as possible to the overpowering sun. In some species the long and narrow phyllodes carry this still further by hanging downward,

Fig. 18.

Fig. 19.

and in such cases they often assume a cimeter-like form. This I would venture to suggest may be in consequence of one side being turned outward, and therefore under more favorable conditions.

In one very interesting species (*Acacia melanoxylon*, Fig. 17), the plant throughout life produces both forms, and on the same bough may be seen phyllodes interspersed among ordinary pinnate leaves, the respective advantages being, it would appear, so equally balanced that sometimes the one, sometimes the other, secures the predominance.

In the case of the eucalyptus, every one who has been in the south of Europe must have noticed that the young trees have a totally different aspect from that which they acquire when older. The leaves of the young trees (Fig. 18) are tongue-shaped, and horizontal. In older ones, on the contrary (Fig. 19), they hang more or less vertically, with one edge toward the tree, and are cimeter-shaped, with the convex edge outward, perhaps for the same reason as that suggested in the case of acacia. There are several other cases in which the same plant bears two kinds of leaves. Thus, in some species of juniper the leaves are long and pointed, in others rounded and scale-like. *Juniperus chinensis* has both.

In the common ivy the leaves on the creeping or climbing stems are more or less triangular, while those of the flowering stems are ovate-lanceolate, a difference the cause of which has not, I think, yet been satisfactorily explained, but into which I will not now enter.—*Contemporary Review.*

EARTHQUAKE PHENOMENA.

By RALPH S. TARR.

AT the present time the earth seems to be in a state of great seismological action. Different parts of the world have recently been disturbed by earthquakes which have caused wide-spread destruction. Those in Spain, which began December 24th, and have lasted, with slight interruption, down to the time of writing, have been among the most destructive of recent earthquakes. Over two thousand people have been killed, many more wounded, and thousands of houses destroyed. Such a state of affairs can not help arousing an interest in this phenomenon.

The earth is constantly quivering, some point on the surface being the seat of a slight quake nearly every moment of the day. By far the larger number of these are of little intensity, being felt only by delicate instruments, and the majority of cases come from volcanic regions. So few facts are known, that we can neither draw deductions nor even determine the causes. It is reported, however, that earthquakes more commonly occur at night, and that they are more abundant in winter than in summer.

The only settled facts about earthquakes are, that they are the result of some shock imparted to the rocks at a considerable distance beneath the surface, and that this shock reaches the surface in a series of concentric rings, all points on the circumference of each ring receiving the shock at the same moment, even though they may be hundreds of miles apart. In other words, all points at equal distances from the center of the earthquake receive the shock at the same moment. Although this is theoretically the case, according to well-known physical laws, still, in practice, the facts are somewhat different ; for the shock is retarded or accelerated according as the rock opposes or favors the passage of the wave. The severity of the shock in a given place is dependent upon a variety of causes. These are : 1. The strength of the original shock ; 2. The distance from the earthquake center ; and, 3. The kind of rock on which one is standing, loose gravels greatly diminishing the force of the shock. The destructiveness of earthquakes depends rather upon the suddenness of application than the amount of motion. In that at Rio Bomba, it is reported for a fact that a man was hurled across a stream a distance of one hundred feet, and landed on an elevation fifty feet higher than his original position. It is an undoubted fact that objects are frequently thrown great distances. In the Mississippi Valley, during the earthquakes of 1811 to 1814, the tops of trees were twisted and entangled, and strong log-cabins were thrown to the ground. Rivers are sometimes checked in their flow, and, in past geological ages, some have been completely turned from their course by earthquakes.

At least four theories have been seriously advocated by scientists to explain these phenomena. The first, which is now abandoned, is based upon the supposition that the earth's interior is in a fluid condition. This being the case, the combined action of the sun and moon upon this molten mass beneath the surface causes it to surge and swing in tides of liquid fire. It is the shock from this that we feel on the surface. (I dismiss this theory, as one having no value whatever).

Another theory is, that earthquakes are due to volcanic action. The passage of the immense quantities of gas which escape from volcanoes must necessarily cause shock after shock. This gas, under pressure of thousands of pounds, is contained in a subterranean boiler, from which it is continually trying to escape. The moment the pressure becomes sufficient, the walls in some part give way, and the transmission of this shock reaches us as an earthquake. When the pent-up gases have broken through successive strata, always coming nearer to the surface, they finally reach the uppermost stratum, and this, which has been weakened by previous eruptions, gives way before the pressure, and lets the steam out as a volcanic eruption. It is thus, then, that the continual succession of earthquakes in volcanic regions is produced. When, however, we study the country about many earthquakes, and find no evidence of volcanoes, we are forced to abandon this theory for those regions, and look further. This is the case with all New England earthquakes, and with those in Spain.

Let us look at the next theory. We all know that water is continually soaking into the ground, and is dissolving out all matter which it can. Limestone is one of these substances, and it is to this property that we owe the great caverns of Kentucky. Water not only works on or near the surface, but it even penetrates thousands of feet into the earth, and at this depth possesses even greater power of solution. Indeed, we have every reason to believe that deep down in the earth's crust vast caverns have been excavated by this erosion of water, and that in some places, especially limestone regions, these are numerous. Granting, then, that there are such great holes in the ground, and supposing that one of them should suddenly collapse, we can readily imagine a shock which would cause wide-spread devastation. But this theory also will apply merely to certain limited localities, and we have not yet found a general theory—one for all regions.

Let us travel for a moment in a mountainous region, and we will see thousands of feet of rock folded, twisted, and bent in every conceivable manner. Now, it is a well-proved fact that these rocks were originally deposited in a horizontal layer, and that they have since undergone contortion. It can be conceived, then, that such rocks must be in a constant state of strain ready to relieve themselves at any favorable moment. Let us suppose that we have a long board held down on each end by a bank of earth. Remove a part of one bank, and a point will be reached when the board will spring up with considerable force, striking anything above it a severe blow. This is the condition of our mountain-rocks. Material is constantly being eroded from some and piled upon others. The time finally comes when they snap or spring, and, striking the rocks above, send out an earthquake shock. Quarrymen frequently feel a slight shock, and immediately after hear a report, showing that the strain in some rock has been relieved. A most curious instance is reported where a very long column of granite rock was being split from a quarry by the use of wedges. At last the mass was split from the bed, and instantly it expanded itself with such suddenness as to produce a very perceptible jar; and when the rock was returned to the place where it originally lay it no longer fitted, and the drill-holes did not coincide as before. Here, then, we have an earthquake on a small scale started by artificial means. Probably many of the slight shocks result from similar causes, or from the action of frost, or by contraction and expansion caused by the daily change in temperature.

These, then, are the theories for earthquakes, but neither of the three can be called general. We can usually tell when volcanic action is the cause, and are thus limited in our choice to two. In some cases the cavern theory may apply, but these are rare, and can usually be determined, so that in any region not volcanic the third theory is the most probable. This accounts for the fact that earthquakes are much more frequent and violent in mountain-regions of recent origin. The Appalachian, which are the oldest mountains in America, are, therefore, very free from earthquakes, because the rocks have, as a rule, long since relieved themselves ; while, on the other hand, the comparatively new Rockies are the seat of more frequent tremblings.

There is a theory for the cause of earthquakes, which is rather neglected by scientific men, but which, I think, will explain many of those phenomena not otherwise accounted for.

At the mouth of the Ohio, and at Newburyport, Massachusetts, both of which have in times past been the seat of very severe earthquake shocks, the layers of rocks are not badly bent. And, further, I do not see how the theory of bent rocks can explain the frequent repetition of shocks which we have recently seen in Spain, in Newburyport in 1727, and near the mouth of the Ohio in 1811. These regions had been comparatively quiet for years, and suddenly a severe shock was felt, followed by a series of successive shocks, which, in the case of Spain, have not yet ceased, although the original shock occurred December 24, 1884. The theory, which I have spoken of, and which would explain this, is that there are great quantities of gas accumulated at certain points beneath the surface under great pressure, and that this gas, in its attempt to free itself, bursts open the rocks, causing shock after shock, until it has finally relieved itself sufficiently to remain quiet. This, one will see, is similar to the volcanic theory, except that there is no necessity for the presence of a volcano. What this gas is, does not matter ; it may be accumulations of steam, or it may be evolved from petroleum, or it may be carbonic-dioxide gas evolved by acids working on calcareous rocks. In the Newburyport earthquake, which was the most severe ever recorded in New England, large quantities of gas escaped to the surface; and, on the Ohio, gas also escaped. This shock, which was at first wide-spread, finally narrowed itself down to a very limited marshy area and died out.

To sum up, then, it may be said: 1. That in volcanic regions earthquakes are a part of an eruption, premonitory warnings ; 2. That in a limestone country the falling in of the walls of caverns may account for some ; 3. That in regions of recent mountain-making the sudden release of tension causes many ; 4. That the pressure of pent-up gases on the surrounding rocks, which are finally burst, may be the cause of a large number, more especially those which are followed by a long-repeated series of shocks ; and, finally, that in any one of these regions either or all of the other causes may (with the exception of volcanic in non-volcanic regions) enter into the production of earthquakes.

CURIOSITIES OF STAR-FISH LIFE.*

By FREDERIK A. FERNALD.

FOR a dozen years past, the eminent English zoölogist, who has become so widely known as an investigator of animal intelli-

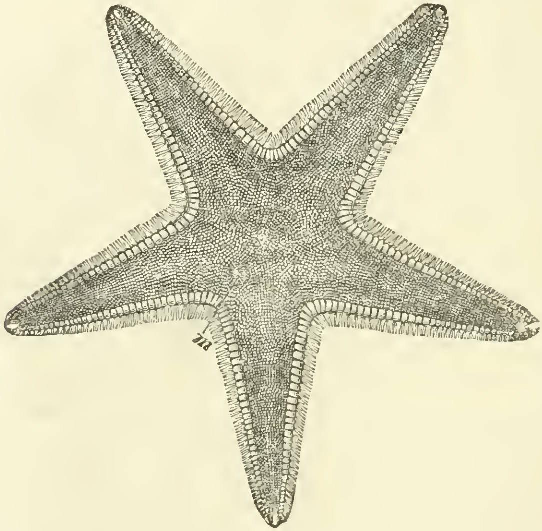


Fig. 1.—Upper Surface of a Star-fish (*Astropecten*). (From Cassell's "Natural History.")

gence, has spent his summers at the sea-side, studying several common forms of marine life. He compares a season's work of this kind to a prolonged picnic, the pleasure of which is accompanied by a sense that no time is being profitlessly spent. Sailing about upon the sunny sea to dip up in muslin nets the creatures at the surface, steaming away far from shore to dredge for other material, and carrying on observations among the tanks and bell-jars of a neat little airy workshop, all have their charms. Even the necessity of devising makeshift apparatus, and of teaching unskilled hands how to help, adds to the enjoyment, as does the overcoming of similar obstacles in a pleasure-excursion. Dr. Romanes has devoted his attention mainly to jelly-fish, star-fish,

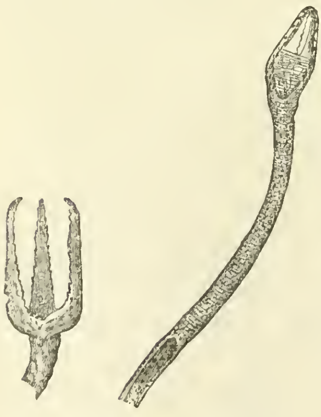


Fig. 2.—Pedicellariæ (magnified). (From Cassell's "Natural History.")

* The material and illustrations of this article are drawn from "Jelly-fish, Star-fish and Sea-urchins," by Dr. G. J. Romanes, the latest issue in the International Scientific Series.

and sea-urchins, or more particularly to the nervous systems, and the movements controlled by them, in these creatures.

A star-fish, as we all know, consists of a central disk and five radiating arms (Fig. 1). Upon the whole of the upper surface occur numerous calcareous nodules imbedded in the soft flesh, and supporting short spines. One of these nodules, much larger than the others, is always found a little to one side of the center, and is called the madreporic tubercle (Fig. 1, *m*). With the aid of a lens we may see also on the upper surface a number of small organs, each consisting of a pair of pincers supported on a flexible stalk, scattered about among the calcareous nodules, or attached to the spines; these are known as pedicellariæ (Fig. 2). These organs are provided with muscles by which the stalk is swayed about, and the pincers are opened and shut. What it is that these curious organs are adapted to seize, and therefore of what use they are in the economy of the animal, has long been a puzzle to naturalists, but Dr. Romanes and his associate, Professor Ewart, have succeeded in throwing some light on this point. In some species of star-fish the size of the central disk is increased so as to fill up the spaces between the rays, the form of the animal thus becoming a pentagon. In other species the reverse process has taken place, the rays having become relatively longer, and, being at the same

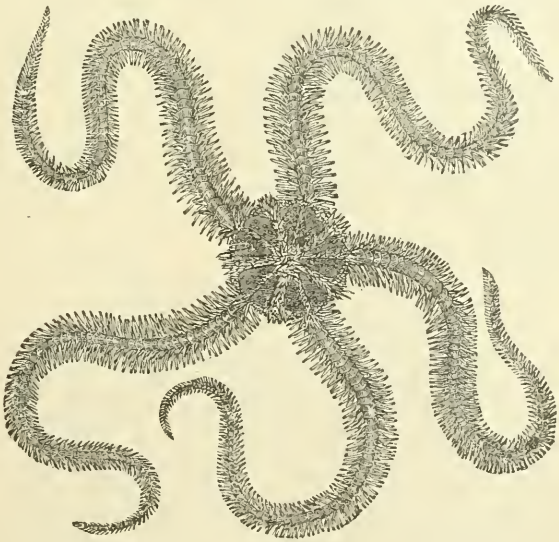


Fig. 3.—A Brittle-star. (From Cassell's "Natural History.")

time very active, they look like five little snakes joined together by a small circular disk (Fig. 3). Again, in another species the rays branch, these branches again branch, and so on till the animal looks like a mat. Turning now the under surface of our star-fish uppermost, we see that the mouth is in the center of the disk, and that from the mouth radiate five grooves, each extending to the tip of one of the five rays (Fig. 7). On each side of these grooves are many actively moving membranous tubes, which are used for crawling, and are called the pedicels or feet. They are closed at the free end, but communicate by a system of tubes within the body of the animal with the madreporic tubercle. It has been surmised that this tubercle acts as a filter to the sea-water which, with some admixture, forms the liquid circulating in the tubes, and Dr. Romanes has proved the surmise to be correct; for colored fluid, injected under pressure into any part of the system of tubes, found its way to the madreporic tubercle, and oozed through its porous substance. The tube-feet are thrust forth or withdrawn by being distended with liquid or emptied. With the exception of a few at the tip of each arm, every tube-foot bears a sucker (Fig. 4); these suckers are pressed closely to a flat surface by filling the tube-feet with liquid; the pressure within the tubes is then lessened, and the greater pressure of the surrounding water holds the suckers fast. They are released by increasing the pressure of the liquid within the tube-feet.

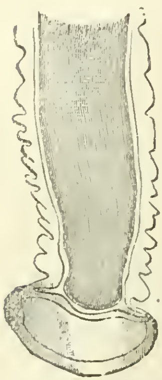


Fig. 4.—The Terminal Portion of a Tube-foot (magnified).

The common star-fish usually crawls in a determinate direction, the feet on the tip of the foremost ray being used as feelers. In a tank, when the star-fish has ascended the side and reaches the surface of the water, it often performs peculiar movements which may be called acrobatic. The animal does not wish to leave its native element—in fact, can not do so, because its sucking feet can act only under water—neither does it wish to descend at once.

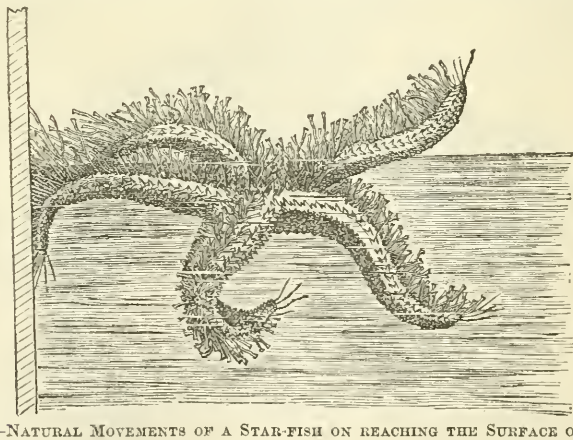


Fig. 5.—Natural Movements of a Star-fish on reaching the Surface of Water.

It therefore crawls along the side of the tank, now and then throwing back its uppermost ray or rays to feel about for rocks or sea-weed (Fig. 5). If it finds any solid support it will very likely attach its uppermost rays to it, and then, letting go its other attachments, swing from the old support to the new. The activity and co-ordination manifested in these acrobatic movements, says Dr. Romanes, are surprising, and give to the animal an almost intelligent appearance.

The feet of astropecten are partly rudimentary, having lost their terminal suckers, and these star-fish assist themselves in locomotion by the muscular movements of their rays. The brittle-stars are still further removed in the same direction from the common star-fish ; their tubular feet are of no use for crawling, while their rays are so long, flexible, and muscular, as to enable them to shuffle quite rapidly over horizontal surfaces. Two opposite arms are used upon the floor with the motion of swimming, the animal leaping forward about two inches at each stroke, and, as these leaps follow one another quickly, the star-fish is able to travel at the rate of six feet a minute. A common star-fish can crawl only two inches a minute. Some of the *Comatulæ*, in which the muscularity of the rays has proceeded still further, are able actually to swim by the co-ordinated movements of their rays.

The sea-urchin, or echinus, is a modification of the star-fish structure, having the form of a flattened sphere, and is covered with hard spines (Fig. 6). In the living animal these spines are movable in all directions, each being mounted on a ball-and-socket joint, and provided with muscles at its base. Like the star-fish, the echinus has a madreporic tubercle, pedicellariæ, and feet. If we shave off the spines and pedicellariæ, we come down to a hard shell, which is hollow and filled with liquid. The liquid resembles sea-water, but is richly corpusculated, and coagulates when exposed to the air. Five double rows of holes extend symmetrically from pole to pole of the shell. It is through these holes that the feet are thrust out, so that in its main features an echinus is merely a star-fish with its five rays curved into the shape of a hollow spheroid, and then converted into a rigid box, with holes left for its feet to come through. The urchin crawls in the same way as the common star-fish, but makes use of its spines also to help push itself along. The suckers, moreover, in being protruded from all sides of a globe instead of from the under side of a flat organism, are of much more use as feelers than they are in the star-fish. If

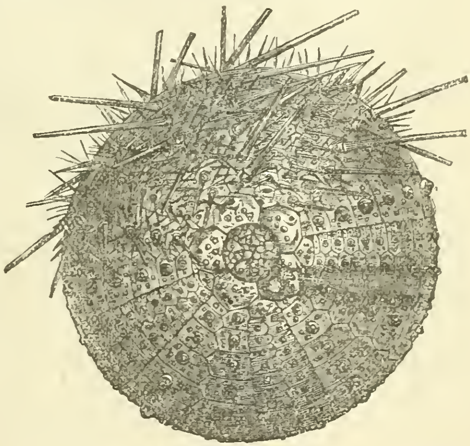


FIG. 6.—AN ECHINUS PARTLY DENUDED OF ITS SPINES. (From Cassell's "Natural History.")

the animal while walking be turned half round, it will continue its movements as before, and hence will proceed in a direction opposite to its former one. When at rest, some of the feet are used as anchors, and others protruded as feelers.

All species of the *Echinodermata*, when turned upon their backs, are able to right themselves. The brittle-stars can easily perform the

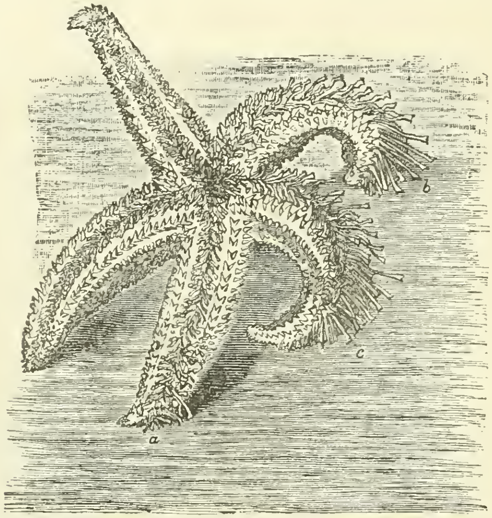


Fig. 7.—Natural righting Movements of Common Star-fish.

needful manœuvre by wriggling some of their snake-like arms under the inverted disk, and heaving the whole body over by the mere muscularity of these members. The common star-fish, however, experiences more difficulty, and executes the manœuvre mainly by means of its suckers. It twists round the tip of one or more of its rays until the feet there situated are able to get a firm hold of the floor (Fig. 7,

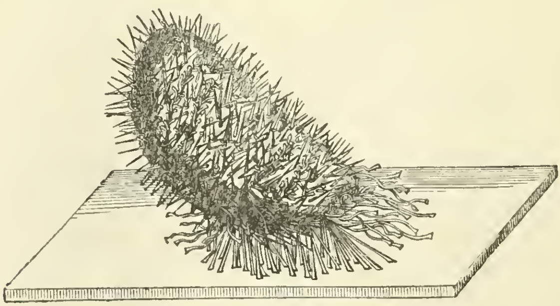


Fig. 8.

a), then, by successive action of the feet further back in the series, the whole ray is twisted round (*b*), so that the under surface of the end is applied flat against the floor (*c*). The semi-turn or spiral then travels on down the ray. Usually two or three adjacent rays perform this manœuvre simultaneously, the spirals of the co-operating rays being invariably turned in the same direction, and, when they have proceeded sufficiently far to drag over the remaining rays, these then abandon their hold on the bottom so as not to offer any resistance to the lifting action of the active rays. The whole movement does not occupy more than half a minute.

But it is in the case of echinus that these righting movements become most interesting, from the fact that they are so much more difficult to accomplish. Two, or perhaps three, adjacent rows of suckers are chosen out of the five to accomplish the task. As many feet in these rows as can reach the floor are thrust downward and fastened firmly to it; by their combined action, as by the pull of liliputian ropes, the globe is tilted slightly in their own direction, the anchoring feet in the opposite rows releasing their hold on the floor to admit of this tilting (Fig. 8). The next feet in the active rows are thus enabled to reach the floor, and, when they have established their hold, they assist in increasing the tilt; then the next feet in the series lay hold, and so on, the globe slowly but steadily rising until it stands upon its equator (Fig. 9). The difficulty of raising such a heavy mass into this

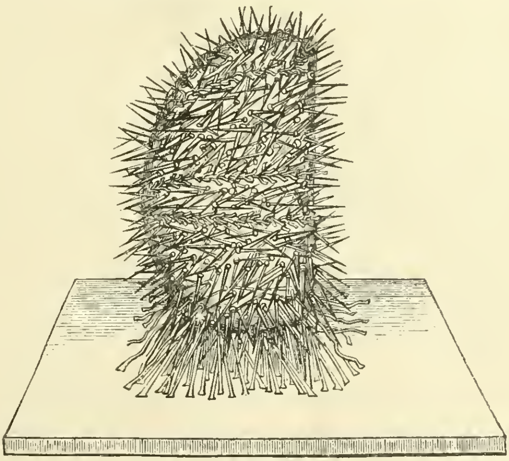


Fig. 9.

position by means of the slender motive power available is manifest not only from the extreme slowness with which it takes place, but because specimens not perfectly strong may fail completely to reach the position of resting on the equator. Moreover, in some cases when this position has been reached with difficulty, the echinus gives itself a breathing-space, as it were, before beginning its descent. It will be perceived that, as soon as the descent begins, gravity is no longer an obstacle but an aid to the righting movement, and it might be anticipated that the echinus would now simply let go all its attachments and allow itself to roll over into its natural position. But an echinus will never let go its attachments without some urgent reason, seeming to be above all things afraid of being rolled about at the mercy of currents, and therefore it lets itself down almost as slowly as it pulled itself up (Fig. 10).

Single rays separated from a star-fish crawl as fast as the entire animal, and likewise in a determinate direction. They also crawl up

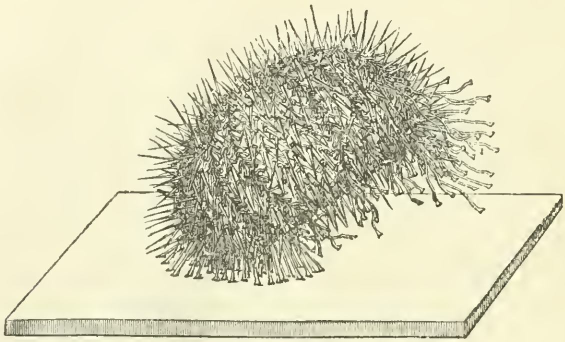
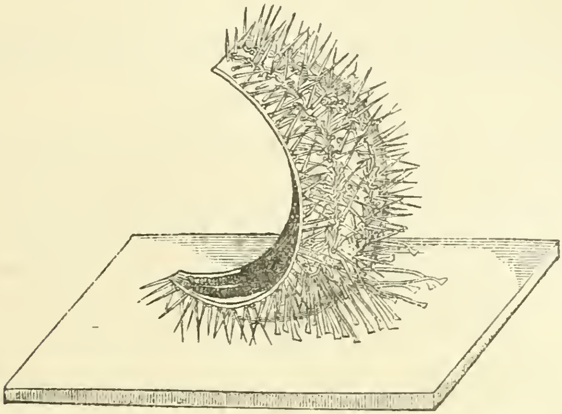


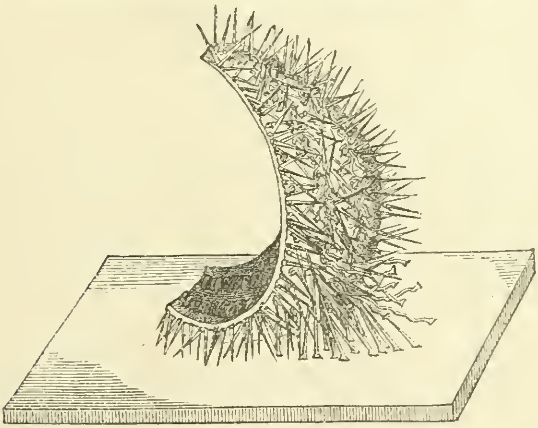
Fig. 10.

perpendicular surfaces, and when inverted right themselves as quickly as do the unmutilated creatures. A segment of an echinus bearing a single row of ambulacral feet, when propped up on its ab-oral pole, (Fig. 11) will right itself after the manner of entire animals (Fig. 12). It, however, experiences more difficulty in doing so, and very often fails to complete the manœuvre. Such a segment is, of course, analogous to a single detached ray of a star-fish; but on account of the rigid consistence and awkward shape of the segment—standing erect instead of lying flat—it presents a much more curious appearance in locomotion than does the ray of a star-fish.

Dr. Romanes reports observations which show conclusively that the whole external surface, not only of the soft and fleshy star-fish, but even of the hard and rigid echinus, is everywhere sensitive to stimulation. This sensitiveness, moreover, is highly delicate. If any part of the external surface of an echinus is lightly touched with the point of a needle, all the feet, spines, and pedicellariæ within reach of that part, and even beyond it, immediately close in upon the needle and grasp it tightly. This simultaneous movement of such a little forest of prehensile organs is a very beautiful spectacle to witness. Here we have proof of the function of the pedicellariæ. In climbing perpendicular or inclined surfaces of rock covered with waving seaweeds, it must be of no small advantage to an echinus to be provided on all sides with a multitude of movable stalks bearing forceps, which can instantly seize a passing frond. The frond being thus arrested, the spines come to the assistance of the pedicellariæ, and both together hold the sea-weed steady till the ambulacral feet have time to establish their hold upon it with their sucking-disks. This operation may be witnessed by drawing a piece of sea-weed over a healthy echinus in the water.

The capability of the spines for co-ordinated action is highly remarkable and interesting. Thus, for instance, if an urchin be taken





Figs. 11 and 12.—Righting and Ambulacral Movements of several Segments of Echinus.

out of the water and placed upon a table, it is no longer able to use its feet for walking, as the suckers can act only under water. Yet the animal is able to progress slowly by means of its spines, which are used to prop and push the globe-like shell along in some continuous direction. If a lighted match be held in front of the moving animal, as soon as the echinus comes close enough to feel the heat, all the spines begin to make the creature move away in the opposite direction. There is an urchin-like form of echinoderm called spatangus, which differs from the echinus in having shorter feet and longer spines. When, therefore, a spatangus is inverted it is unable to right itself by means of its short feet, but uses its long spines to perform the manœuvre. The process is a tedious one, and there are generally numerous failures; but the creature perseveres until it eventually succeeds.

ETHICS AND THE DEVELOPMENT THEORY.

By GEORG VON GITZYCKI.

THE question of the bearing of the theory of evolution upon morals deserves a serious examination. The doctrine of development breaks at many points with cherished traditional notions, and its opponents have predicted that it would result in a spiritual revolution which would convulse society to its foundations by destroying the sanctions of conscience and paralyzing the religious sense.

The science of ethics has a theoretical and a practical part; the former, founded on the study of the nature of volition and the moral feelings, the latter having for its object to determine what ought to be. The latter, the establishment of rules of conduct, is the real object of ethics, while the purely theoretical researches have only the value of means.

Ethics can, it appears to us, learn much out of the theory of development, or can at least find a confirmation of single principles hitherto recognized by only a part of the students of morals. This theory teaches that the feelings and inclinations, as well as the bodily forms, are results of the adaptation of the living being to the conditions of his existence, and are therefore to be recognized as life-maintaining functions; that, the more complicated are the conditions of life, the less perfect is this adaptation: therefore, in the human world, spontaneous feelings and impulses are not safe guides. We may learn from it, also, to regard the moral feelings and conceptions as the most important part of the adapting of man to the conditions of social existence. It teaches us to bring into special consideration the moral conceptions of the most successful nations in the struggle for existence; for, if their views of right and wrong had diverged greatly from what is really beneficial to society, they would not have reached their dominant position. But the recognition that, in consequence of the complicated conditions of life, the adaptation is never complete, must restrain us from ever regarding the "positive morals" of a people—that is, the sum of their actual moral ideas—as being absolutely perfect.

The development theory, which has made us acquainted, as perhaps no former generation has been, with the idea of progress, has also accustomed us to regard the moral as one of the fields in which progress takes place; and, furthermore, to look forward to perfection in the moral nature. Moral progress consists, not in men coming nearer to their ideals, but in their ideals reaching a higher plane.

This theory shows us how dependent man is upon his race, and how erroneous it is to separate him from that connection. That the faculty of conscience is a result of the adaptation of man to the conditions of social existence appears to be doubted by no adherent of the theory of development; but the exponents of the doctrine vary greatly in their views of the manner in which the moral conceptions arise in individual life. Some regard them as to a greater or less extent instinctive, or transmitted by inheritance from the accumulated experience of ancestors; while others are inclined to accord a more prominent agency in the matter to training. We may apparently, however, presume that that which is practically the most wholesome will endure in the character, provided the teacher does not trust too much to the innate moral instincts, but recognizes that, while his child has the qualities requisite to his becoming a moral man under favorable conditions, this is not sure to be the case if those conditions are wanting, and therefore exercises extreme care in moral instruction.

We turn next to the answer to the question, What is the bearing of the development theory on the practical part of ethics? Man's place in Nature, as determined by that theory, is very different from that indicated in the older ideas of men; just as the Nature in which man finds himself set is not the Nature that existed in the conceptions of the past. The new conception of man and his morals again approaches, in many respects, that which was implied in the ethics of classical antiquity. Man no longer stands outside of Nature, but within it, as one of its integral parts. He is subject to the same laws of life as the animals. All in him, like all around him, is a product of natural, regular development. Even his moral part is not something laid upon him from outside of Nature, but something which has been shaped out of his own nature, molding itself according to the conditions of his existence. To an ethicist who accepts this view, morals will appear an affair of humanity and for humanity—for humanity on earth; and will give the most comprehensive construction of the saying of Christ, that man is not made for the Sabbath, but the Sabbath for man. We can not perceive that this view involves any practically destructive tendencies; and there are not a few distinguished men who avow the belief that there is no irreconcilable variance between evolution and religion.

With this view of the place of man in Nature, the ethicist can not easily oppose the doctrine that the same legality rules in the human will as in all the other processes of Nature. Even in the matter of the appearance of new individuals, the development theory admits no void in the endless chain of causation; for the dispositions which man brings into the world are, in consequence of it, nothing else than a product of the energies of his predecessors. The recognition of the fact of the transmissibility of mental as well as of physical characteristics, if not to the children to the children's children—a transmissibility whose sphere of influence in individual cases is not susceptible of definition—can not but heighten the feeling of responsibility, because we are thereby made aware that the consequences of good as well as of bad conduct extend further than we had supposed.

A few adherents of the development theory, including Darwin himself, have held that not the good of mankind, but the maintenance of his existence, is the moral principle resulting from it; and that feelings of pleasure and of pain are only the means which Nature uses to promote the exercise of life-favoring and restraint from life-injuring conduct; that the real end of all action is not pleasure and the avoidance of pain, not the greatest possible excess of pleasure over pain for as many as possible, not the greatest good of the greatest number, but only the most prolonged existence of the greatest number. The greatest possible endurance of species, or the mere maintenance of species, not their welfare, would be according to this view the chief moral principle. This position appears to us to be a difficult one.

The chief moral principle expresses that from which all of the rules of right may be derived, and accordingly means the highest rule of conduct, the highest moral aim of life, or the ethical highest good, and serves as the highest standard of estimation and judgment. Those evolutionists of whom we have just spoken start from a teleological view of the world—from the view that the course of Nature is governed by some purpose. But the majority of the Darwinians are opponents of teleology, or try to be. Rolph has shown that, in following the history of organic development on the earth, we can really perceive no tendency to an adaptation showing design, to the production of forms that may be represented to human conception as higher. Its result has been only to produce forms better adapted to what is around them; and the change just as often consists in a deterioration, even though some advantage is always gained for the creature. As not final causes, but efficient causes, working causes, have worn out the river-bed and determined the course of the stream, as it has formed its channel not with reference to its final outlet, but to the local conditions, so, as Darwin and his followers have shown, it is with all organic phenomena. The investigator has to break with teleology in all its forms; and, even in ethics, the question of the object, of the destiny of man, will have to be given up. This idea of a purpose or design in Nature, when we come to analyze it, of a preconceived and voluntary operation working to produce determined effects, presumes by necessary implication the agency of a will behind the causes which are leading up to those effects. It follows, hence, that there is purpose in Nature in the domain of man and the higher animals, because men, and in a certain but very much less degree the animals, form conceptions of processes which they strive to carry through; but that aside from these one can speak of Nature's purposes, of purposes which general Nature is pursuing, only if he regards Nature as a thinking and volitional being, or as the creature of such a being. A teleological view of the world thus of necessity always includes some kind of a theological view; and it seems to be decidedly a *non-sequitur* to entertain the one without holding to the other.

We men actually make our continued existence an object of fundamental importance, because, without realizing it, no other object is attainable. We are thus justified in calling all our properties that contribute to the maintenance of life adapted to that purpose. And, as we refer this same relation to the animal and the whole organic world, we are accustomed also to designate all their life-maintaining properties as likewise adapted. But life is never a purpose to animals. The idea of preserving life does not arise in their consciousness, and can not therefore be the object of a volition; while the lower animals have no ideas, but only sensations and perceptions. They have, therefore, no purposes. Still less can we speak of the purposes of plants, for plants have no consciousness. It is thus clear that, so far as the sub-human world is concerned, the designation of the life-preserving attributes of existence as designed, unless we are speaking in a theological sense, is only metaphorical. For this designation implies the premise that life is an object; and this, in a proper, untheological sense, is true only as respects human consciousness. Thus, a speaker who would avoid transcendental implications and metaphorical modes of speech should always avoid the word "designed," and this can be done without leaving any fact undetermined.

But, if we, regarding our belief in God as a justification for the introduction of the divine idea into science, and not heeding the many difficulties which ethics has hitherto encountered in basing its precepts on the presumed will of God, endeavor to determine what his will is, we shall have very little, if any, success in convincing the faithful that it is for the most prolonged existence of the greatest number.

Even as relating to men, these persons will not believe that self-preservation as such is the highest good. Bare existence is no good, much less the highest good; but it may be, if it is a bad existence, the highest evil, and this according to the perfectionist doctrine as well as according to the utilitarian theory of happiness. There is said to be existence, yes, eternal existence, even in hell; and, according to the ancient fathers of the Church, "the most prolonged existence for the greatest number."

Evolutionists, who recognize that life is valuable only as it is good, have occasionally fallen into the mistake of considering among the consequences of conduct only the effects on the condition of soundness, and of disregarding the pain that may be immediately produced by it; and they have not always been mindful that, according to their own definitions, fullness of life can be valuable only if we include in it fullness of happiness or some cause thereof.

Those evolutionists who appeal to the ancient principle of a Nature-fitted life have apparently not sufficiently considered one thing. Science teaches what has been, but not what will be. If the "tendencies" of Nature which they think they have determined were simply laws of Nature, conditions of the inevitable occurrence of events, there would be no reason in seeking to make a moral imperative of them; for that can not be a matter of injunction which will without fail happen of itself. But if those "tendencies" are not a fate to be fulfilled with irresistible necessity, but can be antagonized, then the question arises, Why should we act according to them, and not try to counteract them? If we were once agreed that the complete working out of those tendencies would cross all our desires and hopes, would we recognize the ethic imperative of promoting them? On the contrary, we should recognize the obligation of so far as possible preventing their realization. And we should obey the moral command to make those tendencies ours, and advance them according to our strength so far as they appear good to us; as we also should hold a corresponding conduct to be right without this, without regarding it as advancing natural tendencies. What we should regard as good or evil, as worth striving for or to be avoided, must present a corresponding character to our own perception; and what that is arises out of our own nature, not out of something different from what that might be. Thus, the final decision as to what is to be striven for and what to be avoided lies in us, in our mind and will.

We observe, also, that the aspiration for what is according to Nature is so far from being an obvious ethical object, that the ancient Christians regarded the natural as something leading to evil. The ancient Greeks, on the other hand, premised an agreement of the two; and so it came to pass that the former held a pessimistic and the latter an optimistic view of the world. But the Greeks did not believe in the natural because it was natural, but because they thought it good; as the Christians disbelieved in it because it appeared bad to them, and seemed to contradict their moral convictions.

We are glad to learn from the evolutionist all he can tell us of the nature of things, and of the means of reaching the object sought after by us. Of this object, however, we do not learn from a natural history of the objective world, but from the study of our own hearts. It is, therefore, self-evident that the utilitarian or the ethicist, who regards the highest general good as the chief moral standard, will make use of all knowledge that can cast light on the way to his end. Consequently, he will certainly avail himself of all the facts of biology and sociology that are of importance in regard to it.

Existence is the condition of happiness. If the happiness of millions of present and future living men is to be assured, then their existence must be assured first of all things. Everything, therefore, that is important for the most prolonged existence of the greatest number is also important for the greatest happiness of the greatest number. The utilitarian will utilize all that the evolutionist can tell him—and one thing more.

The evolutionist will tell him that there is a correlation, on one side, between disagreeable and destructive, and on the other side between pleasurable and advantageous action; that the "useful," in the sense of the pleasurable, nearly agrees with the useful in the sense of the life-maintaining; and that there is a close connection between health and happiness and between disease and unhappiness. While this correlation is far from being perfect, it is, nevertheless, true that a more certain road to happiness lies through maintaining or improving the health than through a direct striving after a maximum of pleasure. The same rule prevails in society. The sound health of society must be the practical end through reaching which alone the real prosperity of society can be attained.

The truth that health is a fundamental condition of happiness has, indeed, not been unknown to any ethicist; that pattern of ancient cheerfulness, the philosopher Epicurus, is an emphatic reminder of this fact. And that the care of one's own health is enjoined also through regard for others, and that the so-called duties toward one's self are really duties toward others, and for that reason only duties, is likewise a doctrine that did not have first to be learned from Darwin and Spencer. But we have to thank Spencer for having adduced, in his exposition of the facts of transmission, so potent evidence of this truth, that no such dictum upon it as Schopenhauer has uttered will ever again be possible. While, however, he has performed the service of defining the physical conditions of happiness with greater emphasis than any of his predecessors, it does not follow that the utilitarian method founded by Bentham will have to be given up. Evolutionist writers have reminded us that too little attention has been paid to health in discipline and in public instruction. This is too true, but it is not in consequence of the application of utilitarian but of non-utilitarian precepts. And if it has been declared to be one of the results of the doctrine of a correlation between species-maintaining and pleasure-bringing action that family happiness is the highest human happiness, that is only a confirmation of a view expressed long ago by utilitarian ethicists, as appeared most plainly a hundred years ago (1785) in Paley's "Principles of Moral and Political Philosophy."

If, however, by the phrase, "health of society," something else is understood than a society consisting of healthy individnals, then the word "health" is only a metaphor, and one the sense of which is not clear; and to put this metaphor in the place of the principle of the happiness of the whole can not be regarded as an improvement. If Bentham should return now, he would have to censure the evolutionist ethics in no slight measure for its vague generalities and empty declamations, and its playing with phrases, and to combat its lack of circumspection. The evolutionists have joined generally with the utilitarians, but they are not practical ethicists. They could hardly succeed in actually working with their principle in such a compass as Bentham worked with his.

We come now to consider what is the bearing of the Darwinian doctrine of the struggle for existence upon morals. The objection has been brought against this doctrine, in divers phrases and with a variety of statement, that it leads to extreme demoralization. It can not be denied that Darwin's designation of the principle discovered by him as the "struggle for existence" is not fortunate, and is a metaphor, indicating a conscious hostile contention between living beings, each seeking the other's destruction, that has no real existence as such. And it will not be disputed that Darwin has been led into errors similar to those embodied in the theory of Malthus; or that great mischief has been done by the use of the phrase "struggle for existence" by persons who have never learned the A B C of ethics, but have still believed themselves called to offer their crudities to the public. But those mistakes are not to be alleged against the principle as such.

The principle of the natural selection of those beings whose modifications best adapt them to the conditions of their life is in the first place only an expression of that which has been, not of that which is to be. It is a law of Nature, not of morals. We are subject to this natural law of organic life, just as we are subject to the law of gravitation, or of the persistence of force, wholly without regard to our will. Natural selection is an agent which has operated as the general regulator of life upon the actual constitution of what is now existing in the organic world. It is the universal natural force that also regulates human life. And what do we see in human life? A fearful amount of moral and physical evil which is not prevented, but rather in part begotten by that regulator. We make it our task to contend incessantly by our premeditated action against that evil, while we regard the world, which is here without our assistance, not as the best possible, but as something which we must labor to improve and make more rational. What happens through the operation of the universal forces of Nature can not be a moral rule for us; for those forces produce also everything that is bad. This regulating principle implies that the being which possesses the most advantageous constitution, that is, which is best adapted to the conditions of its existence, has the best chances to maintain itself and to increase; and it applies to human beings as to all others. The fittest, or best adapted, survive. We have to distinguish among the life-conditions of man, or in his environment, between the physical and the social factors; the former regulating in general his physical, the latter his moral constitution.

What, now, is the moral constitution which enables the individual endowed with it to maintain himself? The principle of natural selection is not contradicted by any fact in the history of mankind. The determination of what of its members shall survive is an affair of the particular constitution of a society. There are, as Everett * has remarked, different kinds and degrees of immorality which are always important to the result. A certain degree of honor, according to the proverb, is required for a man to preserve his social standing in a society of thieves. But, besides the avoidance of flagrant violations of the social contract, there is nothing which is universally and always debarred by the demands of the social environment. The man who was fitted to succeed in the early days of the Roman Republic would have failed in the later age of the empire; and one whom the social elements of the empire lifted up would have fared badly in the time of the republic. Indeed, societies in which the highest and noblest moral attributes are a passport to success are very rare. The "fittest" in the moral sense, and the "fittest" in the sense of Darwinism, are not often the same.

And is this the last word that is to be said for Darwinism in its relation to morals? Is the judgment that the moral best and the fittest in the Darwinian sense are often not the same, of unconditioned effect? We believe not.

The principle of natural selection regulates not only the life of individuals; it rules also over the lives of generations and of peoples. It may, indeed, happen to be the means of success in some one commonwealth to practice the religion of *£ s. d.* It may be that in a particular society selfishness, cunning, trickery, overbearing violence or fawning subserviency, and moral cowardice, or high living and ostentation, will give good chances for getting on; men of such characters may have, in some states, the best opportunity to raise themselves and their families, while one who despises injustice, lying, and hypocrisy, will have to go to the wall. But there is, nevertheless, as Matthew Arnold says, "an eternal power, not ourselves, that makes for righteousness." Characteristics, it is true, are transmitted; but not in the same combinations as they existed in the father or the mother; immoral characteristics, like those we have named, never in that which is adapted to insure success in a certain constitution of society. If we allow, by transmission or by training, some other peculiar quality to enter into the composition of the character, or if we let a certain quality be lost, then that "lucky balance" that brought success will be destroyed. The chances that the posterity of men possessing such traits of character as we have sketched will maintain themselves long, that they will not, sooner or later, fail, in consequence of collisions with the "physical, legal, or social sanction," with the laws of health or of the state, or with the demands of society, are not very great.

But "the eternal power, not ourselves, that makes for righteous-

* C. C. Everett, in "Unitarian Review," October, 1878; "The New Ethics."

ness," asserts itself in a still more imposing manner. We have hitherto considered only the lives of individuals and of single generations, but we must also regard the lives of peoples. It is manifest in this collective life, in a vastly higher measure than in individual life, that "the wages of sin is death." As Everett has remarked, again, one society may favor the growth of righteousness and honor, another that of knavery and hypocrisy. In one, drunkenness and sensuality, and similar vices, may cause a man to sink to the lowest circles of society; in another, they may raise him till he reaches the highest. But here, at last, we have a principle, to which these social conditions are themselves responsible. The one society will develop one type of character, the other a different one; but according to the type of character which it favors will it stand or fall. In this we find in the facts of history a confirmation of the fundamental difference between right and wrong. What we call justice is the only enduring basis on which society can rest. The nations that do wrong and despise justice, which lose themselves in sensual intoxication, are at last broken up, and a purer, stronger, and less depraved race takes their place.

If the opinion comes to prevail in a society that the struggle for existence justifies or demands a reckless pursuit of one's own interests, the oppression and ruin of the weak by the strong, the destruction of misery by destroying the miserable, the extirpation of the voice of compassion, which protests within us against such a course; if physical strength and refined cunning and selfishness are carefully cherished as the highest ideal, then the days of that commonwealth are numbered, for it has worked for its own dissolution by authorizing a "strife of all against all," which, true to its precepts, may come in at any moment when a community of interests may not be present. Let periods of want and danger, or of war, ensue, and we shall see what will be the fate of a society in which patriotism, devotion, ideal standards, and regard for truth and justice have been objects of ridicule.

All positive human authorities are subject to the authority of life-conditions. If they will not adapt themselves to the nature of things when they deal with the bases of social life, their enterprises will at last be shattered under the might of that authority.

Two elements, according to Everett, have contributed more than all else to the success of men in the conflict with animals, and of civilized men in contending with barbarous. One of these elements is knowledge, or the power of thought, the other is the force of the social impulse. Ideas on the one side, a self-forgetting resignation on the other, are what have given the victory to the higher races. Whatever restricts the course of either mental or moral development strikes the hardest possible blow against the stability of the social organism.

The distinction between right and wrong, to use an expression of John Fiske's, has its roots in the deepest foundations of the universe. The cosmical power of natural selection is not against, but for, morals.

It sanctions the most exalted ethical ideals, such as the choicest minds have conceived. It is a judgment-power, because it permits only that which is right and perfect to endure, and lets the unjust, the base, and the evil perish.

The knowledge that this world-power supports virtue, and contributes its part in elevating the moral nature, will inspire the moralist in his efforts in behalf of the good, and in his contention against the bad. But we must be careful not to mistake the true significance of this law. There is arising in the newer evolutionist literature a kind of fatalist optimism or optimistic fatalism, the effects of which may be no less disastrous than those of an undiscriminating pessimism. If natural selection is to select the good, then the good must already be there. It does not contradict this principle, that the human race will die out as other species have died out; but it follows directly from the principle that the race must die out if it becomes bad. Not without us, but through us, through our volition, conscious of that purpose, will the continuous development go on. In our day, says Salter, in his "Religion of Morals," evolution is sometimes regarded as if it was something outside of us and above us, and we had only to wait on its motion. But evolution operates through you and me. It is only an abstract name for the course which your energy and mine and that of other beings take. It is for better or for worse, according as we are better or worse. It goes on rapidly or creeps along painfully, according as our thoughts are quick or slow and dead. It is not enough to perceive that the bad will at last perish and the good persist. We must wish it to be the good that will triumph. It is still true that the sources of history are in us. The result of these considerations must be a heightening of the feeling of responsibility.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

MOTHS AND MOTH-CATCHERS.

By AUGUSTUS R. GROTE, A. M.

II.

To understand the way in which our North American moths are distributed (and by North American we mean the territory north of Mexico and the West Indies), we must study the physical geography of the continent. There is a perfect host of species and individuals, which depend on special kinds of plants, for the most part, and their diffusion is, of course, limited by the area of the plant upon which their caterpillars subsist. But the greater bulk of the species are not confined in their young stage to one sort of plant, while, from their activity, these flying flowers, the moths, range farther than the more slowly traveling blossoms whose honey they extract.

If we take a map giving a bird's-eye view of the continent, with the elevations marked, we can understand the problem better. Ranges of mountains obstruct, valleys and river-channels assist, the dispersion of moths. They travel on the wings of the wind, and an important factor is the prevailing seasonal direction of the air-currents. There is in North America a summer migration of many species from the South to the North, so that, toward the autumn, several tropical kinds have crept up along the coast, or inland, up the valley of the Mississippi. The "cotton-worm moth," which, in its caterpillar state, inflicts great damage at times upon the plantations, is a case in point. Individual specimens or flocks of other moths, such as the "great eye-spot" (*Erebus odora*), the "blue and green hawk" (*Argeus labruscæ*), visit us yearly, coming up from the West Indies. They die out in the winter here, and leave no progeny behind them to continue the species in our high latitudes.

Rivers assist in the dispersion of insects, and, in a less degree, perhaps, the particular insects we are here discussing. Nevertheless, upon leaves and sticks the eggs of moths are floated on the current, while the commerce of the water-routes brings the cocoons with the vegetables and fruits which it carries from place to place in boats and ships.

A bird's-eye view of our continent shows us the elevations of the Rocky Mountains and parallel spurs in the West, and the Alleghanies in the East. Mountain-ranges stand in the way of the spreading of moths, which perish in the cold atmosphere and the storms which gather about the rocky summits. Our faunæ can be understood by studying the formation of the land in this way. Over the vast plain east of Colorado the same kinds of moths generally prevail. The valleys in the West, on the other hand, contain a majority of peculiar species or kinds, often more local than in the East. In New York we are cut off, again, by the Alleghanies from many species which are plentiful in Ohio and Indiana. Our tropical wanderers come to us up and along the coast. I have met, sailing on the Gulf Stream, flights of moths, mostly of a few kinds, which fell on the rigging and sides of the vessel in great numbers. In the autumn, on Staten Island, I have captured specimens whose true home was Cuba and Jamaica. Although smaller faunæ, or limits of particular species, are traced by naturalists, our mountain-ranges are the best general guide as to the changes in the sorts of moths which we may expect. From Ohio to Louisiana we meet much the same kind of moths, with a difference in the rarity of certain species, and in the presence of others dependent on particular kinds of plants. But, when we get into the valleys of the Rocky Mountains, we shall have taken leave of the most of our dusty-winged Eastern friends. Some kinds take the voyage with us completely across the continent, but these are comparatively few in number, and are sometimes almost cosmopolitan.

So true is it that one branch of a subject leads to quite different questions and to matters apparently foreign to the immediate inquiry, that here the subject of the range of North American moths leads us into myth and poetry. For, in finding out that we have species of moths which are found in other continents, the question arises at once, How did they get here? They could not fly over from Europe, nor could they now cross Behring Strait, with the Arctic climate there existing. Imaginative persons have supposed a submerged Atlantic Continent, which bridged the chasm in a remote geological period. The myth of the Atlantis has been recently furbished up under the facts supplied by the deep-sea soundings of the English steamer Challenger, and the discovery of a plateau at the bottom of the ocean, between North America and Europe. But, if it ever existed, it probably did so at a time before the ancestors of our present moths came into being.

For a moment, let us leave this matter and look at the question of the affinities of our moths. I have shown, in the "American Journal of Science and Arts," the detailed characters of one family of our moths, the *Sphingidæ*, and what is true of them is true generally. Our moths, in regard to their structural relationship with the moths of the world, fall into three main categories : 1. Those which are peculiar to North America. 2. Those which have their nearest allies in South or tropical America. 3. Those which have their nearest allies in Europe or Northern Asia.

With these last we have here to deal, and to account for their presence with us. This class falls into two main groups—those which are absolutely the same, and those which differ more or less, but clearly reveal their common ancestry. But there exists in these respects every gradation. Some differ so little that there is much dispute as to whether they constitute different "species," and some, again, only differ perceptibly in certain stages. Others differ a little throughout in all stages, and form what are called "representative species." So, far off in Arizona, I have found a species (*Copimamestra occidenta*) which "represents" a common European species (*Copimamestra brassicæ*). What is this little moth, with its big name, doing in Arizona, and how did it get there? With regard to those kinds which are absolutely identical in America and Europe, some have evidently come over through commerce in historic times. We have found out almost the particular voyage which brought the "white-cabbage butterfly" from England to Quebec, whence the insect has spread over the New England and Middle States, to the great injury of our market-gardeners and cabbage-growers. But of some the distribution is such that this can not be the explanation of their presence here. Of others it may be doubtful. I am inclined to believe that another cabbage-insect, the moth called *Pluria ni*, has been brought over in this manner. But how about our Arizonian *Copimamestra?*

We shall have to leave entomology and go into geology to answer this question. Formerly there was a warm climate in the north during the Tertiary period. This was a certain measurable time ago, when the circumpolar regions had a warm average temperature, with no winter, and the moths of the period were then substantially the same species from Norway across Siberia to Greenland. During this happy time—happy, at least, so far as weather was concerned—we must imagine that no impediment existed to the migrations of animals across what is now Behring Strait. It is probable, even, that the Tertiary epoch, as it witnessed the first appearance of man, saw his first wanderings in North America. He, too, came from Asia by way of the north and Behring Strait. Evolution had performed surprising work in the mean while with one branch of the human family, members of which, landing from Scandinavian or Spanish ships, met, upon American soil, the descendants of a migration from Asia to America in a former geological period, and to the east! At the close of this Tertiary period of the earth's history, cold and snow and ice set in; the long winter of the ages made its appearance in the shape of the Glacial epoch. The circumpolar moths, whose more humble fortunes we must be content here alone to follow, were forced southward gradually by the change in climate which gathered its frigid strength in the north. The European, Asiatic, and American faunæ then became separated, the latter the most completely, and by barriers both of ice and ocean. The American species of moths, which formerly lived upon the shores of the Arctic Ocean, were gradually forced down, year by year, until they reached Mexico, or the elevated portions of the Southern States. When the glaciers subsided, and the floods of ice which had submerged the continents gradually melted and slowly drained away, the moths, much changed by the long conflict, also retraced their steps northward. As marks of the retreat and advance, colonies of moths were left on the mountains to tell of the flood. At this time our "Western clawed cutworm" (*Copimamestra occidenta*) had been long separated from its present European brothers, and the differences by which we now recognize the two species as distinct had become slowly established through a long series of succeeding generations. What miles of land and sea separate the two to-day! The descendants of a common circumpolar species find themselves partly in Germany, partly in Arizona, and the Southwestern territory of the United States!

Let us turn back to the other theory, that of a submerged Atlantic Continent. Whatever may be finally proved from geology as to the existence of such an Atlantic bridge, it is clear that the myth of the Atlantis must be separated from such facts, as being of much more recent origin. Primitive man existed æons before the notions which were worked into the poetic and semi-historical myth of the Hesperides and Atlantides. The setting sun was followed by human eyes for untold ages, as it bathed itself in the golden flush of evening, and was at last whelmed by the waters which were held to surround the supposed circular flat earth. The sun was the golden apple of the garden of the Hesperides, the Golden Fleece after which Jason sailed. The poet transformed the primitive notions into charming myths, which probably had their origin from the observation of low-lying clouds floating, like islands, in a sun-flushed western sky. In this region of imagination and romance it is, perhaps, better—at any rate, it is excusable—to abandon prose and take to verse. So we shall quote a modern rhymer for the explanation of "the Atlantis":

The western sky is all ablaze,
And, floating on that golden sea,
The clouds, like islands in a maze,
Blest dwelling-places seem to be.

When first this sight was viewed by man,
He thought the earth was flat, not round;
That all about its rim there ran
An ocean which the land did bound.

The poet in those early days
Immortalized the sun-flushed seas;
He peopled those far slopes and bays,
And called the isles Atlantides.

And so the legend grew until
The clouds in evening's dreamy light,
With which the poet showed his skill,
Had vanished from the mental sight;

Instead, the story true appeared,
And every sailor did his best,
While straight from port the vessels steered
For those far islands in the west.

But none returned: of all who went,
Who sight of those fair islands caught,
Through the white waves the tempest sent
The barks which shattered home were brought.

And some returned no more—but these
Were fabled to have reached the strand,
Where, anchored in luxurious ease,
Their ships will never leave the land.

The crews lie on these sunny slopes,
Purple with fruit, with vintage blest;
The ships are held by flowery ropes
In sleepy bays content to rest.

The poet steps into his boat,
The sunset makes his starting fair;
Through the long night with Death he'll float,
And in the morning he'll be there.

The study of the geographical distribution of moths has led us a long way back in the history of our own race, to that East whence art and science sprang. There is only one other fact to be briefly mentioned here, and that is the discovery by Louis Agassiz, who accomplished so much toward an understanding of our entire fauna, of a tropical colony of moths inhabiting the southern extremity of the Peninsula of Florida. I have examined the specimens brought thence, now in the Museum at Cambridge. Standing in the way of the south winds and the Gulf Stream, Florida receives constant accessions to its tropical colony of insects. Not a few of the Florida moths seem to have changed a little, and the probability is that here also we may have to do with descendants of a very ancient colonization. Our continent, in fact, has harbored many immigrants besides the Pilgrim Fathers, who are distinguished among these by their greater importance, and the results of their adventurous voyage.

The celebrated receipt of Mrs. Glass, which is of such general application and has served so many literary purposes, must be employed before we can place our specimens of moths in the cabinet. And, indeed, everything depends upon the catching of them, and their appearance after being caught. The scales and the little fine fringes which edge the wings are but delicately fastened to the membrane of the wing itself, and are lost with the lightest rubbing. Some species can never be captured on the wing in a really perfect condition. When the "bee-hawks" (*Hemaris* sp.) emerge from the chrysalis, there is a dusting of fine scales over the glassy portions of the wings, which is scattered by the first fluttering flight of the insect:

"Like gold motes in the air it flies."

Again, several moths are ornamented with patches of looser and bright-colored scales which are readily lost, the specimens still appearing fresh after they have vanished. Thus the "dark-red underwing" (*Catocala cara*) has the fore-wings adorned with spots of a greenish hue when it leaves the pupa, but they are apt to fall and the wings then appear all of a dark-brown. Not knowing this, the fresh specimens have been described as a new variety, by an enterprising and unfortunately somewhat critical writer, under the name *Carissima*.

We have the choice of pursuing our entomological prey in each of its stages of growth—of eggs, caterpillar, chrysalis, or moth. If we gather them in either of the first three states, we have to nurse them until they are brought to the last, and, since in this way we can always obtain bright examples, it is much preferred by moth-fanciers. It is, indeed, the only way to obtain adequate information about these insects, and, as they are usually brought through them all with less difficulty than the other insects in captivity, the breeding of moths becomes an alluring and profitable pursuit.

Egg-hunting is the least remunerating way of procuring moths, from the difficulty of detecting the little objects, like pins' heads, upon the leaves and flowers where they are laid. Eggs are usually stuck fast to the under side of the more tender leaves of the plant, though this rule is not invariable, either as to position or choice of leaf. Usually the outer leaves are chosen, and by turning them up with care and running the eye over them, and especially down the midrib, the little whitish or greenish egg may be seen. It requires good eyes and much patience, but I have found the eggs of about twenty species in this way: those of the "bee-hawk" on honeysuckle, of the "Cecropia" on apple and lilac bushes, the "white-lined-hawk" on purslane, etc. The "lackey-moths" (*Clisiocampa*) and the "deer-moths" (*Hemileuca*) lay their eggs in circular patches around the smaller branches of fruit and oak trees. The eggs are found sometimes to have been stung by a little clear-winged fly, and out of these, instead of the expected caterpillar, only the tiny but full-grown parasite escapes.

The rearing of larvæ or caterpillars may be conducted on a variety of plans. I have found an upright box, with glass in front, and perforated zinc for the sides, or fine wire netting and a solid door at back, by which the fresh food is introduced, very serviceable. A drawer at bottom is filled with fine washed sand, over which is placed a layer of garden-mold, and then a covering of moss. The food is placed in short water-bottles, to keep it fresh, and the caterpillars are placed on these. But, when a boy, I reared many species in an empty butter-tub, covered by common gauze. Almost all caterpillars may be handled with impunity. Some of them are ferocious-looking enough to inspire a fear of their biting powers, but they are unable to hurt us in this way. The caterpillars of the "hawk-moths" have a formidable-looking horn on the last segment or ring of the body. I have noticed that inexperienced persons often mistake the position of this horn; they regard it as being in front, whereas it is attached to the tail-end of the larva. There is nothing "poisonous" about any of these caterpillars, but two kinds cause a painful irritation to the skin when touched with the hand, by means of the fine hairs which are thus forced into the pores, and, the tips breaking off, cause fever and pain as from a bee-sting. These two are the odd-looking caterpillar of the "brown hag-moth" (*Empretia stimulea*), and the delicate-green caterpillar, with pink and white stripe on the side, of the "corn emperor" (*Hyperchivia so*). Other hairy caterpillars may also produce more or less discomfort when handled, but the frightful stories which circulate in the newspapers from time to time, of people being stung to death by the caterpillars they chanced upon, are all false. Caterpillars can not sting, for the simple reason that they have nothing to sting with, and when an injury of this kind has been really inflicted it will be found to have been occasioned by something other than a caterpillar.

Hunting for caterpillars is attended usually by more success than the seeking for eggs of moths. One can readily detect the presence of these often unwelcome visitors by the damage they do to the treasures of the gardener and farmer. Many kinds feed in clusters, and make nests into which they retire in the daytime, separating usually before full grown and to make their cocoons. The larger species are all solitary, and some are the most beautiful objects one can wish to see. The caterpillar of the "imperial moth," which may be found on the horse-chestnut, tulip, and gum trees in Central Park every September, when it is full grown, is a thick, green worm, as long as the thumb, with four beautifully notched horns on the back, behind the head. Delicate hairs adorn the body, and the fleshy feet behind are ornamented by a design in black-and-white, looking like bead-work, and as if the creature wore Indian moccasins. In April and May we may find the larvæ of species which pass the winter in that state. One of our handsomest caterpillars is that of the "great Indian moth" (*Ecpautheria scribonia*), black, studded with bristles and with the incisions of the rings of the body marked in scarlet. I have fancied that this caterpillar is the one noted by the Indians, and sung of by Longfellow in "Hiawatha."

It is very interesting, no matter what the species is, to watch it through all its changes, and be rewarded finally by the moth disclosing all its fresh beauties before our eyes, as it hangs on the side of the breeding-cage. The caterpillars of the "hawk-moths," and many "owlet-moths," enter the ground to pupate; and for this purpose the sand and soil in the bottom of the breeding-cage must not be kept too dry, nor suffered to become hard. Those which do not go into the ground will transform within cocoons spun among the moss, or on the sides of the breeding-cage.

To collect the perfect moths, an empty quinine-bottle must be prepared by putting a few small lumps of cyanide of potassium on the bottom, and pouring on sufficient plaster of Paris to cover them perfectly. When the plaster is set, the fumes of the decomposing cyanide penetrate through the plaster, and the moth introduced into the bottle is almost instantly killed. Poison-bottles, so prepared, are indispensable to the collector, and they can be recommended on account of the speedy and probably painless death which they inflict. The objection to entomology is its apparent cruelty. I think that an unnecessary number of specimens are sometimes killed by the enthusiastic collector, but, after a little, this fault will be corrected by reflection and experience. When we recollect that insects are the main store of food to numberless birds and animals, besides falling a prey to each other, so that the greater proportion meet a violent death in any case, the comparatively small number which fall a sacrifice to the pleasure of the collector, or supply the studies of scientists, can not in reason be objected to. Our æsthetic pleasures are increased by the contemplation of the lovely colors and delicate patterns which adorn the wings of moths.

That man is feral, and a hunter by nature, is an obvious reflection, even when we step into the shop of an entomologist, such as Cooke's, in London. Nets, traps, and "fearsome gins" of all sorts and sizes meet the eye. Boxes, pins, dark-lanterns, in fact an array of implements too numerous to mention, are there displayed, and, whether we go a-hunting for game or for moths, the ingenuity of man has invented a large quantity of apparatus, by which the result may be obtained with the least exertion and the greatest certainty. Simplicity here as elsewhere is, after all, to be commended. A small folding-net which may be carried in the breast-pocket and afterward screwed to the end of a walking-cane, a poison-bottle, and a couple of boxes which may all be carried in the coat-pocket, are a sufficient outfit, and one with which great results in the moth line can be reached. The box for caterpillars should be of tin, and care must be exercised not to place too many together, since some kinds have strong cannibalistic tendencies and may devour each other before we get them safely home. But not only by day are moths captured. They fly readily to light in the evening, and the best results are obtained by spreading a bait, made of beer and molasses, with a paint-brush, on the trunks of trees standing free. In the spring and early summer this method of catching moths may be practiced with almost the certainty of taking many rarities. After this means the best plan is to watch the flowers which the moths frequent in the evening in search of natural sweets, and in which occupation we may fatally surprise them.

Having caught our moth in one way or another, it must be pinned and set, before placing it in the cabinet. In America the long German pins are used, especially manufactured for entomological purposes. The moth must be pinned directly through the center of the thorax, taking care to displace the scales as little as possible. Setting-boards are easily made by fastening two strips of soft pine-wood upon a thin board, near enough together to admit of the free passing of the body of the moth between them. They must be of several sizes, to correspond with the breadth of wing of the moths, which must be pinned with the body resting in the groove and the wings lying flat upon the strips. The board may be ruled across with lead-pencil, at different intervals, the lines serving as a guide to get the wings straight. With a bristle fastened to the end of a little stick, the front wings should be carried forward until their lower margin is about parallel with the hind edge of the thorax. They may be held in position by small three-cornered cardboard braces till all the wings are evenly placed, and then fastened down by strips of smooth paper, kept tightly in place by pins above and below the wings. It takes from a few days to a fortnight to properly dry the moths so that they can be placed in the cabinet.

Various and multiple are the store-boxes, implements, and "traps" of a moth-catcher. To describe them all would take a moderate-sized hand-book. My experience is, that simplicity is the most necessary guide for the collector, whether in the field or closet. A few tools and some cork-lined boxes will accomplish a great deal in the hands of an expert, while the expensive paraphernalia of the novice will fail of adequate result. As a rule, the most pleasure and information are yielded to the student who gradually increases his stores from his own catching, who follows the moths into their retreats, and by his industry and pertinacity compels Nature to yield to him a measure of her secrets.

Long ago I remember catching moths one summer night in the country, back of Newburg, on the Hudson. What a lovely and perfect night it was! A sheen lay over the grass, and the field-daisies stood tall and pale and spectral in the moonlight. Their white flowers looked like silver crowns, waiting for some love-sick damsel to pluck and gather her fate from the number of their petals. They stood in silver and gold, without envying the yellow and brown daisies of the meadows which were hardly open yet. The air was traversed by leather-winged bats, also out after insects, and I felt convicted by being in their company. A pale-green moon-moth fluttered by the skirt of the dark wood, the long "tails" to her wings trailing like the court-dress of a queen. I stayed my hand and let her sweep by, hoping that those marauding bats might not espy her as she floated in the night-air, heavy with the scent of roses. For aught I saw, she escaped them, and the peril of having her white body devoured, her green wings clipped from her shoulders, falling idly, like the petals of dying flowers, upon the ground.

Painters have not yet learned all they can from the coloring of moths. Some moths are pale-pink and yellow, only these two colors, reminding one of apple-blossoms and yellow moonlight. I saw a panel of C. Colman's once, for the contrast of colors of which it seemed he must have studied the wings of moths. As the musician can use the songs of birds, so the painter may copy the colors of the moths for our greater pleasure and his own benefit. A great deal may be said of the unconscious schooling we get from Nature.

"All sorts and conditions of men" and not a few talented and accomplished women are among the American students and collectors of moths. Before the last quarter of a century, those who interested themselves in America with this department of our fauna were few, and those who published the results of their investigations might be counted on the fingers of one hand. Harris in Massachusetts, Fitch in New York, Kirtland in Ohio, Gosse in Canada, were the best known. Thomas Say, of Philadelphia, published two species in his "American Entomology." But since that time, Professor Packard, Professor Fernald, Mr. Henry Edwards, Mr. F. Pepper, Mr. Lintner, and a number of talented writers, have become familiar names to those interested in the subject in the pages of its literature. The "New York Entomological Club" publishes a monthly magazine, entirely devoted to Lepidoptera. The Buffalo Society of Natural Sciences has issued three handsome volumes chiefly devoted to studies on our moths. In Cambridge, where Harris lived and studied, a very useful journal—"Psyche"—appears, while in London, Canada, Mr. Saunders edits "The Canadian Entomologist" in monthly parts. The various State entomologists publish yearly reports, and the Department of the Interior has published valuable monographs and papers relating to our moths in the publications of the geological survey. The great work which has been done in the United States in science has helped also the increase of information upon this comparatively small branch of natural history. I should have mentioned the ladies first, but it is not out of politeness that the conscientious historian records the services to science of Mrs. Eliza Bridgham, of New York; Mrs. C. H. Fernald, of Orono, Maine; and Miss Mary Murtfeldt, of St. Louis, Missouri. Mrs. Bridgham's extensive collection, commenced under the eye of Agassiz himself, is a model of useful collecting for scientific purposes. The species are not represented by single individuals, but the varieties of each species, and a sufficient number of duplicates to allow of the study of the structure and changes, are all carefully placed and labeled. Years of patient and careful toil have their reward in the most interesting local collection, from a scientific stand-point, I have yet seen.

In Europe our moths have been described and studied by two French scientists, MM. Boisduval and Guenie. In Germany, Professor Zeller and Dr. Speyer, together with Herr Moeschler and the lamented and talented Viennese lepidopterist Julius Lederer, have published interesting studies upon our North American fauna. In England, the late Mr. Walker accomplished less satisfactory work in the precincts of the British Museum, and is now succeeded by Mr. Arthur G. Butler, whose work merits all praise. But our best incentive to the study of our moths has been afforded by the example of Lord Walsingham. It is ten years ago since his lordship visited the United States, where, unlike many of his countrymen who come to hunt buffalo, he went West to hunt moths. Lord Walsingham visited California and Oregon, and camped out like a true hunter. While his companions took the rifle, he handled the entomological net, and to such good effect that science has been the gainer by hundreds of new species, and a much clearer general knowledge of the subject than before existed. The delicate operation of setting his tiny captures, Lord Walsingham accomplished successfully even on horseback, as the camp was shifted from place to place—quite a feat, when it is recollected that the tiny specimens, many not a quarter of an inch in expanse of wing, require a steady hand and the most favorable conditions to be successfully prepared for the cabinet. This memorable trip of Lord Walsingham's had the result of directing the attention of our collectors to the richness of Western fields for moth-catching. Their cabinets soon presented new "beauties," vying with Indian and Brazilian species in varied colors and far surpassing them in general interest.

I said that "all sorts and conditions of men" were among those interested in forming collections of moths, and it may be inferred that there are queer specimens among the owners of the cabinets as well as in the drawers of the cabinets themselves. Moth-catching is a hobby, and, like other hobbies, it depends upon how it is ridden to pronounce upon its value from a social or scientific point of view. Some collectors amass their material from an apparent simple satisfaction in possessing rare or odd specimens. They have no appreciation of the bearing which the subject has upon general science, and no higher artistic interest in their possessions than the one that they have something no one else has got, and which it is difficult to obtain. A sort of purposeless mania seems to fall upon many of them, and they might as well get together a lot of old bottles or stones as moths. They deceive each other as to the locality for their rarities. I have even heard of one rabid collector, now happily deceased, who destroyed every specimen he had or could buy up of a certain rare exotic species, except one pair in his own collection, so that he could say he was the only one who had it! Another openly stated in an advertisement that he "coveted" certain specimens, which he offered to buy; thus, probably unintentionally, using a word which expressed his condition exactly, and in this way succeeding in breaking a commandment and exposing his state of mind at the same time.

While the "brethren of the net," as the moth-catchers are fond of styling themselves, are, generally speaking, a friendly and useful class, they necessarily include many who follow the occupation, but are yet not truly of them. From such the gentler student will soon turn away, sometimes not detecting them until he has suffered in purse and cabinet. Like other "confidence operators," they generally take in uninformed and young collectors, whose rarities are speedily transferred out of their keeping by the false statements and industrious letter-writing of these moth-poachers. They are the dark side of a picture which would be otherwise too bright and happy.

Among the figures of moth-catchers which have crossed my own path, I finally recall that of a kindly old gentleman, now no more, who for many years was a visitor to my humble study. His beardless, wrinkled face, framed in gray hair, had ever such a good and serene expression as betokened a mind which had caught its serenity from the countenance of Nature herself. I visited him in turn and not unfrequently, and I remember on one particular occasion that he showed me a new capture which he had made on Long Island, a new butterfly, not then described in the books. As he took it from the box and placed it on the table before him, pinned, dried, and set, in all its beauty, a little dog, which was his pet and companion, sprang at his knee and with one blow of his paw broke the butterfly. To the old gentleman it was as to Sir Isaac Newton—the loss was great, and the shock must have been intense. Although I had hardly seen the specimen, I was profoundly affected by the mischance. But he neither struck the dog nor spoke loudly. With a trembling hand and flushed face he set to work at once to gather up carefully the disjointed wings of his specimen, which was happily accomplished, and, with a little gum and much patient dexterity, the damage which seemed at first irreparable was remedied. It taught me a lesson I have never since forgotten. The butterfly was the rare *Papilio Calverleyi*, of which up to the present time but one other specimen has been found. I have now new faith in that old story, from having witnessed a similar occurrence, and fresh belief in the goodness of that human nature which science and its pursuit often tend to strengthen and confirm.

HYGIENE OF THE AGED.

By L. H. WATSON, M. D.

DIFFERENT epochs in life are marked by the frequency or infrequency of certain morbid phenomena constituting that departure from the normal standard of health which we denominate disease.

What is life? is the unanswerable question the human race has ever sought to solve. Bichat called it "the sum of the functions by which death is resisted." Physiologists of the present day offer little more that is satisfactory in their definitions, calling it "the aggregate of the phenomena peculiar to living organisms." The inscrutable mystery which surrounds the principle of vitality renders any attempt at definition illogical and unsatisfactory. We have to deal with the phenomena of life, and the functions through which these phenomena are manifested. In the child we have an exuberance of life. Manhood is the period of repose; waste and repair seem to neutralize each other; and calmness, deliberation, and quietude prevail.

With old age come disturbance, waste without repair, destruction without building up, action without reaction, decay and death. These phases of animal life are constantly repeating themselves. In discussing the diseases of old age, we have to deal with the phenomena of life, the perversion of functions which have hitherto counterbalanced each other. The prime of manhood and stability is passed; internal resistance now fails to maintain itself against external force. Nutritive action does not respond to the demand to renew effete material. The equilibrium being destroyed, decay and the products of decomposition become the most important factors in the study of the diseases which now threaten to disintegrate this hitherto self-sustaining system.

It will easily be seen that the diseases which disturb the formerly evenly balanced organism tend toward what pathologists call destructive metamorphosis. Blood-changes, tissue-changes, and secretory changes, are subjecting us to constantly varying standards of health. How to maintain the equipoise as long as possible, and prevent the too rapid decline of the vital forces, as well as to suggest measures—when care and forethought can ward off the blow—is the province of the thoughtful medical man.

Threescore years and ten should certainly be reached by most of those who attain adult age, provided no inherited taint weakens the vital forces. It is difficult to determine the exact period of life at which the decline commences. In fact, there can be no absolute standard from which we can predict with unvarying certainty the gradual failure of the physical powers. Some seem to inherit a vitality which almost defies the ravages of time; but, although they are apparently in the full vigor of life, close scrutiny rarely fails to detect the fact that the scale is tipping downward. We do not grow old in a night, although we often make the remark that So-and-so has grown ten years older since the occurrence of some great grief, or some disastrous reverse in business. The eye-sight gets poorer, the hair and beard grayer and thinner; the form is more bent, the walk more uncertain, the *arcus senilis* appears in the cornea. After all, this is not old age; these are all warnings, but the heart is still warm, the eye still bright, the muscles still firm. The world looks as fair and inviting as it did in early manhood or womanhood—a little larger print to read, a smoother road to walk on, a few more flannels at night, and a little less labor during the day, with perhaps a greater disposition toward quiet, a greater fondness for home-life, and a disinclination to encourage the enthusiasms which time and experience have so often proved to them to be illusive.

We are to consider the physiological and pathological conditions arising during this epoch of life. Many of these are characteristic, and do not earlier manifest themselves. We have many works upon the diseases of children and adult life, but almost none pertaining to the diseases incident to age. And yet they are peculiar. The pneumonia of a child is not the pneumonia of an aged person. Slight ailments, unobserved or disregarded in the adult, become positive disease in advanced life. Our acute fevers, inflammations, fluxes, etc., are not met with among the aged.

Congestions, chronic inflammations, tumors of the brain, paralysis, rupture of blood-vessels, enlargement of the heart, chronic bronchial affections, dropsical effusions, indigestion, diseases of kidneys and bladder, especially the latter, cancers, etc., are what the physician is most often called upon to prescribe for in old people. Aside from actual disease, the conduct of the life of elderly persons is to be studied and observed. Ordinarily old age brings with it, or should, a certain degree of leisure and immunity from the distressing anxieties which vex and worry the lives of men actively engaged in business. The danger of sickness from exposure, as far as the *liability* to exposure is concerned, and the danger arising from accidents are lessened ; old people are careful, and warily thrust themselves into danger. Calmness, quietness, and a regular habit of life, succeed to confusion, activity, and an indulgent and irregular method of living. Life wanes, the descent is easy and gradual, a peg is lost here and a prop there, the sympathies become blunted, the intellect chilled, the senses lose their acuteness, and "the play is played out." What more delightful spectacle than an aged person in full possession of all his faculties, enjoying life with the zest of manhood's prime, appreciative of the pleasures of the table, the society of friends, the charm of music, and the intellectual feast that a good book presents to him !

Hufeland, in his "Art of prolonging Life," advises old people to eat sparingly. There is a great difference between a "*gourmet*" or "*gourmand*" and a glutton. The pleasures of eating dependent upon the sense of taste, when eye-sight and hearing are daily becoming more and more impaired, the possession of leisure in which to cultivate their gastronomic talents, as well as the quiet necessary for the performance of the digestive act, combined with the necessity for careful nourishment, prohibit old people from yielding to any mistaken notion that, because they are old, food is of little consequence to them, and that the ordinary rules governing assimilation and nutrition do not hold in their case.

A great deal of the immunity of old people from sickness will depend upon their power of digestion and assimilation.

Food and drink should be partaken of sparingly, and at proper intervals : an overloaded stomach, or a stomach filled with badly cooked food, or food taken at an improper time, will occasion much distress to an old person. At the same time, it may lay the foundation for disease which will cut short a hitherto robust old age.

If actual pain and danger do not follow this gorging, it will probably entail loss of sleep, and consequent exhaustion, all of which we seek to shield the old from, as we do the child.

In the normal act of digestion, the consciousness of that act is wanting. Most persons engaged in active life fail to give the proper amount of time to eating and digestion ; for this natural and physiological action to be performed with the ease and perfection of detail which Nature, in her arrangement of the means for such an end, intended, deliberation must accompany the eating, and rest of mind and body the digestion of food. Haste when eating, and activity, bodily or mental, during the digestive process, are fatal to the object for which food is taken. It is only in old age (I refer particularly to America), now, that that leisure which is indispensable to the proper performance of digestion is obtained, and yet, when, after years of toil, we perchance through the inheritance of a resisting power which has enabled us to arrive at sixty years of age, and upward, find the *time* to rest, our teeth are gone, our stomach, from constant action, is unable to act with that promptness and energy which early in life enabled us to digest food on the run, as it were. Then the physician is called upon to encourage, stimulate, and prop up by his art, Nature's waning forces.

The manifestations of dyspepsia in the aged do not vary materially from those of adults, but the causes are somewhat different; the treatment is conceived on a plan based on the age and life-long habits of the patient. An aged stomach is not an active stomach. Atony characterizes its functional action. Acid digestion, gastric catarrh, and flatulency, are the leading forms of dyspepsia of the aged. Old people have not in general what we call a healthy appetite. One well-known writer has said that they eat because no other interesting occupation is afforded their senses. This may be true of the *very* aged, and it undoubtedly is a fact that most people of eighty years and upward find as much pleasure in eating as in almost any other occupation left them. The appetite is often lost when no disease can be detected. There is loss of the sense of taste, and even several days without food does not provoke hunger. In another form, the breath is somewhat offensive, the tongue furred, when in the former case it was clean.

Fisher tells us that, if this continues, it leads to senile marasmus or atrophy of the aged. Some old people suffer from a difficulty in swallowing, which seems to be the result of a partial paralysis of the throat; the pharynx does not respond to the stimulus of food as it passes over it. Solids pass more easily than liquids. Deglutition is more difficult in an upright than in a horizontal position. Fisher speaks of the case of a man sixty years of age who swallowed soft and mucilaginous preparations with great difficulty, but warm food, salty or irritating substances gave little trouble. Day has noticed the same fact, and observes that irritating or highly seasoned foods were the only ones swallowed easily. Canstatt thinks that the abuse of tea and coffee leads to the development of this state, which he says is very common in Holland.

Old people are subject to accumulations of gas in the intestinal tract, which not only occasion distress from over-distention of the stomach, causing pressure upward upon the diaphragm, and consequent interference with the heart's action, especially when lying down, but also from its passage downward into the bowels.

Diarrhœa is one of the consequences of dyspepsia, and it is not unusual to find old people who have several movements of the bowels daily, without any of the exhaustion attendant upon ordinary diarrhœas. Another remarkable fact is, that we find, even in very old people, a diarrhœa which would naturally seem to weaken and prostrate even a strong man, but the effects of which are not noticed until suddenly we learn that death has taken place. Overfeeding is a frequent cause of these senile diarrhœas. The pressure of undigested food in the intestinal canal is followed by a sudden purging, without pain, but exceedingly rebellious and difficult to conquer. Before treating of the methods of cure for dyspepsia and its accompaniments, such as loss of appetite, difficulty in swallowing, flatuence, constipation, etc., there remains to be studied the food suitable for old people, the quantity to be eaten, and the time for eating.

It would be useless to present a dietary list to which one should be strictly confined. A long life of indulgence in eating and drinking, as well as diversity of taste, would preclude any attempt at regulating the diet of healthy elderly people. To those who have arrived at an advanced age without any form of indigestion, I would suggest a cup of coffee and a slice of dry toast before rising in the morning. The reason why this should be served while one is yet in bed is, that very old people, even when perfectly well, are often subject to a slight faintness and nervous tremor before rising, and the exertion necessary to dress often leaves them too faint to eat. It takes but a few moments to prepare it, and, as old people like to rise early, it is usually an hour or two before the family are prepared for the morning meal.

A light luncheon at noon, and dinner not later than five or six o'clock. If the dinner is taken at noon, and supper at six o'clock, it will be found to suit the habits of the aged better in one way, as old people love to retire early. In most countries, among civilized nations, the practice of crowding three meals into the twelve hours or more of daylight has grown to be such a habit that it seems a heresy to suggest eating when hungry, day or night; nevertheless, I would suggest to the healthy and not *too* aged person to forget the "bugbear" of "not eating before retiring," which compels many a person—otherwise disposed—to pass ten or twelve hours with the stomach in a collapsed condition, while during the other twelve it is constantly distended with food. I would say to the aged, eat sparingly and eat frequently. Let your food be light, and easily digestible, but eat when hungry, whether it be twelve o'clock at noon or twelve o'clock at night. Aged people are light sleepers, and often wake up during the night with an intense craving for food, and a good plan is to have a cup of bouillon and a cracker on a stand near the bed. The broth can be readily heated by an alcohol lamp in five minutes. This simple habit will often procure hours of uninterrupted slumber, which would otherwise be passed in restless longing for daylight and breakfast.

I have said, eat sparingly and frequently; eat sparingly, because the digestive action is not so strong as in earlier life, nor is the demand for large quantities of food so urgent. Eat frequently, for several reasons. The digestive organs are not then burdened with large quantities of food, and dispose of it with greater ease. A moderate amount of food in the stomach gives a feeling of comfort and quiet to a person whose sole occupation may be a little reading or knitting, or even nothing at all, when extreme age is reached.

The kind of food to be eaten varies with the condition: if the old person needs building up, the more nutritive foods, that is, those containing the greatest amount of nourishment to a given volume, the greatest proportion of assimilative matter; if, on the contrary, it is necessary to encourage the digestive action, we select stimulating food. In this connection I shall quote from an eminent French authority: "As age advances, not only is one able to bear with impunity food which is piquant, pungent, and more exciting, but the use of these latter foods is necessary to the physiological conditions acquired by the 'organs of digestion.'

"This alimentation becomes especially necessary to individuals whom residence in great cities, sedentary life, and confining work separate in a great measure from the natural conditions of life, found in free air and bodily exercise." With regard to the use of wines or liquor by the aged, I would say, if there is a proper time in the life of a man when he should use stimulating drinks, that time is when he has arrived at a good old age.

A glass of sherry or burgundy during dinner often aids digestion wonderfully. When the tongue is pale, and the desire for food absent, a "nip" of brandy will stimulate the stomach into secreting properly. This condition of atony or sluggishness of action is not at all unusual. A glass of milk-punch at night often goes, as a very good and exceedingly temperate old lady once said to me, "to the right spot." Coffee is a natural drink for the aged. Its mildly stimulating, soothing qualities directly indicate it as a beverage for the old. Gasparin tells us that "coffee has the property of rendering the elements of the body more stable, and thus, if not affording nourishment, it diminishes the waste going on."

The origin of many dyspepsias in the old will be found in the lack of the proper means for the complete mastication of their food. The loss of their teeth, and the neglect to replace that loss with artificial ones until a dyspepsia is established, will often entail a long train of ills. A set of false teeth will sometimes remove dyspeptic troubles of long standing. The teeth with metal plates (plātinum or gold), although more expensive than rubber or celluloid, are to be preferred. Mastication must be well performed even if the food is not very solid. The one golden rule is to eat slowly.

Some old people have idiosyncrasies about certain foods, which must not be overlooked. Milk is one of the most easily digested of foods, on account of its various constituents, and can be taken when nothing else is permissible. Eggs, soft-boiled or raw, are easily digested. Oysters, fish, and lamb, follow in about the order named. Beef, mutton, and fowls, and wheaten bread, occupy about the same time in digestion. I have met with two forms of dyspepsia more frequently than any others in prescribing for old people—the acid form, where there is an excess of acid found in the stomach, and the atonic form, where there is sluggish action of the mucous membrane of the stomach, and the time for digestion is greatly lengthened. In acid dyspepsia, Dr. Ringer recommends the use of glycerine, stating that an old gentleman, upon learning that glycerine prevented milk from turning sour, concluded that it would be just the thing to prevent "himself from turning sour." I have used glycerine combined with charcoal with considerable success in remedying this form of dyspepsia.

Dilute nitro-muriatic acid, a half-teaspoonful in a claret-glass of water, immediately after meals, breaking up the weaker acids and affording the natural acids of the stomach, is an exceedingly useful remedy. The atonic form of dyspepsia, combined with loss of appetite, requires quite a different treatment. The stomach is feeble, and needs stimulating ; two or three grains of capsicum with one half-grain of aloes in a capsule will excite it to action ; the constipation which often accompanies this form will be obviated. When there are accumulations of gas, charcoal tablets an hour or two after meals generally give great relief ; but it is not a good plan to keep up their use permanently, as it tends somewhat toward constipation. Electricity is the great tonic for these debilitated, relaxed stomachs. The sympathetic nervous system is rehabilitated, and the most marvelous effects are often produced. The apathetic condition of the intestinal track is dissipated, the liver pours out its bile, and life seems to move on again. Alkalies taken before meals stimulate the flow of the gastric juices. Slight fatigue often spoils the appetite, and lowers the digestive power. Nothing so securely revives this as a glass of wine before meals. While small quantities of alcohol aid digestion, larger quantities retard it and encourage gastric catarrh. The quantity of wine or brandy must be small when taken for this purpose.

THE OLDEST AIR-BREATHERS.

WE alluded in the March number of the "Monthly," to the fossil scorpions recently discovered in the Upper Silurian formations of Sweden and Scotland, recognizing them as the most ancient specimens of land or air-breathing animals yet found. The subject has since gained a new interest through the discovery of a still older fossil of an insect, and by these our knowledge of the land of the earth and of some of its inhabitants is carried back by at least two immense geological periods. We therefore give place to a fuller account of the discoveries, with portraits of these newly found oldest inhabitants of the solid part of the globe, collating the facts and borrowing the illustrations from the French and English scientific journals. Scorpions had already been found quite abundantly in the lowest carboniferous strata. The first palæozoic specimen that came to light (*Cyclophthalmus senior*) was found in the coal formation of Chombe, Bohemia, and was described by Count Sternberg in 1835. Three years later another scorpion (*Microlabis*) was described from the same locality. The next discoveries were American, and were made in the coal-measures of Illinois, of two genera which Meek and Worthen described as *Eoscorpius* (dawn-scorpion) and *Mazonia* (from Mazon Creek, where they were found). In 1873 Dr. Henry Woodward showed that *Eoscorpius* remains occurred in the coal-measures of England and in the carboniferous limestone of Scotland; and in 1881 Mr. Benjamin N. Peach described a considerable number of scorpions which had been obtained by the officers of the Geological Survey of Scotland from the lowest carboniferous rocks of the Scottish border. In his paper, which was published in the "Transactions" of the Royal Society of Edinburgh, he pointed out the general resemblance and almost equally high organization of these ancient scorpions and those of the present day, and expressed regret that Messrs. Meek and Worthen had given the name of *Eoscorpius* to their specimens, "for the dawn of the scorpion family must have been at a much earlier period, and we may hope that their remains will yet turn up in the Devonian and Silurian plant-beds when these come to be thoroughly searched."

This prediction has been verified in the discovery of the Scotch and the Swedish Silurian fossils. The Scotch scorpion was discovered first, by Dr. Hunter, of Carluke, who obtained his specimen from Lesmahagow, in Lanarkshire, in June, 1883; but the Swedish professor, Lindström, although a year later in discovery, anticipated him in announcing it and in publishing the description of his fossil.

In a letter of November 24, 1884, to M. Alphonse Milne-Edwards, Professor Lindström says of his scorpion (Fig. 1): "The specimen is in sufficiently good preservation, and shows the chitinous brown or yellowish-brown cuticle, very thin, compressed, and corrugated by the pressure of the superposed layers. We can distinguish the cephalothorax, the abdomen, with seven dorsal laminæ, and the tail, consisting of six segments or rings, the last narrowing and sharpening into the venomous dart. The sculpture of the surface, consisting of tubercles and longitudinal keels, entirely corresponds with that of living scorpions. One of the stigmata on the right is visible, and clearly demonstrates that it must have belonged to an air-breathing animal, and the whole organization indicates that it lived on dry land." Professor Lindström points out, as a feature of great importance in the conformation of the animal, the existence of four pairs of thoracic feet, large and pointed, resembling the feet of the embryos of several other tracheates and animals like the *Campodea*. This form of feet, he remarks, "no longer exists in the fossil scorpions of the carboniferous formation, the appendices belonging to which resemble those found in the scorpions of our own day." This species has been named *Palæophoneus nuncius*.

The Scottish specimen (Fig. 2) is described by Mr. Peach in "Nature" as being about an inch and a half long, and lying on its back

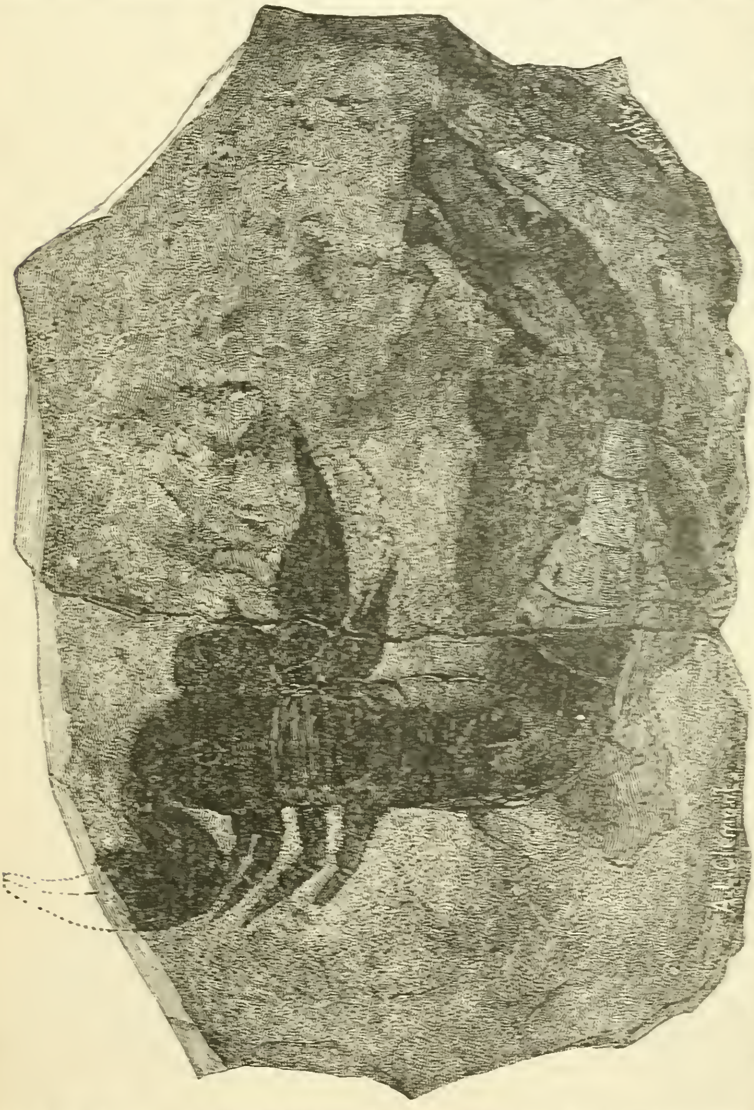


Fig. 1.—Fossil Scorpion (*Palæophoneus nuncius*), found in the Silurian rocks of the Island of Gottland, Sweden. From the photograph sent by Professor Lindström to M. Alphonse Milne Edwards. (From "La Nature.")

on the stone. "Its exposed ventral surface shows almost every external organ that can be seen in that position, and in this way serves to supplement the evidence supplied by the Swedish specimen. As in the northern individual, the first and second pair of appendages of the cephalo-thorax in the Scottish example are chelate, but the palpi are not quite so robust. The walking-limbs, though not so dumpy as in *P. nuncius*, also terminate in a single claw-like spike. The arrangement of the sternum shows a large pentagonal plate (metasternite), against which the wedge-shaped coxæ of the fourth pair of walking-limbs abut. The coxæ of the third pair bound the pentagonal plate along its upper margins, and meet in the mid-line of the body, where they are firmly united. The coxæ of the first two pairs, as well as the bases of the palpi, are drawn aside from the center line of the body, showing that, as in recent scorpions, these alone were concerned in manducation, or rather the squeezing out of the juices of the prey ; from the circumstance of these being drawn aside, the medial eyes are seen pressed up through the cuticle of the gullet, and a fleshy labrum (camerostome) appears between the bases of the chiliceræ.

"Behind the pentagonal plate and the coxæ of the hindmost limbs there succeeds a space shaped like an inverted V, where the test is thin and wrinkled in the line of the long axis of the body. It is just along this line that the trunk or abdomen most easily separates from the cephalo-thorax in recent scorpions, and it is at once apparent that the trunk in this case is as far separated from the cephalo-thorax as it can well be without being detached. Similar longitudinally wrinkled skin is seen to unite the dorsal and ventral scutes up the whole right side of the trunk. At the interior angle of the inverted V there hangs downward a narrow bifid operculum flanked on each side by the combs, which have each a broad triangular rachis set along its lower edge with the usual tooth-like filaments. The combs almost hide the first of the four ventral sclerites, which bear the breathing apparatus in recent scorpions, notwithstanding which all four of these exhibit on their right side undoubted slit-like stigmata at the usual places. The fifth ventral scute of the trunk suddenly contracts posteriorly, and to its narrow end is articulated a long tail of five joints and a poison-gland with a sting. These joints are all constructed on the same principle as those of recent scorpions, and, as the articular surfaces are more highly faceted on the dorsal than on the ventral aspect (a portion of the tail of the specimen lying sidewise allowing of these observations), there can be no doubt that the animal was in the habit of carrying the tail over the head (so to speak), and stinging in the same manner as its recent congeners." These characters are shown in the accompanying illustration (Fig. 2), which is on the same scale as that of the figure of the Swedish example (Fig. 1), viz., about twice the natural size.

The animal is supposed to have wandered to the sea-shore in search of food, and there been imbedded in marine strata. From the completeness of the remains, it is evident that it can not have been carried far out to sea ; the rocks of the formation in which the fossil was found abound in Eurypterids, or fossils of a crustacean allied to the king-crab.

Of the recent discovery of earlier Silurian insects, we have the following account given by M. Charles Brongniart to the French Academy of Sciences :

"Fossil insects have been found in the carboniferous strata. The coal-beds of Commentry have furnished some thirteen hundred specimens, and Mr. Scudder has described six specimens that were found in the Devonian beds of New Brunswick ; but, until very recently, no representative of that class had been detected in any of the more ancient formations. M. Douvillé, a professor in the School of Mines, has shown me a piece of Middle Silurian sandstone from Jurques, Calvados, bearing a distinct impression of an insect's wing (Fig. 3). The state of preservation is not perfect, but we can still distinguish most of the nervation. The wing, which is about thirty-five millimetres long, belonged to a *blattid*, an insect of the cockroach family. The humeral field is broad, and upon it may be seen the superior humeral vein ; the inferior humeral vein, bifurcated at its extremity ; the vitrean or median vein, likewise divided into

FIG. 2.—FOSSIL SCORPION, from the upper Silurian rocks of Lesmahagow, Lanarkshire, Scotland, found by Dr. Hunter, Carluke. (Magnified two diameters.)

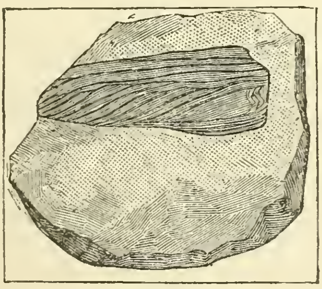


FIG. 3.—WING OF A FOSSIL BLATTA (*Palæoblat'ina Douvillei*), in a piece of Silurian sandstone (natural size).

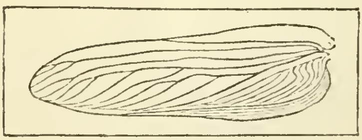


FIG. 4.—RESTORATION OF THE FOSSIL WING.

two branches ; the upper and lower discoidal veins, with their very oblique divisions meeting again at the end, just as they may still be seen to do on some living *Blattæ;* and we can follow the anal vein, which is nearly straight and extends almost to the end of the wing, together with the axillary veins parallel to it. The remarkable feature which distinguishes this impression from the wings of all other blattids, living and fossil, is the length of the anal nervature and the scant width of the axillary field. Among the blattids of the coal period, the *Prognoblattina Fritschii* (Heer) and the *Gerablattina fascigera* (Scudder) have a nervation a little resembling that of our Silurian wing. We propose to name this ancestor of the *Blattæ, Palæoblattina Douvillei,* in honor of Professor Douvillé.

"Geologists regard as identical the sandstones of May and Jurques

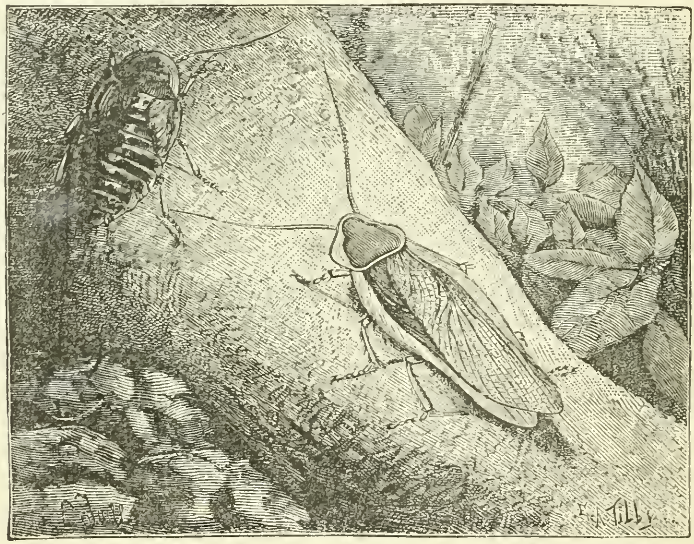


Fig. 5.—Living Blattæ, male and female (*Blabera claraziana*), from Mexico.

in the Calvados, and place them in the Middle Silurian, while the schists of the Island of Gottland belong to the Upper Silurian. Our blatta-wing, then, must be regarded as older than the scorpion described by Professor Lindström and the other similar scorpion from the Upper Silurian of Lanarkshire."

Besides the engraving of the actual fossil wing in Fig. 3, we give in Fig. 4 an ideal restoration of the same; and in Fig. 5, for comparison, a representation of a living blatta from Mexico, the venation of whose wings nearly corresponds with that of the fossil.

SKETCH OF PROFESSOR S. P. LANGLEY.

By EDWARD S. HOLDEN.

I HAVE been asked to write a sketch of the life of Professor Langley, to accompany his portrait in this number of "The Popular Science Monthly."

Something of the life of every scholar and of every public man belongs to his audience ; while most of that personality which endears him to his friends is their private possession, not to be set forth, except within narrow limits.

Professor Langley was born at Roxbury (now Boston), August 22, 1834. Like many another Boston boy, he was sent to the Boston Latin School, where Latin and Greek and little else was taught.

Latin and Greek was reputed to be the sum and end of learning, and Harvard College seemed to show dim perspectives of more Latin and Greek. It was no wonder that young Langley, whose genius lay in quite another direction, should look about him, after his graduation from the school, to see if there were not some practicable way in which he could pursue those mechanical and astronomical studies that already had fascinated him. He had little inclination to enter college, and the openings in astronomy proper were very rare in those years, even rarer than now. Since he was ten years old, he had been reading and studying astronomy, making small telescopes, using these and others, with various success, but always with ardor. The practical question of how to shape his life was one that had to be solved, and a variety of causes led to his determination not to go to college, but to become a civil engineer. Here at least was a profession whose basis was mathematical, and in which mechanical tastes and acquirements would have scope. So the practice of engineering was begun ; special circumstances forced him into architecture, and for some years this was his pursuit. These were dull years, mostly spent in the West, where at that time there were few opportunities to display any real ability in this special calling.

There is little doubt but that the long and dreary hours spent over the drawing-table were an admirable though tedious preparation for the series of astronomical delineations which have been of so solid a use to science. But, finally, in the lack of real opportunities, architecture ceased to be a profession, and became a business, a means to live simply.

In 1864 Langley felt the need of some marked change in his life, and he spent the greater part of the years 1864 and 1865 in Europe.

In 1865 he returned to America, then thirty years old, and found himself entirely free, for the first time in his life, to follow his own inclinations. So, at thirty, instead of twenty, we find him as one of the regular assistants at the Harvard College Observatory. From this time forward he belongs to astronomy, although many an obstacle was yet to be overcome before he could freely exercise his special and high talents.

After a few months at Harvard, Langley was offered the position of Professor of Mathematics at the United States Naval Academy at Annapolis. Before the war, a small observatory had been founded at Annapolis by Professor Chauvenet. It contained a six-inch equatorial, and an exquisite meridian circle, by Repsold, with which Chauvenet had already made some observations. The removal of the Academy to Newport and the resignation of Professor Chauvenet left these instruments unused, and it was Langley's first business to remount them and to place the small observatory on a working basis. The next year was an apprenticeship in the practice of astronomy. In 1867 Professor Langley was invited to become the Professor of Astronomy in the Western University of Pennsylvania (at Pittsburg), and to take charge of its observatory on one of the high hills across the river (Allegheny City). The previous history of the observatory had been a checkered one, and its equipment was in the last degree inadequate and incomplete.

It had been built in a good situation ; there was a dilapidated dwelling-house on the grounds ; the observatory building itself was there ; an equatorial of thirteen inches aperture was mounted ; but this was all. Everything was bare ; the equatorial was not provided with the necessary apparatus ; the observatory was entirely empty, except for a table and three chairs ; and the professor was expected to be active there, while at the same time he was to attend to the full duties of a chair at the college ; no assistants were provided, and the observatory had no income ! It is hardly possible to conceive a situation more tantalizing and less hopeful.

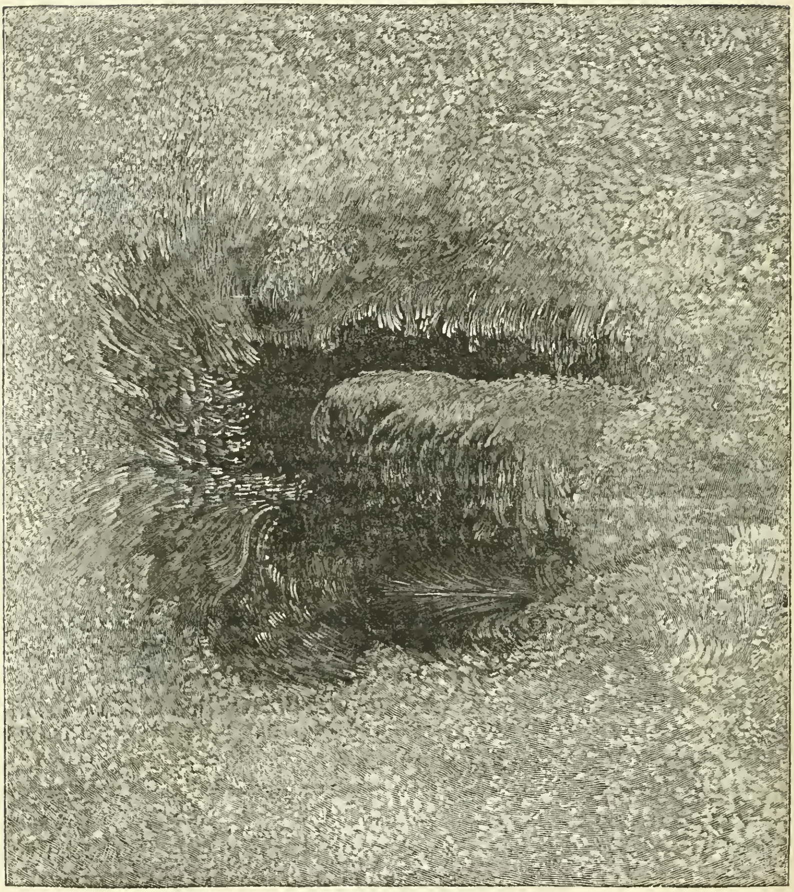
A way out soon suggested itself. For the prosperity of the observatory some definite income was essential, and it was absolutely requisite to *earn* this. What has an observatory to sell, that the business men of Pittsburg—the railways, the iron-masters, the glass-founders—will buy ? Clearly, the only thing they want is the correct time. But will they pay for it ? This was what Professor Langley set himself to provide, and by 1869 the full system was in successful operation and yielding a fair income to the observatory. For some years before, certain other observatories had established more or less complete time-services (at Albany, Washington and elsewhere), but the system at Allegheny was the most complete and elaborate of any, and the first which was looked to for an adequate support of an observatory.

Besides regulating the public time of Pittsburg and of numerous private offices, the observatory provided the standard time for the whole system of railways centering in Pittsburg, and daily sent (automatically by electricity) the beats of its standard clock over the telegraph lines from New York and Philadelphia west as far as Cincinnati and Chicago, north to Lake Erie, and south to Washington. This system is still in full operation, and has always maintained a high character for accuracy.

The United States Coast Survey organized several parties to observe the total eclipses of 1869 and 1870, and Professor Langley went to Oakland, Kentucky, in 1869, as a member of the party of his friend Professor Winlock, Director of Harvard College Observatory. In 1869 his station was upon the very edge of the shadow, and the object of his observation was to determine the limit of total eclipse. In 1870 the station assigned to Professor Langley was at Xeres, in Spain, where he determined the polarization of the solar corona to be radial.

During the year 1870 the affairs of the observatory began to assume such a shape that some time for original work in astronomy was available. The success of the time-service had created a small fund out of which the more pressing needs of instrumental equipment were provided; and Professor Langley now began a period of the most incessant work on the minute study of the features of the sun's disk. The situation of his observatory at Pittsburg, where dense clouds of smoke and dust and dirt obscure the heavens, and the meager state of his instrumental equipment, almost forced him to take up the study of the sun, which has light enough to penetrate even a Pittsburg fog. Fortunately, this study demanded very few auxiliary pieces of apparatus: the telescope has to be directed upon the sun, its motor-clock keeps it constantly pointed upon the same spot, and the observer has to follow, with infinite diligence and patience, the elusive details which the moments of best vision may allow him to glimpse. Two very important and rare qualifications are also necessary. The observer must be entirely unprejudiced and impartial; recording that which he sees, whether it is expected or not, and recording nothing which he does not see, no matter how firmly he may be convinced that it ought to be visible. This is the first qualification—one of unusual mental constitution; and the second is one of unusual manual skill. The observer must be able to delineate the most extraordinary and complex details justly and correctly. Both of these unusual qualifications Professor Langley possesses in a marked degree. His well-known and most beautiful drawing of a "Typical Sun-spot" illustrates this. This has since been copied in very many places, and it has received the very highest praises from all competent judges.

Professor Langley's earliest published paper on the sun (February, 1874) may be taken as a type of his best work. It possesses that hardly-definable quality by which we become aware that it was written from a full mind. It is only fifteen pages long, yet we are not conscious of undue brevity. One has a sense, in reading, that every state-



A Typical Sun-spot.

ment of fact, or every expression of opinion, is based upon a hundred single instances like the one which is chosen, or upon a hundred concurring judgments. It is not that you are overborne by weight but convinced by character. This most important paper came at exactly the right time. It first summarizes the works of other recent observers, which, though important, had left the subject in an entirely unsatisfying condition, and then proceeds straight to the subject in hand.

The minute details, both of the general solar surface and of the extraordinarily complex spots, are one by one satisfactorily and lucidly described, with indications of the physical conditions to which they are due; and, finally, the general bearings of all this on the received solar theories are briefly set forth. We may fairly say that this paper is fundamental. It treats of a subject of which little had been accurately known, and it leaves this subject in a satisfactory and settled condition. Four years of labor on this subject had not failed to suggest many other researches.

A detailed study of the distribution of the heat of the solar surface was begun about this time, by means of the thermopile, and was quickly rewarded by the discovery of an unknown thermo-chroic action in the sun's atmosphere, such that it transmits the light less readily than the heat, owing to the difference in wave-length. An interesting consequence of this action is that, if, at any time, the sun's atmosphere should grow thicker, the color of the sun would tend toward red ; if thinner, then toward blue. These changes, which are quite possible, suggest interesting explanations of some of the phenomena of the variable stars. The glacial epochs on the earth may be connected with changes in the solar atmosphere.

In 1877 we find another outcome of the series of measures of the heat from various parts of the sun's disk, and especially from the umbræ, etc., of sun-spots. The periodic changes in the spotted area of the solar disk, which had long been known, induced the inquiry whether changes in the *amount* of spotted surface bore any relation to changes of temperature on the earth's surface.

The result of the extremely delicate measures of Professor Langley led plainly to the conclusion that the *direct effect* of sun-spots on terrestrial temperature is sensible ; that, when the spotted area is a maximum, the temperature is on that account lower, and the converse ; but that the total direct effects of the periodic changes in the spotted area on the earth's mean temperature are extremely small, not more than a change of three tenths of 1° C. in eleven years, and not less than one twentieth of 1° C. The *indirect* effects are not here considered.

A thermopile used in connection with the most sensitive galvanometers is an extremely delicate instrument ; and Allegheny Observatory now possessed a most complete outfit of this sort.

But the most important and pressing questions in solar physics demanded a means of measurement of heat still more delicate. When it was a question to measure the heat radiation from the different parts of the sun's disk, the thermopile was adequate. But if the heat from one of these parts is spread out into a heat-spectrum several feet or even yards long, it becomes necessary to devise new means of measuring the minute differences between the various parts. Such a device is the bolometer, which consists of two systems of extremely thin steel or platinum strips. Through these two systems an electric current passes. A sensitive galvanometer connected with both systems keeps its needle steady when the currents are equal.

If one system is now exposed to heat radiations while the other is protected from them, the temperature of the first is raised, its electric resistance is increased, and the battery-currents through the two systems and the galvanometer no longer balance. The galvanometer-needle then moves, and the amount of this motion measures the amount of heat disturbance. The sensitiveness of the instrument is from ten to thirty times greater than that of the most delicate thermopiles possible, and its constancy specially fits it for its work. The years 1879 and 1880 were given to perfecting this new and powerful instrument. Some of its first results were to show, by direct experiment, that the maximum of heat in the normal spectrum was in *the orange*, not the *infra-red* (then an interesting fact); and that the solar-constant,* as determined by previous methods, was decidedly too small. The most suitable methods of determining this important *constant* were pointed out.

In 1881 Professor Langley organized an expedition to the top of Mount Whitney, in California, for the purpose of applying these new methods under the most favorable conditions. The expenses of the expedition were jointly borne by the United States Signal Service and by the private subscription of a wealthy gentleman in Pittsburg, who had now for some years taken the greatest interest in the researches of the observatory, and whose liberality had provided many of its instruments.

His name *ought* to be here mentioned. He has materially aided science in the most liberal and thoughtful way; but, against his expressed wish that he should be nameless in this connection (as he is in hundreds of other kind deeds), I have no right to contend.

The most important single result of the previous experiments with the bolometer had been the establishment of the fact of *selective absorption* of the solar rays by the earth's atmosphere. The results of this action are so important that I may be permitted to quote from Professor Langley an elementary exposition of them. He says: "Our observations at Allegheny had appeared to show that the atmosphere had acted with *selective* absorption to an unanticipated degree, keeping back an immense proportion of the blue and green, so that what was originally the strongest had, when it got down to us, become the weakest of all, and what was originally weak had become relatively strong, the action of the atmosphere having been just the converse of that of an ordinary sieve, or like that of a sieve which should keep back small particles analogous to the short wave-lengths (the blue and green), and allow freely to pass the large ones (the dark-heat rays). It seemed from these observations that the atmosphere had not merely kept back a part of the solar radiation, but had totally changed its composition in doing so—not by anything it had put in, but by the selective way in which it had taken out, as if by a capricious intelligence. The residue that had actually come down to us thus changed in proportion was what we know familiarly as 'white' light, so that white is *not* 'the sum of all the radiations,' as used to be taught, but

* The amount of heat received from the sun's rays, falling perpendicularly on a square metre of the upper surface of the earth's atmosphere, in a minute of time.

resembles the pure original sunlight less than the electric beam which has come to us through reddish-colored glasses resembles the original brightness. With this visible heat was included the large amount of invisible heat, and, if there was any law observable in this 'capricious' action of the atmosphere, it was found to be this, that, throughout the whole range of the known heat-spectrum the large wave-lengths passed with greater facility than the shorter ones."

The effect of this selective absorption on the *visible* rays is to cut out the shorter wave-lengths proportionally more ; so that to an eye outside of the earth's atmosphere the sun would be far *bluer* than to us. On the heat-rays taken together, the total amount of the absorption is very great, far greater than had been previously supposed. Professor Langley's experiments give a very great increase in the amount of solar heat reaching the earth over previous determinations, so that for example, according to him, the solar radiation is sufficient to annually melt an ice-shell one hundred and seventy-nine feet thick all round the earth. According to previous determinations, one hundred and ten feet in thickness could be melted. But while Professor Langley finds a vastly greater *amount* of heat supplied by the sun, his law of the selective absorption comes in to profoundly modify its terrestrial manifestations. *Were there no such selective absorption, the temperature of the soil in the tropics, under a vertical sun, would probably not rise to that of the freezing-point of mercury.* "The temperature of this planet, and with it the existence, not only of the human race but of all organic life on the globe, appears, from the results of the Mount Whitney expedition, to depend far less on the direct solar heat" than on the hitherto neglected quality of selective absorption.

The bearing of the observations at Mount Whitney on a great number of important questions, the temperature of the sun, the radiation from the sky, etc., etc., can not be here considered for want of space. The solar spectrum previously known was but half of that mapped out by the expedition, and there is good reason to believe that Professor Langley's observations have now revealed the whole of it to us.

The partial results of these investigations, published from time to time in foreign periodicals, have done much to make Professor Langley honored in other countries than his own. In 1882 he was invited to address the British Association for the Advancement of Science at Southampton, and did so. His paper on that occasion reminds one of that of February, 1874, in the astonishing fullness of experiment, thought, and judgment which seems to lie just back of the sentences. It comes from a full mind. In the spring of 1885 Professor Langley goes to England at the invitation of the Royal Institution to lecture before it.

There are many other most interesting researches of Professor Langley's which should be referred to here, were it not for limited space. His observations on the moon's heat; on the solar eclipse of 1878 (at the summit of Pike's Peak); his direct comparison of the sun with the molten metal of a Bessemer converter; his investigations at Mount Etna, Pike's Peak, and Mount Whitney, on the conditions of vision at great altitudes, all deserve more than this brief notice.

His published scientific papers are very numerous. A list of the more important of these follows this article. There are forty-six separate papers in the years from 1869 to 1885. Besides these, the magazines have contained many more popular articles; and his courses of lectures at the Lowell Institute, the Peabody Institute, and elsewhere, have been most successful.

Professor Langley is a member of the National Academy of Sciences and of numerous American and foreign bodies, and has received the recognition of honorary degrees from various universities.

PROFESSIONAL AND OTHER PAPERS BY S. P. LANGLEY, IN CHRONOLOGICAL ORDER.

No.	Date.	Title or subject.	Where published.
1	August, 1869....	Eclipse of August, 1869	"United States Coast Survey Reports."
2	December, 1869..	Proposed Plan of Time-Service...	Pittsburg.
3	January, 1871...	Eclipse Expedition of 1870.......	"Nature," January, 1871.
4	February, 1871..	A New Form of Solar Eyepiece ...	"Franklin Institute Journal," February, 1871.
5	April, 1871	Observations on Eclipse of 1870...	"United States Census Reports."
6	September, 1872.	*American System of Electric Signals*	"American Journal of Science," November, 1872.
7	August, 1873....	The Solar Photosphere	"Proceedings of the American Association," 1873.
8	February, 1874..	*Minute Structure of Photosphere* ..	"American Journal of Science," February, 1874.
9*	Aug. & Sept., 1874	External Aspects of Sun, with *Typical Sun-Spot* Plate............	"Franklin Institute Journal," August, 1874.
10*	September, 1874.	Photosphere and Sun-Spots.......	"Popular Science," September.
11*	December, 1874..	Transit of Venus................	"Popular Science," December.
12*	March, 1875.....	Sources of Solar Heat (lecture)....	"New York Tribune," Mar. 10.
13	March, 1875.....	*Comparison of Theory and Observation*...................... See, also, Memorie degli Spettroscopisti, *Typical Sun-Spot Plate with each Memoir.*	"American Journal of Science," March.
14	March, 1875.....	Temperature Relative des, etc.....	"Comptes Rendus," Mar., 1875.
15	September, 1875.	Radiations Superficielles de Soleil..	"Comptes Rendus," Sept., 1875.
16	September, 1875.	The Solar Atmosphere...........	"American Journal of Science," 1875.
17	November, 1876..	*Effect of Sun-Spots on Terrestrial Climate*	"Royal Astronomical Society Notices," November.
18*	April, 1877.....	The first "Popular Scientific Treatise"	"Popular Science," April, 1877.
19	May, 1877......	Nouvelle Methode, etc. .... See, also, "American Journal of Science," August, 1877.	"Comptes Rendus," May, 1877.

No.	Date.	Title or subject.	Where published.
20	July, 1877......	Possibility of Transit Observations without Personal Error	"American Journal of Science," July, 1877.
21*	April, 1878.....	Electric Time-Service	"Harper's Monthly," April.
22	April, 1878.....	Photographs and Optical Studies ..	"American Journal of Science," April.
23	June, 1878	Transit of Mercury of May 6th....	"American Journal of Science," June.
24*	1878–1879......	Six Articles on the Sun	"Scientific American."
25	October, 1878...	*Pike's Peak Observations of Eclipse of 1878*.....................	Washington Observatory publication.
26	October, 1878...	Remarkable Groups in Lower Spectrum (A and B lines)..........	"Proceedings of the American Academy."
27	October, 1878...	Temperature of the Sun (Bessemer Converter, etc.)...............	"Proceedings of the American Academy."
28	August, 1879....	Saratoga Address as Vice-President of the American Association....	"American Association."
29	July, 1880......	Observations on Mount Etna	"American Journal of Science."
30*	July, 1880......	Wintering on Etna..............	"Atlantic Monthly," July.
31	January, 1881...	*The Bolometer and Radiant Energy*	"Proceedings of the American Academy."
32	March, 1881.....	The Actinic Balance.............	"American Journal of Science."
33	March, 1881.....	Sur la Distribution de l'Énergie, etc.	"Comptes Rendus."
34	March, 1881.....	Distribution de l'Énergie	"Comptes Rendus."
35	March, 1881.....	Distribution de l'Énergie	"Annales de Chimie et de Philosophie."
36	September, 1882.	*Observations du Spectre Solaire*....	"Comptes Rendus."
37	October, 1882...	Sunlight and Skylight............	"Nature." See, also, "American Journal of Science."
38	December, 1882..	Transit of Venus	"Monthly Notices of the Royal Astronomical Society." See, also, Ast. Nach.
39	March, 1883.....	*Selective Absorption of Solar Energy* See, also, Weidemann's "Annalen," "Annales de Chimie et de Philosophie," London edition; and Dublin "Philosophical Magazine," for republication in full.	"American Journal of Science."
40	June, 1883......	The Spectrum of an Argand-Burner.	"Science," June, 1883.
41	March, 1884.....	On the Measurement of Wave-Lengths, etc.................. See, also, above-cited journals for republication in full.	"American Journal of Science."
42	September, 1884.	Amount of the Atmospheric Absorption	"American Journal of Science." See, also, London edition, and "Dublin Philosophical Magazine."
43*	September, 1884.	The New Astronomy	"Century Mag.," September.
44*	October, 1884...	The New Astronomy	"Century Mag.," October.
45*	December, 1884..	The New Astronomy	"Century Mag.," December.
46	1885...........	*Researches on Solar Heat*.........	"Signal-Service Professional Papers, No. 13."

NOTE.—The above list omits numerous minor publications. It includes original contributions to science (the more important in italics), and articles of a popular character (marked with *).

EDITOR'S TABLE.

A PERNICIOUS POLITICAL TENDENCY.

THERE is no more important subject for consideration in the present day than that which is involved in the question whether the powers of government ought to be extended or restricted. The tendency, as every one must be aware, is toward extension, not restriction, and one of our contemporaries, the "Christian Union," snubs a correspondent who suggests restriction by telling him that he is "about half a century behind the times." The earliest form of government, it proceeds to say, is military despotism, the next is one of police regulation; while the happy dispensation under which we now live is one of industrial co-operation. Government is "organized to do for the community, by community action, whatever it can do better in that way than in any other." This is a little enigmatical, suggesting as it does that "government" might proceed in a great many other ways than by community action; but we may perhaps assume the meaning to be that government is organized to do for the community whatever can be better done through its agency than by any form of private effort or enterprise.

The first objection we make to this position is, that a great deal of ambiguity attaches to the word "better" as here employed. The resources of the Government are practically boundless; and that the Government, with boundless means, should do a particular work "better" than it would be done by private individuals with limited means, is not quite decisive of the question whether the Government should undertake the work or not. Anything can be done well if money without stint is applied to it; but the question remains, Are government methods of doing work really beneficial to the people? If the Government undertook to manage all the private gardens in the country, on the understanding that it might levy whatever taxes were necessary for the purpose, no doubt there might be a considerable improvement, on the average, in the way in which lawns and flower-beds and vegetable patches would be kept. It would take time to organize the necessary army of gardeners and laborers; but the thing could probably be accomplished in the end. There would be fat places for the politicians and clerkships without number, in addition to the actual outside workers; but the vast machine would sooner or later be brought into motion; and then no doubt some people, carried away by their admiration for the greater uniformity of government work, would proclaim that the principle of state management had scored another triumph. But meanwhile where would the money come from? Would the whole question of expediency be decided by pointing to the fact, if it were a fact, that, on the average, gardens were kept in better shape by the Government gardeners than they had been by the private owners? Would not the question of economy call loudly for consideration? And would it not be a further question whether Government was not doing more harm by diminishing the power of individual initiative than it was doing good by keeping hedges, and borders, and walks in superior trim?

When, therefore, we hear of Government doing this or that thing "better" than private enterprise would do it, we should like to go below the surface of things and examine a little into underlying questions, economical and moral. Every one seems to admit that a benevolent despotism would do certain things "better" than they are done by our republican Government. Why is it, then, that we will not hear of any kind of despotism—that our repugnance to a benevolent despotism is scarcely less than our repugnance to a purely selfish one? Because we hold that the word "better," as applied to the work of a despotism of any kind, is a very shallow "better"; and that, while certain superficial aspects of the national life might be improved under such a *régime*, the deep and abiding interests of the country would suffer. Well, what people have to learn is that something despotic attaches to all government action outside of the sphere which peculiarly belongs to government, the protection of the community from foreign, and of individuals from private, aggression. All government action is of a compulsory character; all takes away something from the liberty of the individual; all stands in the way of the spontaneous development of the agencies for doing what the Government unnecessarily undertakes. Social bonds are not knit by what the Government does, but social bonds are knit by every development of private enterprise, by every spontaneous development of means to ends for social purposes. If government managed everything for us, society in the true organic sense would cease to exist. The individual would find himself at every turn face to face with a great mechanism, and would no longer have the sense of belonging to a living and growing system. It is easy to sneer at these ideas as being "half a century behind the times"; but whoever does so should remember that at least one illustrious name stands associated with them, and that it is not usual to cite the author of the "Synthetic Philosophy" as a man left in the rear of the world's intellectual march. "Democracy," we are told, has left these notions behind, and will never take them up again. What democracy will or will not do in the future it is rash to assert; for our own part we venture on no predictions. We should just wish, however, to remark that it settles no question of right or wrong, truth or error, to say that "democracy" has done so and so. Democracy, we presume, is not infallible. These abstractions, however, are most misleading. Tell us the exact truth: that a certain community living under certain institutions, and at a certain stage in its intellectual and moral development has turned its back on a particular set of ideas; and we shall not only know precisely what you mean, but shall also be able to estimate the importance and value of your statement. But tell us that the abstraction "democracy" has done the same thing, and we are entitled to reply that no abstraction is capable of any such action.

On the principle our contemporary has laid down, it is impossible to say at what point state action should cease; for the more the state undertakes the more it is impelled to undertake. To add one new function to-day is to prepare for the addition of a dozen within a few years. Take the case of the English Government. Having the post-office under its control, it was led to make use of the post-office organization for the issue and payment of money-orders. Then followed the establishment of post-office savings-banks; then the absorption of the telegraph system; then the establishment of a parcel-delivery and general express business. On the Continent the post-office collects debts, pays newspaper subscriptions, and carries money in very much the same way as the express companies do here. Where is this kind of thing to stop? The larger the organization, the greater the temptation to apply it in some new way, or to accomplish by means of it some new object. There are those, no doubt, who think this increasing influence and interference of government a hopeful sign, and who look forward to the day when government will seize upon all the great lines of industry and forever break the power of private enterprise; but few intelligent persons in this country are of this turn of mind. We would therefore say to those who wish to preserve upon this continent a society alive in all its parts and full of individual initiative and resource, to beware how they give heed to the seductive doctrine that government should undertake whatever it can do "better" than private individuals. We might pay too dear for having our garden-walks rolled by government rollers, and too dear in many other ways for the alleged benefits of official rule.

BEECHER ON EVOLUTION.

The Rev. Henry Ward Beecher has worthily crowned his splendid career as a liberal religious reformer by announcing and entering upon a series of discourses to his congregation in exposition and defense of the doctrine of evolution in its religious aspects and bearings. The taking of this noble stand in a formal way at the present time is undoubtedly the most momentous act of his intellectual and professional life. At a time when most men are worn out and ready to retire, when enthusiasm is usually chilled and opinions become hardened and unadaptive, Mr. Beecher strikes into a new field with the fire of youth, and takes the leadership in a movement of religious reform of quite incalculable moment. He commits himself boldly and broadly to the most comprehensive, far-reaching, and revolutionary truth yet established by science, and which carries with it a total reconstruction of the relations of science and religion; and this he does in opposition to the narrow-mindedness and dull indifference of the community, and more especially to the organized ignorance, the sacred traditions, the inveterate prejudices, the bigotry and the intolerance of the theological world. We confess to unaffected admiration for the sagacity, the independence, the courage, the loyalty to conscience and to truth, that have prompted Mr. Beecher to take this brave and significant step.

Undoubtedly he has undertaken a very difficult task, and he is aware that he has not much child's play before him. But there are important advantages in his position; and the first of these is, his independence of religious organizations: he has to reckon only with his congregation. In various respects, no doubt, his audience is but poorly equipped to appreciate the value of facts and the force of reasoning on the subject of evolution. For it must be remembered that the proof of that great principle is not of a kind to be given to an uninstructed person at a sitting. It is the diversity, and wide concurrence, and cumulative confirmation of the evidences that give the overwhelming force of demonstration to the theory. It must be assumed that Mr. Beecher's congregation has not been very well prepared in the philosophy of evidence, any more than they are familiar with the sciences from which the proofs are derived. It consists of bright, intelligent people, whose mental cultivation has been chiefly in literature, politics, and theology; while in proportion to their proficiency in these will they rank low in science, knowing little of its facts and less of its spirit and method.

Nevertheless, Mr. Beecher's congregation has had a very valuable and important preparation, which will be pretty sure to carry them with him in the present movement. Evolution is by no means a thing of yesterday with Mr. Beecher; he has long been on the road to it. The doctrine of progress has been one of the favorite and most powerful elements of his preaching for a quarter of a century. It has been the key to his theological philosophy, and his people have been trained into thorough familiarity with the conception as an all-interpreting principle in both theology and politics. Yet evolution is only the expansion and full scientific elucidation and wider sweep of application of the idea of progress. Nor is there anything now in evolution more fatal to orthodoxy than there was a generation ago in the first vague divergence from the old rigid dogmatic systems in recognizing a progressive element in religion. Mr. Beecher and his people have been themselves evolved into their present position, and might furnish an object-lesson in the law of development. There will probably be more trouble in accepting the newer *name* appropriate to the later stage of growth than there has been in assimilating the underlying truth.

We congratulate Mr. Beecher on his intrepid course, and his determination to bring his pulpit into harmony with those revelations of science that a reshaping the thought of the age; and we commend his example to the numerous clergymen who give their private assent to evolution doctrine, and then go on promulgating the old beliefs from desks sacred to antiquated error.

SPREADING IT TOO THIN.

At a meeting of the Massachusetts Teachers' Association, held a short time ago, President Eliot, of Harvard, spoke in strong terms of the unsatisfactory character of the great majority of the so-called high-schools of the Commonwealth. Out of a total of two hundred and twenty-eight such schools, seventy-two only had as many as three teachers, and the whole together sent only one hundred and ninety-nine students to the colleges of the State during the year 1884. The simple fact, President Eliot states, is that the majority of the schools are not fit to prepare youths for matriculation at college, though in the general system of public-school education that is a recognized part of their function. "It has been the policy of the Board of Education," we are told, "to encourage small towns to establish high-schools in order that as large a percentage as possible of the population may have a school higher than the grammar-school within easy reach." That policy has been so far successful that over ninety per cent of the population nominally enjoy the privilege in question. The result, however, is a thinning and impoverishing of the education just in proportion to its extension. Seventy-five of the high-schools are maintained in towns of less than five hundred families. Nearly half of the whole number existing have less than sixty pupils each. President Eliot naturally calls for such a change in the law as may enable two or three or four smaller towns to establish a joint school, and employ in rendering it really efficient the funds which now are more or less frittered away upon the maintenance of two or more weak and inefficient schools. He also suggests that the colleges should meet the schools half-way by establishing liberal systems of options, so that no student need be debarred from the higher advantages that the colleges afford by his inability to pass an entrance-examination in one or two subjects in which he feels no interest, and which he has no ulterior intention of pursuing.

We call attention to this matter because we have reason to believe that the practical evil which the President of Harvard describes is not confined to the State of Massachusetts, but is widely prevalent throughout the country at large. It is a result, no doubt, of our democratic ideas, and of the local jealousies which, it will hardly be questioned, democratic institutions bring in their train, that we try to bring to every man's door what we bring to one man's door. The thing can only be accomplished, however, at the expense of a marked deterioration in the article supplied. A good and well-equipped high-school can not, as things now are, be maintained in every village and township. We may have the name of the thing, but the reality we can not have. If the system could be worked at all it could probably be worked as successfully in Massachusetts as in any State of the Union; but President Eliot tells us that it does not work well there at all, and that, owing to the poverty of the great majority of the schools, a gap which ought not to exist, and which is inconsistent with the theory of the public-school system, has established itself between the so-called high-schools and the colleges. The schools ought to prepare their students for matriculation at the colleges; but the most of them neither do nor can do anything of the kind.

What applies to the high-schools applies also, generally speaking, to the colleges themselves. They are not what they ought to be, simply because there are too many of them. The consequence is, that there is a great deal of false and shallow culture abroad in the land. A college ought to be a place where a youth would be certain to come into contact with men of an altogether superior order of thought and attainment. It ought to be the center of a true intellectual life. Of all our colleges, how many answer this description? It is needless to say that the country does not possess a sufficient number of men of real intellectual mark to fill all the chairs in our innumerable "colleges." If it did, we should indeed be exceptionally favored. Now, the effect of shallow learning tricking itself out in the garb of real erudition is to confuse all intellectual perceptions and standards. We do not say that a little learning is a dangerous thing, but we say that a little learning that mistakes itself for great learning is apt to make more or less of a fool or a charlatan of its possessor. We do not know whether there is much to be gained by struggling against what seems to be one of the main currents of the time; but we are profoundly convinced that the cause of American culture calls for concentration not dispersion of effort, for centralization as opposed to localization, for the sinking of petty rivalries in the endeavor to found strong, permanent, and widely beneficial institutions. Let our common schools which penetrate everywhere be placed on as sound a basis as possible; let high-schools be established in centers where they can be vigorously and generously sustained; let our colleges and universities be proportioned in number to the need actually existing for the highest culture, and let them have such support as national and individual interest in such culture prompts—and we shall then have all the necessary means for making the American people the equals in education of any other nation in the world. At present we have a vast but somewhat disjointed apparatus, and the results, however soothing they may be in some respects to democratic pride, are, from the point of view of national culture, far from satisfactory.

We call particular attention to the weighty testimony of Dr. Edward Frankland, the eminent English chemist and sanitarian, to the claims of the Yellowstone National Park as a great American health resort in winter for invalids with chest and pulmonary difficulties. Dr. Frankland has investigated this subject long and carefully, and is especially familiar with the conditions and effects of the celebrated Engadine Swiss sanitarium in the valley of Davos. Dr. Frankland came to this country last summer, attended the British Association at Montreal, and, having heard much of the Yellowstone Park, he went there and spent considerable time in examining its claims as a great winter sanitarium for the American people. He contributes to the "Monthly" a valuable paper, giving the results of his observations, and the more valuable, as it is a comparative study of the health-merits of the two localities; the marked advantages being in favor of the Yellowstone Park over the celebrated Swiss valley. The article is most instructive, and the subject one of interest and moment to our people.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, VOLUME L.

The Common Sense of the Exact Sciences. By William Kingdon Clifford. With One Hundred Illustrations. New York: D. Appleton & Co. Pp. 271. Price, $1.50.

Professor Clifford was applied to in 1871 to prepare a volume for the "International Scientific Series." He was asked if he would undertake a book to be entitled "Mathematics for the Non-Mathematical," the object of which should be to find out how far it is possible to go in explaining mathematical ideas to persons of intelligence who have had none of the higher mathematical training. This idea had been before proposed to several mathematicians, who agreed that nothing could be made of it; but it was suggested that if anything could be done with it Clifford's was the genius to do it. Professor Clifford was struck with the idea as novel and interesting, and said he would make a study of it and see what it promised. The result was so favorable that he decided to undertake the book and give such attention to it as his slender health and various pre-engagements would allow. There was but little doubt that the project was eminently suited to the peculiar characteristics of Clifford's mind; and that the subject was certain to be handled by him with originality and result in a valuable contribution to mathematical literature. But it soon became apparent that there was a serious question about the possibility of his accomplishing the task at all, on account of his declining health. He, however, did considerable work on it, but left it in an unfinished and fragmentary condition at his death in 1879.

In arranging the plan of the work it was Professor Clifford's intention to treat the fundamental conceptions of mathematics in six parts or chapters under the heads of Number, Space, Quantity, Position, Motion, and Mass. Of these six subjects he dealt with but four, dictating the chapters on Number and Space completely, the first portion of the chapter on Quantity, and nearly the entire chapter on Motion. Shortly before his death he expressed a wish that the book should only be published after very careful revision; that the title, *The First Principles of the Mathematical Sciences explained to the Non-Mathematical*, should be abandoned, and that the volume should be entitled *The Common Sense of the Exact Sciences.*

It was not easy to find a mathematician who would undertake to finish Professor Clifford's work. Upon his death, Professor Rowe, of University College, engaged to do it; but he also died before accomplishing the task, so that the final revision had to be made by still another hand. There are parts of this work contributed by Professor Clifford which answer finely to the original idea of it, and show what might have been done if he had lived and adhered to the first conception. A mistake was made by the subsequent editors in seeking to finish the work as they thought Clifford would have done it, rather than as in their judgment it might seem best. As it is, the work will probably be found more attractive to mathematicians than to non-mathematicians.

Annals of the Astronomical Observatory of Harvard College. Vol. XIV. Parts I and II. Observations with the Meridian Photometer during the Years 1879–'82. By Edward C. Pickering, Director, aided by Arthur Searle and Oliver C. Wendell. Cambridge: John Wilson & Son, University Press. 1885.

Almost the earliest record we have of astronomical observation is the catalogue of 1,028 fixed stars in the "Almagest" of Ptolemy, the epoch of which is A. D. 138. The chief value of this catalogue consists in its classification of the stars into six magnitudes, which classification, so far as those stars which are visible to the naked eye are concerned, has been continued to the present day. Since that time many other astronomers have made systematic observations on the relative brightness of the stars, the comparisons up to the present century having been made either by the naked eye, or with the assistance of an opera-glass only. About the middle of this century photometers specially adapted for comparing the light of the stars were first used by German astronomers. Zollner invented a photometer, consisting of a telescope in which the light from a kerosene-lamp, admitted through a very small hole and presenting the appearance of a star, is compared with the real star under observation. C. S. Pierce, of the United States Coast Survey, used such a one in the construction of a photometric catalogue of 494 stars, published in Vol. IX of the "Annals of Harvard College Observatory." His description of his difficulties with this very imperfectly contrived and still more imperfectly constructed instrument would be amusing, if it did not excite regret that so accurate an observer and excellent a mathematician should have been weighted with an instrument so poorly adapted to the work.

Up to within a few years, only about 500 stars had been the subject of photometric observation, and for some time it has been regarded as highly desirable that systematic comparisons should be made of the light of all stars visible to the naked eye.

In Vol. XIV of the "Annals of the Observatory of Harvard College" we have the records of the most extensive and complete photometric observations ever undertaken. The great attention which Professor Pickering, the director of the observatory, has given to astro-photometry. and the large experience he has had with photometers, both of his own and others' construction, peculiarly fitted him for such a task.

Part I of the "Annals" opens with a description of the meridian photometer devised by Professor Pickering. Having ascertained by experiment that any change of position on the part of the observer had an injurious effect upon the observations, he constructed his instrument in the form of a broken transit, in which, the line of sight being always horizontal, stars at all altitudes could be observed without moving the head. Experience with other photometers had also satisfied him that no artificial light could be a proper standard of comparison for the light of a star. A real star was therefore chosen, and the fact that the pole-star is always visible, and its light, on account of its very slight changes of altitude, a constant quantity, directed him in his choice of it as the standard of comparison for all stars. To make sure that it was otherwise suitable, a large number of observations were made of the pole-star, to ascertain if its light was subject to any periodical variation.

A reliable instrument and perfect standard having been thus obtained, and many preliminaries settled which it is impossible to touch upon here, observations were begun in October, 1879, and continued till September, 1882. During this period seven hundred series of observations were made, including 94,476 separate comparisons, the result being that every star not fainter than the sixth magnitude, between the north pole and thirty degrees of south declination, was compared from three to fourteen times with the pole-star. The whole number of stars thus compared is 4,260.

The space to which this review is necessarily restricted renders it impossible to give even a passing notice to the immense amount of work expended upon the subject of astro-photometry as recorded in these "Annals." An idea can be formed from the statement that there are in all ninety-one tables, some of which occupy several pages. The "General Catalogue," constituting Table XXVII, alone occupies 211 pages, each line having twenty-six columns, one of which has fourteen sub-headings.

Part II of the "Annals," the publication of which has been delayed till the present year, is largely devoted to a discussion of the work of those astronomers, from Ptolemy to the present day, whose estimates of the relative magnitudes of the stars Professor Pickering has chosen for comparison with his own. A very complete list of all known or suspected variable stars is also given, with copious notes as to dates and observers. There is also a chapter on the distribution of the stars.

Professor Pickering does not close his work with the advancement of any theories of his own. But, for whatever purpose an exact determination of the relative magnitudes of the stars may be desired, either for the discovery of variable stars, or to ascertain the position of the sun in the Galactic Cluster, this volume of the "Annals" fills a place which no other work yet published can make any pretense to. Whether we consider the perfection of the instrument employed, the plan of observation pursued, the accuracy and care with which the observations were made, the large number of stars observed, the completeness of the records, or the exhaustive comparisons that have been made of the observations with those of other astronomers, we are equally satisfied that, so far as the photometric observation of all stars visible to the naked eye in northern latitudes is concerned, the work of Professor Pickering and his able assistants leaves nothing to be desired.

The Chemistry of Cookery. By W. Mattieu Williams. New York: D. Appleton & Co. Pp. 328. Price, $1.50.

Since the publication of Johnston's "Chemistry of Common Life," thirty years ago, no book so important has appeared in this line of inquiry as the volume before us. Johnston's work was of broader scope, and, in fact, contributed little to the science of the culinary preparation of foods, to which Williams's work is devoted. Much has been done in this direction in the last generation, and a work was needed embodying the most important practical results. This Professor Williams has now given us in a very satisfactory form. Of the extent and importance of the information conveyed in his pages nothing need be said to the readers of "The Popular Science Monthly," in which the successive articles have appeared; but, now that they are collected together and offered as a treatise on the science of cookery, it is proper to state that the work has been ably done, and is entitled to rank as a standard upon its subject. Mr. Williams has given us "the present state of knowledge" on the chemical changes to which alimentary substances are subjected by customary kitchen operations. His facts and his chemistry are to be relied upon, and his conclusions are generally made with judgment, but some of his speculations may be extreme, and will be received with caution. His work has been criticised as if he had made too much of the test-tube and analytical operations, and built unwarrantably upon their results. There are, of course, many things about organic substances and their subtile changes which chemistry can not explain, and it certainly can not give us a complete science of foods. But the author of the present work is quite aware of this, and we do not think he has unduly strained the resources of his science in his efforts to elucidate the subject. His book will prove invaluable to read, for practical instruction, for reference in using common cook-books, and as a text-book for classes wishing to study the science of cooking in a careful and thorough manner.

A Text-Book of Hygiene. By George H. Rohé, M. D., Professor of Hygiene, College of Physicians and Surgeons, Baltimore. Baltimore: Thomas & Evans. Pp. 324.

Every important division of the subject receives some attention in this treatise. It is intended to present the essential facts upon which the art of preventive medicine is based, in such manner as to form a guide for the American student, practitioner, and sanitary officer. Beginning with general considerations in regard to air, water, food, and soil, the author goes on to the special hygiene of dwellings, hospitals, and schools, and takes up also industrial, military, marine, and prison hygiene. Several chapters are devoted to personal hygiene. Histories of the epidemic diseases are given, and the subjects of disinfectants, quarantine, and vital statistics are also included. A list of special works is given with each chapter. The author makes little claim to originality; the qualities which he has especially sought are comprehensiveness and reliability.

The Microtomist's Vade-Mecum. By Arthur Bolles Lee. Philadelphia: P. Blakiston, Son & Co. Pp. 424. Price, $3.

This work—"a hand-book of the methods of microscopic anatomy"—has been prepared chiefly with the design of furnishing a complete but concise account of all the methods of preparation that have been recommended as useful for the purposes of microscopic anatomy. In order to make it also a suitable guide for beginners, a general introduction has been added, and introductory paragraphs have been prefixed, when needful, to the different chapters, which, taken all together, go far to make up a formal treatise on the art. To furnish to instructed anatomists, for whom the book is primarily designed, information on points of detail as to which their knowledge or memory may be at fault, a collection of formulæ is given and a number of special methods are described. For beginners, again, a collection is furnished of examples, which are not intended for imitation, but as hints suggestive of the most fitting processes.

The Diamond Lens, with other Stories. By Fitz-James O'Brien. New York: Charles Scribner's Sons. Pp. 337. Price, paper, 50 cents.

Mr. O'Brien was of Irish birth, a poet and story-writer of bright genius, whose contributions to the newspapers and magazines attracted much attention when they were published, and were generally popular and widely read, showing distinct originality and strong powers of penetration and description; they deserve to be remembered. The present series, including a baker's dozen of the stories, was published in 1881, with a biography of the author, by Mr. William Winter, and now appears again in a second edition.

The Life of Society. By Edmund Woodward Brown. New York: G. P. Putnam's Sons. Pp. 270. Price, $2.

This work is intended to present a general view of the various factors, in nature and man, that work upon the structure and methods of society, and of the influence, in turn, of society upon man. The author's object has been, in a systematic study, to obtain as deep and adequate a general conception of society as possible, "the society of any township or any country of the world to-day, or the whole world of society in the past. . . . I wish," he says, "to find an explanation of society that will suit wherever society is in any country, or has been in any country or age. I want to get a general view of the constant part of every society. I want to evidence and illustrate this by social and historic facts, drawn from the wide range of society in the past or the present." In general, he adds, "I hope, then, I have shown the real foundation of social science, though, doubtless, there are deficiencies." The subject is considered under the head of the effective causes acting upon society, among which are the influences of the body, man's intellect, man's will, habit and usage, disposition and feeling, etc.; then are considered various features of society, the influence of the parts of society upon one another, and of the whole upon the parts; the growth and progress of society; its incompleteness, imperfection, and deterioration; rhythm and epochs in the life of society; its laws, restraints, liberties, forms, and institutions; and, finally, a general view of the spheres of society. The work bears the marks of laborious thought.

The Limits of Stability of Nebulous Planets, and the Consequences resulting from their Mutual Relations. By Professor Daniel Kirkwood. Pp. 110.

This monograph is an inquiry respecting the extreme limits within which a planet's atmosphere may exist, as measured by the distance from the planet's center, at which gravity and the centrifugal force will be in equilibrium; and further into the original or maximum values of the corresponding distances, which were much greater before the members of the system had contracted to their present dimensions. These found, the author applies the bearing of the answers to the discussion of the question, "Were the planets formed from nebulous rings?"

Third Annual Report of the Ohio Agricultural Experiment Station, for 1884. By William R. Lazenby, Director. Columbus, O.: Myers Brothers, State Printers. Pp. 240.

The theory of the station, it is stated in the introductory part of the report, "is to tell the farmers of Ohio what they most need to know"; and much of the matter in the volume appears to answer to that description. Field experiments were conducted during the year with grasses, fruit, and garden vegetables. The primary object of the tests is to improve upon the best-known methods of cultivation and management. Among practical questions, earnest attention was given to ascertaining the comparative value of the best varieties; the effects of thick and of thin seeding; the effects of sowing or planting at different dates, different distances, and different depths; the value of different methods of manuring and applying fertilizers; and the comparative merits of different systems of culture. In connection with this work chemical analyses were made; experiments were carried on in self- and cross-fertilization; investigations were made in regard to the best treatment of certain insect enemies and plant-diseases; the climatic conditions were carefully noted; and the work begun in practical forest-tree culture was extended. The results of the investigations are intelligently and intelligibly described. We regard the document as a good specimen of what such a report should be.

An Introduction to the Study of the Compounds of Carbon; or, Organic Chemistry. By Ira Remsen, Professor of Chemistry in the Johns Hopkins University. Boston: Ginn, Heath & Co. Pp. 364. Price, $1.30.

The arrangement of this book is somewhat different from that commonly adopted by teachers of organic chemistry. The lowest two members of the paraffin series are first considered, then, in order, their halogen, oxygen, sulphur, and nitrogen derivatives, and after these any peculiarities of higher paraffins and of their derivatives. Fifty pages are devoted to compounds which are at the same time alcohols and acids or aldehydes, etc. Next some account is given of the series of hydrocarbons homologous with the paraffins, and of their derivatives. The benzene series follows, and the various modifications and combinations of the ring molecule are described. Only the more important compounds in each group, and the more important reactions, receive attention. General directions are given for eighty-two experiments, a fair proportion of which the author advises each student to perform; for details in regard to analysis, etc., larger works are to be consulted. The author has taken pains to make the student see for himself the reasons for adopting the prevalent views in regard to the structure of the compounds of carbon, and has aimed to give a general view of the whole field, leaving minute descriptions to the chemical dictionaries. The book is a welcome addition to the unsatisfactory list of text-books in organic chemistry.

A Reprint of Annual Reports and other Papers, on the Geology of the Virginias. By the late William Barton Rogers. New York: D. Appleton & Co. Pp. 832. With Maps.

This republication is made in answer to requests by geologists and others for the reports, which have been several years out of print, or very rare. "Of the value of the scientific discoveries, the generalizations, and the descriptions of the geological formations contained in these reports," says the editor, "there can be no better evidence than the frequency with which they are referred to and quoted by all who are engaged in exploring the geology of the Virginias, and the aid they have given to the development of the industrial resources of these States, which they foreshadowed, and in fact often clearly pointed out, at a time when the geology of the State was unexplored." The reports are arranged substantially in the order in which they were made, with the preliminary correspondence and the arguments addressed to the Legislature for the continuance of the appropriations, so that they have an historical as well as scientific value. The author himself desired to condense and codify the reports, and present them with his special map and sections, as a single whole, but time and opportunity never came for doing so. Thus, the editor's work has been simply to revise the reproduction of the original reports and maps. But a number of papers additional to the reports, relating to the geology of the Virginias, have been embodied in the volume.

An Introduction to Practical Chemistry, including Analysis. By John E. Bowman, F. C. S. Edited by Charles L. Bloxam, F. C. S. Eighth edition. Philadelphia: P. Blakiston, Son & Co. Pp. 248. Price, $2.

In this manual is laid out a short course of laboratory work, beginning with general chemistry, and including something of both qualitative and quantitative analysis. The book has been made especially for college students who have not studied chemistry, and have time only to gain some familiarity with chemical operations, without devoting much attention to chemical philosophy. The author has avoided the use of complicated or expensive apparatus, and has aimed to give clear and full explanatory details of the several processes. Quantities are given in English measures, followed by metric equivalents. In the part devoted to analysis are included blow-pipe tests and determinations of specific gravity. Several new examples of quantitative separation have been added in this edition, and volumetric analysis has been given a separate chapter. Ninety cuts illustrate the operations described. A dozen pages of technical information in regard to reagents are given, also tables of weights and measures, reactions, and solubilities, lists of salts for blow-pipe examination, etc. The uncut edges of the volume are rather inconsistent with the title, "Practical Chemistry."

The Fallacy of the Present Theory of Sound. By Henry A. Mott, Ph. D. New York (printed for the author): John Wiley & Sons. Pp. 103. Price, 50 cents.

We are informed on page 7 of this book that "in 1877 Dr. H. Wilford Hall published a work on the 'Evolution of Sound,' in which he carefully considered, step by step, the present undulatory theory of sound, as elucidated by the distinguished authorities." It is furthermore said that Dr. Hall has shown that the current acoustical theory contains numerous fallacies, and, from the language adopted throughout the book, we should infer that it is shown to be childish, absurd, and wholly unworthy of credence. Dr. Mott avows his agreement with Dr. Hall, and he gave a lecture before the New York Academy of Sciences, December 8, 1884, stating Dr. Hall's objections to the present theory of sound, and this lecture constitutes the volume before us. Dr. Mott says that the work of exploding this theory has already been pretty well accomplished, and in his preface he gives the names of divers presidents of colleges, and professors thereof, from California to New Hampshire and South America, who have accepted "Dr. Hall's discovery," and abandoned as baseless and worthless the hitherto accepted wave theory of sound.

We can not here state Dr. Hall's case as re-expounded by Dr. Mott, but discharge our duty by informing all who are concerned about it where they can get instruction upon the subject. Nor have we formed any opinion, from having examined the arguments, whether the wave theory of sound has been exploded or not. There is getting to be such a free use of dynamite in these latter days among the supposed fundamentals and essentials of science, and long-established opinions seem so liable to sudden overthrow, that we are losing our interest in the operations. Perhaps the safest rule to follow in these revolutionary circumstances is to abide by long-tested principles until given up by those longest and most profoundly trained in the work of scientific investigation.

School Bulletin Year-Book of the State of New York, for 1885. By C. W. Bardeen. Syracuse, N. Y.: C. W. Bardeen. Pp. 160.

The "Year-Book" is intended to serve as a convenient educational directory for the State of New York. It contains sketches of the county superintendents and county commissioners, and a list of the principals of village schools and academies arranged by counties. Every alternate leaf is left blank, for the insertion of notes, additions, and corrections.

Obiter Dicta. New York: Charles Scribner's Sons. Pp. 232.

This is a collection of essays, which may be called critical or discursive, according to the mood of the reader, on "Carlyle," "Mr. Browning's Poetry," "Truth - Hunting," "Actors," "A Rogue's Memoirs," "The Via Media," and "Falstaff." They embody the "gratuitous opinions" of one who seems to be an independent thinker, forcibly and often very pungently expressed. Each essay has its own quality; that on "Falstaff" is a fund of humor; and they are all pleasant reading.

The Sun and his Phenomena. By the Rev. T. W. Webb. New York: Industrial Publication Company. Pp. 80. Price, 40 cents.

Notwithstanding the multiplicity of popular treatises on astronomy, the author has thought there might still be room for a description of the sun, which, confining itself to a brief but careful enumeration of its phenomena, may be found serviceable in elementary instruction. The most recent discoveries are taken notice of.

A Catalogue of Chemical Periodicals. By H. Carrington Bolton, Ph. D., Professor of Chemistry, Trinity College, Hartford, Conn. Reprint from Annals New York Academy of Sciences. 1885. Pp. 53, 8vo.

This bibliography contains the titles of the chief chemical periodicals of all countries, from the rise of this literature to the end of 1884. The titles number 182, and eight languages occur; the arrangement is strictly alphabetical by the first word; cross-references are freely introduced, from the editors' names to the journals published by them, and from the chemical societies to their publications. Bibliographical details are quite full; the different titles borne by a periodical at different periods are arranged in chronological order under the first or earliest title. At the end of the paper is a geographical index, arranged by countries and cities.

The material for this bibliography has been drawn for the most part from a larger "Catalogue of Scientific and Technical Periodicals—1665–1882," by the same author. The larger comprises, we understand, over 5,000 titles, and forms a volume of nearly 800 pages; it will be published by the Smithsonian Institution in a few weeks.

The present catalogue will be useful to chemists, and especially to librarians.

Bulletin of the Philosophical Society of Washington. Vol. VII. 1884. Washington, D. C.: Judd & Detweiler. Pp. 135.

This volume contains the minutes of the society and of its mathematical section for 1884. The society continues to show a vigorous growth. The total number of members enrolled, from the beginning in 1871, is 292. Thirty-five new members were added during the year, and the present number of active members is 173. The annual address of the president, James C. Welling, delivered December 6, 1884, was on "The Atomic Philosophy, Physical and Metaphysical." The "Minutes" include, besides this address in full, abstracts of the papers read at the stated meetings of the society, among which we notice, as of current general interest, Mr. Russell's on "The Existing Glaciers of the High Sierra of California," Mr. Kerr's on "The Mica-Mines of North Carolina," Mr. Russell's on the "Volcanic Dust of the Great Basin," Mr. Dall's on the "Volcanic Sand that fell at Unalaska in 1883," with Mr. Diller's on the composition of that dust; and Mr. Dutton's on "The Volcanoes and Lava-Fields of New Mexico."

How should I pronounce? Or, the Art of Correct Pronunciation. By William Henry P. Phyfe. New York: G. P. Putnam's Sons. Pp. 305. Price, $1.25.

The author assumes that the subject of English pronunciation has not, as yet, had its main facts and principles clearly and concisely presented; and that, among existing books, none consider the question embraced in the title of the present one in its broadest sense, and endeavor to give it an intelligent and satisfactory answer. His effort has been to supply this lack; to furnish the reasons for the directions given, and to indicate the means of becoming proficient in the very important art. After an introductory chapter presenting general views and principles, the topics are considered of the physical nature of sound, the nature and use of the vocal organs, articulate sounds, the sounds of the English language, alphabets, and the English alphabet. The last topic is followed by complete lists of the various sounds for which each letter in the English alphabet stands, and of the various symbols used for each elementary sound, which are claimed to be the fullest that have ever appeared. Then come rules and suggestions for becoming proficient in English pronunciation and the indication of the correct pronunciations, according to both Webster and Worcester, of more than one thousand words that are frequently mispronounced. Proper names are considered in another chapter, and a bibliography of the subject is given in an appendix.

The Lenapé Stone: or, the Indian and the Mammoth. By H. C. Mercer. New York: G. P. Putnam's Sons. Pp. 95. Price, $1.25.

In 1872 a young farmer in Bucks County, Pennsylvania, turned up in plowing a "queer" stone, which he took home and threw into a box with his other "Indian curiosities." It was a piece of a broken "gorget-stone," on which could be discerned carved lines, describing the outline of a mammoth. In 1881 he sold it in a lump with his other specimens to Mr. James Paxon, for the round sum of $2.50. Shortly afterward, a smaller fragment was found, which, joined to the former one, completed the gorget, and also the design of a party of Indians hunting a mammoth. The question necessarily arises, Is the stone with its tracings a genuine aboriginal relic? It is a very important one in American archæology. There appears no reason to doubt the entire honesty of all the persons who are known to have handled the specimen. Unfortunately, the stone itself is not capable of giving evidence; for it was not seen, scientifically, till it had been cleaned two or three times, and its possessors had scratched over the lines to make them plainer. Its occurrence where it was discovered is unaccountable if it is not genuine. It has been submitted to experts in aboriginal relics, and they have expressed different opinions respecting it. Three other carved stones have very recently been found on the same farm, the examination of which and their comparison with this one may throw some light on the subject. Mr. Mercer presents the evidence on both sides with seeming impartiality, but evidently believes in the genuineness of the stone.

PUBLICATIONS RECEIVED.

Report of the Assistant Director of the U. S. National Museum, for 1883. Washington: Government Printing-Office. 1885. Pp. 200.

The Coöperative Commonwealth. By Laurence Gronland. Boston: Lee & Shepard. 1884. Pp. 278. Cloth. $1.

"The Museum: An Illustrated Monthly Journal for Young Naturalists and Collectors." Edwin A. Barber, Editor. May, 1885. 1220 Sansom Street, Philadelphia. Pp. 16. 15 cents a copy; $1.50 a year.

"Mind in Nature: A Popular Journal of Psychical Medicine and Scientific Information." Monthly. Chicago: Cosmic Publishing Company. March, 1885. Pp. 16. $1 a year.

Experimental Investigation of the Reactions of Various Copper Salts with Grape-Sugar. By George Hay, M. D. 1885. Pp. 6.

American Languages, and why we should study them. By Daniel G. Brinton, M. D. Philadelphia: J. B. Lippincott & Co. 1885. Pp. 23.

The Imported Elm-Leaf Beetle. Bulletin No. 6, U. S. Department of Agriculture. Washington: Government Printing-Office. 1885. Pp. 18. Illustrated.

Revolution in the Practice of Medicine. By John F. Bouton, M. D. Chicago: Review Printing and Publishing Company. 1885. Pp. 55. 25 cents.

A Catalogue of Chemical Periodicals. By H. Carrington Bolton, Ph. D. Author's edition. 1885. Pp. 58.

Luck of a Wandering Dane. By Hans Lykkejaeger. Philadelphia: Matlack & Harvey, Printers. 1885. Pp. 130. 25 cents.

The Crime of Poverty. An Address delivered at Burlington, Iowa, April 1, 1885. By Henry George. Pp. 15.

Population by Ages. Baltimore. 1885. Pp. 30.

The Life of an Oyster. By Professor Samuel Lockwood, Ph. D. New York. 1885. Pp. 12.

Thirteenth Annual Report of the Directors of the Zoölogical Society of Philadelphia. Philadelphia. 1885. Pp. 16.

Address delivered at the Convocation of McGill University, April 30. 1885. By Professor D. P. Penhallow, B. Sc. Pp. 8.

Bacterial Pathology. A Series of Papers on the Exhibits at the Biological Laboratory of the Health Exhibition. Reprint from the London "Lancet." New York: The Industrial Publication Company. 1885. Pp. 43. 25 cents.

"The Sanitary Monitor; a Monthly Journal devoted to Individual, Family, and Public Health." Edited by J. F. Winn, M. D. Richmond, Va. Pp. 14. $1 a year.

Bureau of Education: Planting Trees in School-Grounds. and the Celebration of Arbor Day, pp. 64; and City School Systems in the United States, pp. 207. Washington: Government Printing-Office. 1885.

Ovulation and Menstruation considered in their Physiological Relations. By Franklin Townsend, M. D. Albany: Burdick & Taylor, printers. 1885. Pp. 18.

Scarlet Fever. By T. G. Comstock, M. D. New York. 1885. Pp. 19.

The Taensa Grammar and Dictionary: A Deception exposed. By D. G. Brinton, M. D. From "American Antiquarian." Pp. 4.

Clinical Studies of the Incipient Stages of Inebriety. By T. D. Crothers, M. D. 1885. Pp. 12.

On the Acquisition of Atmospheric Nitrogen by Plants. By W. O. Atwater. Pp. 24.

On the Vanadates and Iodyrite from Lake Valley, New Mexico. By F. A. Genth and Gerhard von Rath. 1885. Pp. 13.

A Dictionary of Music and Musicians. Edited by George Grove. Part XX. Macmillan & Co. 1885. $1.

Recent American Socialism. By Richard F. Ely, M. D. Baltimore: Johns Hopkins University. 1885. Pp. 74.

On the Evidence that the Earth's Interior is solid. By Dr. M. E. Wadsworth. Pp. 24.

History and Management of the Land Grants for Education in the Northwest Territory. By George W. Knight, Ph. D. New York: G. P. Putnam's Sons. 1885. Pp. 175. $1.

Memoirs of the National Academy of Sciences. Vol. II, 1883. Washington: Government Printing-Office. 1884.

The Figure of the Earth. By Frank C. Roberts, C. E. New York: D. Van Nostrand. 1885. Pp. 95. 50 cents.

Photo-Micrography. By A. Cowley Malley. London: H. K. Lewis. 1885. Pp. 169.

The True and Romantic Love-Story of Colonel and Mrs. Hutchinson: A Drama in Verse. By J. Antisell Allen. London, E. C.: Elliot Stock. Pp. 88.

The Social Philosophy and Religion of Comte. By Edward Caird, LL. D. New York: Macmillan & Co. 1885. Pp. 249. $1.75.

The Chemistry of Cookery. By W. Mattieu Williams. New York: D. Appleton & Co. 1885. Pp. 328. $1.50.

Outlines of Psychology. By Hermann Lotze. Translated, with a Chapter on the Anatomy of the Brain, by C. L. Herrick. Minneapolis, Minn.: S. M. Williams. Pp. 15. Illustrated.

Materials for German Prose Composition. By C. A. Bucheim, F. C. P. Ninth edition. New York: G. P. Putnam's Sons. 1885. Pp. 252. $1.25.

The Occult World. By A. P. Sinnett. Boston: Houghton, Mifflin & Co. 1885. Pp. 228. $1.25.

The Philosophic Grammar of the American Languages, as set forth by Wilhelm von Humboldt. By Daniel G. Brinton, M. D. Philadelphia: McCalla & Stavely. 1885. Pp. 51.

The Invalids' Tea-Tray. By Susan A. Brown. Boston: J. R. Osgood & Co. 1885. Pp. 67.

Russia under the Tzars. By Stepniak. Translated by William Westall. New York: Charles Scribner's Sons. 1885. Pp. 381. $1.50.

An Inglorious Columbus. By Edward P. Vining. New York: D. Appleton & Co. 1885. Pp. 788. $5.

Collected Essays in Political and Social Science. By William G. Sumner. New York: Henry Holt & Co. 1885. Pp. 173. $1.50.

Mushrooms of America, Edible and Poisonous. By Julius A. Palmer, Jr. Boston: L. Prang & Co. 1885. Pp. 5, and Twelve Colored Plates.

The Copper-bearing Rocks of Lake Superior. By Roland Duer Irving. Washington: Government Printing-Office. 1883. Pp. 464. Illustrated.

POPULAR MISCELLANY.

The American Association.—The next meeting of the American Association is appointed to be held at Ann Arbor, Michigan, beginning August 20th. The Association at its last or Philadelphia meeting expressed a preference for Bar Harbor, Mount Desert, as the place of its next meeting, if suitable accommodations could be secured there, naming Ann Arbor as an alternative place. It has been ascertained that, while hotel-room is not wanting at Mount Desert in July and the latter part of September, all possible accommodations are taken up at the time the Association would meet, in August. At Ann Arbor, the university buildings and the rooms usually occupied by the students will be at the disposal of the Association.

The British Association.—The arrangements for the coming meeting of the British Association at Aberdeen, September 9th, are nearly completed. The president-elect for the year is Sir Lyon Playfair. The general secretaries are Captain Galton and Mr. A. G. Vernon Harcourt, while Professor Bonny serves for the last time as acting secretary. The presidents of the various sections are: A, Mathematical and Physical Science, Professor G. Chrystal; B, Chemical Science, Professor H. E. Armstrong; C, Geology, Professor J. W. Judd; D, Biology, Professor W. C. McIntosh; E, Geography, General J. T. Walker; F, Economic Science and Statistics, Professor Henry Sidgwick; G, Mechanical Science, Mr. Benjamin Baker; H. Anthropology, Mr. Francis Galton. The lecture to working-men will be delivered by Mr. Harold B. Dixon, on "The Nature of Explosives." The other lectures will be by Professor Grylls Adams, subject not announced, and Mr. John Murray, director of the Challenger Expedition Commission, on "The Great Ocean Basins."

How Floras are changing.—Professor C. E. Bessey notices, in the "American Naturalist," on the subject of "Plant Migrations," a few instances in which certain plants have disappeared from the flora of a part of Central Iowa, to have their places taken by other species coming in from abroad. Fifteen years ago the *Dysodia chrysanthemoides* grew by the road-side in great abundance; now it is scarcely to be found, and is replaced by the introduced "dog-fennel," or "May-weed" of New England (*Anthemis cotula*). Then, the small flea-bane (*Erigeron divaricatum*) abounded on dry soils; now it is rapidly disappearing. Mulleins have begun to appear, and the squirrel-tail grass (*Hordeum jubatum*), which had no place in the flora, is very abundant, and has been for ten years. The low amaranth (*Amarantus blitoides*), which was rarely found, is now abundant, and has migrated fully one hundred and fifty miles northeastward. Bur-grass, also, a most offensive plant, has come in, and appears to be rapidly increasing. Professor Bessey is informed by old settlers that in Nebraska the buffalo-grasses were formerly abundant in the eastern part of the State, but have now retreated for a hundred or a hundred and fifty miles, while they have been followed by the blue-stems (*Andropogon* and *Chrysopogon*), which now grow in great luxuriance all over the plains, where twenty years ago the ground was practically bare. The same is taking place in Dakota.

Color of Arctic Animals.—Mr. Wallace's theory that the white color of many Arctic animals is due to protective adaptation or mimicry has been disputed by Mr. Meldola, who speaks of some Arctic animals that are not white, and regards that color as having some relation to the radiation or absorption of heat. Mr. Wallace, defending his view, says that, "if the white coloration of the Arctic animals stood alone, it might be thought necessary to supplement the protective theory by some physical explanation, but we have to take account of the parallel cases of the sand-colored desert animals, and the green-colored denizens of the ever-verdant tropical forests; and, though in both these regions there are numerous exceptional cases, we can almost always see the reason of these, either in the absence of the need of protection, or in the greater importance of conspicuous covering. In the Arctic regions the exceptions are particularly instructive, because in almost every case the reason of them is obvious." The Arctic wolf does not turn white, because he hunts in packs, and concealment is not necessary; the musk-sheep, yak, moose, caribou, and reindeer are able to take care of themselves, and need no protection or concealment. The glutton and sable are dark-colored because they live in trees, and must look like them. The raven, living on carrion, requires no concealment, and continues black. Mr. Wallace is of the opinion that color has very little to do with the absorption or radiation of heat, because those matters are largely determined by the structure and surface-texture of the colored substances.

A Mystery of the Growth of Trees explained.—Mr. John T. Campbell relates in the "American Naturalist" his discovery of one of the causes of the phenomenon of particular tracts of land being covered with a simultaneous, nearly exclusive, growth of trees of a particular species. Some have ascribed the phenomenon to a peculiar fitness of the soil to particular kinds of vegetation, which he does not find to exist. His own explanation is very simple, and is to the effect that the matter lies wholly or mainly in the fact of the ground being in a fit condition to receive the seeds of the various species when they fall upon it. Seeds of different kinds fall at various seasons, and when the ground is in various conditions as to moisture, etc. Those that find the ground in good condition sprout and grow, if no accident occurs to remove the plants when very young. Mr. Campbell has tested this view in his surveys in the occasionally flooded bottom-lands of the Wabash River, and illustrates it by following the futures of the seeds of three species of trees. The balls of the sycamore or button-wood begin falling early in the spring months, and, if a flood is receding at the time, they stick to the soft, moist banks wherever they touch them, and particularly along the highest parts of the sand-bars. Were it not for the subsequent floods in the same spring, no other trees could grow, for these would occupy the ground. But they are easily killed during their infancy by overflows, and this is what happens to most of them. The cottonwood is the next in order of shedding seed, and, if another flood is receding while this is taking place, it will have killed all the sycamores which it has covered, and sprout the cottonwoods. These in turn may be killed by the next flood. It is the turn of the maples next to shed their seed, and try for the ground. If either of these species succeeds in making wood without a flood, it will hold the ground, and its rivals will not be able to get a place. Last spring the edges of the successive plantations escaped the next floods after the seeds fell upon them, and Mr. Campbell could see along the river-banks three belts of young trees, and distinguish them by their general appearance. The upper belt was of sycamore, the second (downward) of cottonwood, and the third of soft maple. In June a bigger flood came than any that caused the seeds to sprout, and killed all the young trees.

Water-Melon Sirup.—In response to the inquiry by Dr. H. Carrington Bolton concerning the manufacture of sugar from water-melons (see June number, page 287), Mr. E. A. Gastman, of Decatur, Illinois, writes as follows: "About 1842 the manufacture of molasses was carried on here in Central Illinois from melons. I do not know how extensive nor how successful it was, but I remember very clearly when a boy on the prairies near Bloomington that our neighbors frequently raised large crops of water-melons, from which they made molasses." It will be observed that the extract from Boyle's work communicated by Dr. Bolton mentions a "sirup," not sugar.

Madness and Crime.—In an address on "Madness and Crime," delivered some months ago, Mr. Clark Bell called attention to a condition of insanity under which crime is sometimes committed which is not recognized by the law and is not often taken notice of by the courts. It is the condition that exists when the man is perfectly aware of the nature of the act he commits, and of the fact that it is prohibited by the law and is punishable, but is at the same time in-incapacitated by mental disease from controlling his own conduct. The most careful discussion of the question has been made by Sir James Stephen, who has proposed as a solution of it the authorizing of juries to bring in a special form of verdict where the existence of such conditions has been proved. It has also doubtless been the element of the case which has often prompted American juries to bring in some of those singular verdicts which have caused remark as contrary to the law and the facts. In Mr. Bell's opinion, "the time has come when legislators must face this question upon its merits. The able and masterly manner in which Sir James discusses it, the decisions in many of the American States recognizing a different test for responsibility, call for a settled law both in England and America, which would be in accord with the principles of justice and commensurate with the civilization of our age. . . . There is no doubt whatever that the uncertainty of verdicts is largely due to the popular conviction of the injustice of the law as it now exists, and as it is frequently construed by the courts. . . . It is a legislative and not a judicial question, and must receive public attention commensurate with its great importance in the administration of criminal jurisprudence."

Sorghum and Beet Sugar in the United States.—Professor H. W. Wiley, chemist of the Department of Agriculture, in his report on "Northern Sugar Industry," gives the amount of sorghum-sugar manufactured at the principal factories in the United States during the season of 1883 at 726,711 pounds. The factories are at Rio Grande, New Jersey; Champaign, Illinois; Sterling, Hutchinson, and Ottawa, Kansas; and the Department of Agriculture. The largest and most successful factory is at Rio Grande, near Cape May, New Jersey, where the soil and climate appear favorable to the production of the crop. A careful calculation leads the author to estimate that the average amount of sugar which can be obtained in marketable form from sorghum is 4·75 per cent by weight of the expressed juice, or 2·37 per cent, or 46·4 pounds per ton, of the cane. Besides this, two other sugars than the crystallizable sucrose are present in the juice, but they are not separable in solid form, and enter into the molasses. This yield is proportionately very large, and, if the production of sorghum-sugar should be carried on with success enough to make it a staple crop, the product of molasses will be greater than ordinary consumption can dispose of. The only other uses to which the molasses can be put will be as food for animals and for distillation; and the latter will be the more money-making. Each gallon of molasses will give a gallon of commercial alcohol. Happily, this kind of alcohol is said to be only fit for use in the arts. Professor Wiley remarks that the fact must be admitted that the present production of sorghum-sugar is not very encouraging after thirty years of endeavor; but nearly all the progress that has been made in it has taken place during the last three years. The outlook is better for the manufacture of beet-sugar, which is pronounced an assured success on the Pacific coast. The five years' experience at the Standard Sugar Refinery, Alvarado, California, is claimed to have proved that beets raised in that State will yield as many tons per acre and are as rich in saccharine matter as any raised in Europe. During the season of 1883–'84 there were produced at this establishment 1,027,826 pounds of white refined sugar, while there were still in tanks at the time of making the report, in process of crystallization, 250,000 pounds more.

Corrupt Legislation.—The causes of the defective and corrupt legislation which appears to be one of the crying complaints of the present time have been reviewed in a short pamphlet by Mr. Simon Sterne, who also makes a general suggestion of a remedy for them. The causes lie in the methods of procedure of our legislative bodies, which are unsystematic, hasty, and unconsidered. The public good is often the thing least thought of. On the other hand, the predominant general motive is the desire of the party in power to keep the other party out; and each member of the body has some "axe to grind," either his own, or the axe of his constituents or of some private or corporate interest. The same was the case in England, till the passage in 1848 of the "standing orders," by which a complete separation was effected in the method of treatment of public and of private and local bills. Public bills are now placed under the wing of the Cabinet. Private and local bills are no longer treated as legislation, strictly speaking, but as petitions to Parliament for special immunity or privileges which are conducted by private parties, and are subject to a strict rule of procedure. They are tried as a lawsuit, in which the petition and bill are filed before the beginning of the session, "and opposed at every step, as a whole and in detail, by the Board of Trade and by every private interest which may be menaced or affected thereby. Counter-petitions, attorneys, counsel, and a trial, a standing and a day in court to all parties in interest before the bill can become a law, prevent wrong to individuals; counsel for the ministry for the public bills, and special counsel for the private bills, committees to aid them in the intelligent discharge of their work, prevent the possibility of working, by collusion, a public wrong." The details of these measures, which we have not space to follow, are carefully adjusted to secure their successful working. The prohibition of special legislation, which has been incorporated into some of our State Constitutions, is regarded by Mr. Sterne as unphilosophical; for there must always be exceptional cases which general legislation can not cover, but for which special provisions are necessary; and it is this need which is recognized in the British system. The prohibition, moreover, defeats itself, for it is evaded, and worse measures are passed for special ends, under the pretense of generality, than could succeed if they were presented in their real character. Mr. Sterne has proposed a detailed plan for a system of legislative procedure, modeled after the British "standing orders," which deserves at least to be thought over.

British Hens and Eggs.—By actual count (for a census has been taken), Great Britain and Ireland contain thirty million head of poultry of all kinds, twenty million of which may be classed under the head of "chickens." The laying hens, which may be estimated to constitute one fourth of the chickens, or five million head, may lay from seventy to two hundred eggs a year. It is safe to average the number at from eighty to one hundred for each hen. This would give four or five hundred million eggs a year. Between a third and a half of the whole stock of poultry are consumed every year. Some of the English cottages derive as much as twenty-two pounds, or a hundred and ten dollars a year, from their fowls, half of which is profit. The poultry are bought up lean by "higglers" or "hagglers," and are fattened for the market by "crammers," who make this their special business. The feeding is performed by machinery, by a rapid process, and the trade is a growing one. The home supply being estimated at eight million chickens a year, and the fowls being valued at two shillings each, we have an annual market value for this stock of £800,000, or $4,000,000. This does not include the turkeys, ducks, and geese, of which eight million are returned in Great Britain and Ireland. If the same proportions of these are brought to market as of chickens, rating them at five shillings a head, we may, by adding the proceeds from them, raise our poultry account to £1,000,000, or $5,000,000. It is impossible to calculate the number of eggs that are consumed in the United Kingdom. If twenty million of the population eat an egg a week, that would be ten hundred and forty millions a year. It is known, however, that during 1883 there were imported nine hundred and forty million four hundred and thirty-six thousand one hundred and sixty eggs, and they were worth £2,732,055, or five times as many dollars; and up to the end of August, 1884, six hundred and eighty-one million six hundred and eighty-three thousand and forty had been received. The home hens are supposed to furnish five hundred million eggs. Adding these to the foreign supply, and valuing the whole at a penny an egg, we have Great Britain's egg bill, £6,250,000, or $31,250,000.

How Yakuts make a Fire.—The process of starting a fire employed by the Yakuts and Tunguses of Northern Siberia is quite elaborate, and is thus described by Commander Mellville in his "The Lena Delta": "To start the fire, a dry piece of wood is procured from the high river-banks, many sticks being cut with the axe and rejected until one entirely free from moisture and fit for kindling is found, which is then carefully split and kept dry. The best of the drift-wood is next selected and also split up and chopped into proper lengths. Thus far, so good: but the natives are ignorant of matches, and with only their flint and steel it would seem a difficult matter to start a fire, since they have no rags, either cotton or flax, or any highly inflammable material like sulphur-sticks. But here is where the Yakut and Tunguse ingenuity asserts itself. The buds of the Arctic willow are forever trying to peep from beneath their thin blanket of snow, and within these buds is a light flossy substance in the nature of thistle-down. Whenever he can, the native gathers a handful of these, and robs them of their down, which he then moistens slightly and mixes with ground charcoal, prepared by cooling a lighted piece of birch-wood in the ashes of his hearth. The dampened floss heavily rolled through the charcoal is next covered up and dried before the fire on the same board whereon it was pounded and the charcoal powdered. It is now an excellent tinder, igniting quickly into a hot and durable point of fire. But, in addition to it, some light match-stuff is necessary, and, to supply this need, a bundle of fine soft sticks, about thirty inches long, is always kept drying over the fireplace. Before the native sets out on a journey, or, indeed, as often as material is required, the old women of the house take down several of these sticks and carefully shape them into sword-blades. They then rest their knives in beveled notches cut in the flat sides of small pieces of wood, about three eighths of an inch broad, one eighth of an inch thick, and one inch and a half long, and the operation proper begins. Along the wooden sword, which is held against the shoulder like a violin, the knife in its gauge is drawn continuously and rapidly, and at each draught a thin coiling shaving drops to the floor or into the lap of the operator. A bag full of these fine curls—which, when matted together, very much resemble the American manufactured material known to upholsterers as 'excelsior'—is always ready for the traveling native, preserved dry in the huts beneath the sleeping-skins, and carried in a fish-skin bag on the journey. So, now, with the materials at hand, we will start a fire. The native takes from his skin pouch a bunch of the 'excelsior' about the size of a robin's nest, rolls it into a ball, punches a hole in it, and then lays it carefully in the snow. Next, taking a pinch of tinder from the bag which always hangs at his hip, he places it on his flint, and with a quick sharp stroke ignites and incloses it in the center of his nest of shavings, which he then lifts up, holding it lightly with his fingers spread apart for the passage of air, and whirls rapidly around his head at arm's length. At first, a faint, pleasing odor of burning birch steals upon the air, then a light streak of smoke follows the revolving arm, and then the heat within his hand notifies the native that a proper degree of ignition has been attained; he suddenly ceases his gyrations, tears open the smoking nest, and with a quick puff blows it into flame. Then depositing the blazing ball on the snow, he soon piles his fagots over and around it, and in few seconds his fire is in full blast."

Religion and Inebriety. — Dr. T. D. Crothers, considering the question whether faith and prayer, or honest intention on the part of the patient, can alone save him from inebriety, expresses his opinion as in the negative, and says: "In a study of ten cases on this point, I found that seven had been, before and after the beginning of inebriety, active church-members, had experienced conversion and led active lives of faith and prayer for longer or shorter intervals, depending on circumstances. Two of these were periodical inebriates, and had, during the free intervals between the attacks, led a most consistent Christian life of faith and prayer. One of the seven exhibited the strange delusion of religious mania when drinking; at all other times he was a quiet skeptic and doubter, but, when once under the influence of alcohol, he was the most ardent religious devotee, exhorting with great enthusiasm, and asking the prayers of every person he met, to save him. His mind seemed troubled with intense fear of failing to get to heaven, and every thought and exertion seemed directed to this end; but secretly he drank constantly, never to be stupid, but just enough to keep up a degree of excitement. This would last two or three weeks, then merge into a low form of nervous fever, from which he would recover and remain sober for an indefinite time. . . . The other three had been good church-members before inebriety came on, but on becoming inebriates left the church." Another case was that of a clergyman whose inebriate fits always began when he was administering the wine at the communion. After quoting a few other cases, pertinent but of not quite so striking a character, Dr. Crothers states his conclusions, which are according to the view he has steadfastly held, that "inebriety is a physical disease which must be reached by both physical and psychical means. All methods of treatment must be along the line of natural laws, and include all means, both physical and spiritual, that can build up and strengthen the entire man. Spiritual means are only valuable as they are used with other means, and where they are effectual alone they are the exception to the rule, and can not indicate any direct line of treatment."

Butcher's-Meat and Headaches. — The prescription of a diet largely vegetarian has long been known to be good for persons subject to attacks of headache. Dr. Alexander Haig relates, in "The Practitioner," a case that came under his treatment which indicates to him that this disease and its attendant phenomena are largely the result of a poison circulating in the blood, which poison is a product of the digestion of certain foods, especially butcher's-meat; and that a cure is best effected by cutting off entirely the noxious food, and aiding the elimination of the poison by the kidneys. The patient was a chronic sufferer from headache, and the afflictions that usually accompany it. He was a hard student, and was most troubled in winter. On the adoption of a strict vegetarian diet, the attacks, which had been severe, ceased at once, and for six months of the cold half of the year there were only one or two slight ones, although they had been recurring weekly. A less strict diet was subsequently allowed, and gave practical immunity, provided butcher's-meat was avoided. It was also found that two or three tumblers of hot water taken every night at bed-time gave increased immunity, and enabled the patient to take even a little butcher's-meat occasionally without fear of an attack. The disease was evidently caused by impure blood, and that by imperfection of the digestive process. The connection with butcher's-meat was indicated directly by the facts in the case. It may be accounted for possibly by reference to Dr. Michael Foster's suggestion that the pancreatic digestion of the proteids in excess is accompanied by the development of bacteria giving rise to fermentative changes; or by the suggestion made in "Le Progrès Médical," that alkaloids are formed in the intestines during digestion similar to those that have been found in the cadaver, and, if they are absorbed in excess, or are not excreted by the kidneys, cause disorders.

Another Side to the Clothes Question.— "An Anthropologist" protests, in the "Pall Mall Gazette," that, if an attempt is made to impose European clothing on the natives of New Guinea, they will all be killed off. It is clothes, he asserts, and not liquor or immorality, that has been fatal to so many natives of tropical countries. The Australians and Tasmanians have been clothed, and exterminated, while the North American Indians have been left in their traditional costumes, and thrive. This matter of the natural garb of savages is one "in which Nature can not be safely tampered with. Whether tribes are found clothed only with a loin-cloth, or only with paint, it is the result of a long evolution, an adaptation to environment, and no foreigners should go among such peoples who can not adapt themselves mentally and morally to customs representing that environment. . . . In the day that these natives of New Guinea begin to clothe themselves beyond what has sufficed for their health, 'they will surely die.' The exact reason for this has not been satisfactorily shown, though I have been told in several places that clothing checks some delicate secretions of the dark skin in warm countries. . . . The germs of European vices are carried too often with European clothes. It is a fact significant of more than female conservatism, to which Mr. Herbert Spencer attributes it, that generally the women of a nude tribe are the last to adopt the fashion of putting on clothes. They are always reluctant, and sometimes show such shame in their first dress as a European would feel without clothing. In many parts of India there is a profound suspicion of the irreligiousness of clothing. The fakir is distressed even by the regulation rag upon which the Government modestly insists, and a fully dressed fakir would be scouted. The late Brahmo minister, Keshub Chunder Sen, expressed the belief that India would never accept a Christ in hat and boots. The missionary should remember that clothes-morality is climatic, and that, if a certain degree of covering of the body has gradually become, in the Northwest, associated with morality and piety, the traditions of tropical countries may have equally connected elaborate dress rather with the sensualities of Solomon in his glory than with the purity of the lily as clothed by Nature."

Persian Carpets.—According to a report by Consul-General Benjamin, of Teheran, the Persian carpets, the manufacture of which constitutes one of the most important features of the industries and commerce of the country, are woven chiefly by the women and children of the peasantry in the villages. A countryman will have a rug made in his own house, and will then take it to the nearest town and sell it for what it will bring. The rooms of the peasantry are small, and hence the rugs are commonly small. Of late years, a larger carpet has been manufactured for the foreign market. Four kinds of carpets are made, large ones and small ones or rugs, the *ghileems*, and the *umads*, or felt carpets. Most of the carpets intended for the covering of floors, of whatever size, are produced in the central province of Irak and in the districts of Sarravend, Garrouste, and Malabir, and are known by the generic name of *pharaghan*. They are more solid and massive than other Persian carpets, and are adapted for rooms of large size. Large Persian carpets, which deviate from the usual shape, are made to order, and for an increased price. There are numerous varieties of Persian rugs. In some classes, such as Turkoman, there is general similarity of design, although no two rugs are altogether identical. In other classes, such as the rugs of Kerwan, Dyochegan, or Kurdistan, there is endless variety in design or texture. The colors formerly used in the rugs of Persia were imperishable, and rugs a hundred years old show no deterioration in tint. The introduction of aniline dyes at one time threatened the ruin of the manufacture of textile fabrics, but the use of those dyes has been forbidden by law. The *ghileem*, which is largely made in the province of Kurdistan, has a pattern identical on both sides, with firm and brilliant colors, and designs often of extraordinary beauty. Their lightness and flexibility qualify them for *portières* and table and sofa covers, and render them easy for transportation. The *namâds*, or felt carpets, are made by forming a frame of the thickness required, or by excavating a space in the ground-floor of a size and depth corresponding with those of the intended fabric. The hair is laid in this and beaten out with mallets, and a design of colored threads is then beaten into the upper surface. Silk rugs are peculiar to Persia, and are rare and expensive, although rugs of the finer types, with silken fringes and sometimes with a woof of silk in the body of the rug, are not uncommon.

Brazilian Oranges.—Oranges flourish and are profitable in all parts of Brazil, and the exportation of them amounts to several millions annually. The Umbigo, the favorite variety at Bahia, is without seeds, large, sweet, and delicious, begins to ripen about May, and lasts till September. The most common and popular kind at Rio Janeiro is the Siletta, which has a sweet and delicate flavor. The Tangerina is a smaller variety than the Siletta, many-seeded and ripening at about the same time, and has a deep orange-colored skin that breaks easily in peeling, with an aromatic odor. The orange-orchards are generally situated on low and sandy land, convenient to transportation by water. The trees are planted along from February to May, about fifteen feet apart, and begin to bear in about five or six years, yielding then from twenty to thirty oranges each, and increasing their crop for ten years till in full bearing, when they produce from two to three hundred, and, in most favorable circumstances, one thousand oranges a year. The trees remain fruitful for more than thirty years. The cost of cultivating and attending a thousand orange-trees in Brazil is estimated at about seventy dollars a year.

Climate and Vegetation.—In a paper on the relations of climate and vegetation, M. M. Bergsman, of Flushing, reaches the conclusion that a mixed climate, with relatively mild winters and warm, sunny summers, is the best suited for the vegetation of the temperate zone. Corn can be cultivated only as a green vegetable in England; is profitable in Western Europe only to 46°, and in the valley of the Rhine to 49°, but in certain regions of North America to 51°, and even under the Polar Circle in Norway, where it has the sun day and night. Plants much resembling those of Central Europe grow in the Amour region of Siberia, where precipitation occurs only in summer, and that season is warm, in the face of a winter temperature much lower than is observed in the most northern parts of Lapland. Radishes, turnips, rape, and the potato grow as far north as there are settlements, but in the extreme north the potatoes are only as large as walnuts, and the plant never blossoms in Greenland. When comparing extreme continental climates with extreme sea climates, the continental climate has the advantage. The extreme southern limit of phanerogamous plants is in the South Shetland Islands, latitude 60° to 63° south, and the last trace of vegetation, in cryptogams, is found on Cockburn Island, 64° south. At the same latitude in Northern Siberia is a forest of very high coniferous trees. The chief reason that corn can not be cultivated in Siberia beyond 62°, at Yakutsk, is on account of the constantly frozen condition of the ground at a short distance beneath the surface. In Europe, even, the climate of the northern parts of the British Isles is not suited for many vegetables and other cultivated plants. It is in Germany where almost all the plants of the temperate zone and those commonly cultivated can be found. Even in that country the summer temperature in general is only a few degrees above that calculated for the latitude. Germany is crossed in July by the isotherm of 68°, and Britain by that of 59°, but the difference in vegetation is not caused by the difference of 9° in mean temperature, but by the difference in the amount of sunshine.

Denudation of the Continents.—Mr. T. Mellard Reade, addressing the Liverpool Geological Society on "The Denudation of the Two Americas," showed that one hundred and fifty million tons of matter in solution are annually poured into the Gulf of Mexico by the Mississippi River. This, it was estimated, would reduce the time for the denudation of one foot of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from six thousand years to four thousand years. Similar calculations were applied to the La Plata, the Amazon, and the St. Lawrence; and Mr. Reade arrived at the result that an average of one hundred tons per square mile per annum is removed from the whole American Continent. This agrees with results he had previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution which, if reduced to rock at two tons to the cubic yard, would equal one cubic mile every six years.

Photographing Colors.—Professor H. W. Vogel has made a report of the final results of his researches on the means of photographing colored objects in their natural shades. Sensitive plates are affected only by the more refrangible rays, so that they present totally unnatural and distorted pictures, as to the shading, of colored objects. Believing that the sensitive collodion is affected only by such colors as are absorbed by it, Professor Vogel's efforts have been directed to making his plates sensitive to less refrangible rays by alloying the silver coating with a substance capable of absorbing those rays. His experiment succeeded with the natural colors, but he could not obtain an effect with the duller artificial colors. He then sought for organic substances possessing a power of absorption more intense and lying nearer to the yellow of the spectrum, and obtained in eosine and in various derivatives coloring substances which hardly possess more than a broad absorption band in the yellow, and with which he obtained the desired result. When these bodies were mixed in due proportions with the dry gelatine plates, the yellow of the colored objects appeared quite clear on the photograph, but the blue was still always brighter. Professor Vogel then inserted a yellow glass between the object and the camera, which partly absorbed the blue rays, leaving the yellow unimpaired, and obtained photographs in which the blue, as well as the green and yellow, and partly even the red, parts of the colored objects presented to the observer's eye the same vivid effects as the original.

The Objects of Bathing.—The object of bathing, says a writer in the "Saturday Review," is fourfold: to produce a certain amount of nervous shock, that should be followed by reaction and an increased circulation of the blood on the surface, resulting in a more rapid change of tissues; to lower the temperature of the body; to cleanse the skin; and to produce pleasurable feelings, and, in connection with swimming, the beneficial effects of one of the best forms of physical exercise. The nervous shock and the reaction from it, following the first contact with the water, are important points, and to obtain them the plunge or the douche is preferable to any other form of bath. To wade up to the middle and stand shivering and fearful of the momentary feeling of discomfort is neither healthy nor pleasant, and timid persons who dare not plunge boldly into the water should be content with the douche-bath. A large garden hose, with a high pressure of water, held at a distance of fifteen or twenty feet from the body, will give an idea of this most delightful curative and bracing agent. Sea-bathing differs from out-door fresh-water bathing in the greater specific gravity of sea-water and its consequent greater buoyancy and more uniform temperature, while the pure air, sunshine, and better sanitary surroundings of sea-side places contribute largely to the results. Mineral baths, as such, have no particular superiority over other baths of the same density and temperature. In addition to the greater healthiness and enjoyableness of out-door bathing, it is probable that the simple exposure of the body to the sun and fresh air is of real benefit, and contributes to the sum total of the good results. Cramps are considered one of the great dangers of bathing, but when they are fatal it is probably the result of syncope or fainting, from failure of the heart's action. A good swimmer in vigorous health would hardly be wholly disabled by a cramp of only a part of his limbs.

Structure of the Edible Birds' Nests.—Mr. Pryer, whose account of his visit to the Gomantin Caves, in North Borneo, has furnished a fund of information respecting the edible birds' nests of the Chinese, has published in a Japan paper an article correcting some misapprehensions that he has found to exist on the subject. That the nests are made from the saliva of the bird he regards as a physical impossibility, for a bird could not secrete in a few days a mass of saliva more than equal, when dried, to the entire bulk of its own body, and then do this nine consecutive times a year. He thinks that some saliva is used by the birds, the algæ being worked up in the bird's mouth in the same manner that mud is worked up by the Japanese swallow. Mr. Pryer at first thought that the black nests owed their color to their being made of the brown outsides of the algæ, while the white nests are made of the inside. This is not correct, for the birds can use only the inside; the black nests are simply white nests grown old and frequently repaired.

How to sleep well.—In sleeping, much depends on securing a comfortable position. Lying on the back would seem to give the most ease, but general experience and practice prove that it does not, and it is liable to some definite objections. In a weakly state of the heart and blood-vessels, and in certain morbid conditions of the brain, the blood seems to gravitate to the back of the head, and to produce troublesome dreams. Persons who have contracted chests, and who have had pleurisy and retain adhesions of the lungs, do not sleep well on the back. Nearly all who are inclined to snore do so in that position. For these and other reasons, it is therefore better to lie on the side, and in lung-disease to lie on the weak side, so as to leave the healthy lung free to expand. It is well to choose the right side, because, when the body is thus placed, the food gravitates more easily out of the stomach into the intestines. Sleeping with the arm thrown over the head is to be deprecated; but this position is often assumed during sleep, because circulation is then free in the extremities and the head and neck, and the muscles in the chest are drawn up and fixed by the shoulders, and thus expansion of the thorax is easy. The chief objections to this position are that it creates a tendency to cramp and cold in the arms, and sometimes seems to cause headaches and dreams. The best sleep is obtained when the shutters are closed so as to make the room dark, and the windows are adjusted so as to admit plenty of fresh air. Early rising is not a virtue, unless the riser has secured sleep enough; and the best rising is obtained when the sleeper wakes naturally.

NOTES.

The works of Darwin, Spencer, Agassiz, Huxley, Adam Smith, and Lewes, are said to be forbidden to be issued from the circulating libraries of Russia. The writings of Moleschott, Büchner, Vogt, and Reclus, are also prohibited.

Doin, of Paris, has begun the publication of a weekly "Journal des Sociétés Scientifiques," which will contain brief reports of the principal scientific societies, in whatever field, of the great cities of Europe. It costs fifteen francs, or three dollars, postage-paid, a year.

M. Alluard has frequently noticed, in passing from his observatory on the Puy de Dôme, to the city of Clermont-Ferrand, that, while the air was clear and transparent to the west of the chain of the Puys, it was obscured on the east. On investigation, he found that the obscurity was caused by the dust which the wind, generally blowing from the west, swept up from the rocks over which it passed. This explanation was confirmed by the fact that the foglike appearance disappeared after a rain.

The use of artificial teeth turns out to be of ancient origin. Two curious specimens of artificial teeth from the Etruscan tombs, dating from four or five centuries before the Christian era, may be seen in the Museum of Corneto, on the coast of Italy. In the bodies of two young girls, on the jaw of one are still to be seen two incisors fixed to their neighbors by small gold rings, while in the other the rings remain, but the artificial teeth have fallen out. The teeth, carefully cut, had evidently been taken from the mouth of some large animal.

Herr Rudolph Jall, of Saarbrücken, Prussia, who has made a special study of volcanic eruptions, states that colliery explosions coincide with or follow closely upon earthquakes. He specifies a number of days during the present season as days which will be dangerous all over Europe.

Mr. Joseph Thomson, in the relation of his journey through the Masai country in Africa to the Victoria Nyanza, speaks of his troop in one of its marches having "done" little short of seventy miles within twenty-four hours, without a drop of water or a bit of food!

A committee has been formed for organizing the celebration of the centenary of the birth of Arago, which will occur on the 17th of March next.

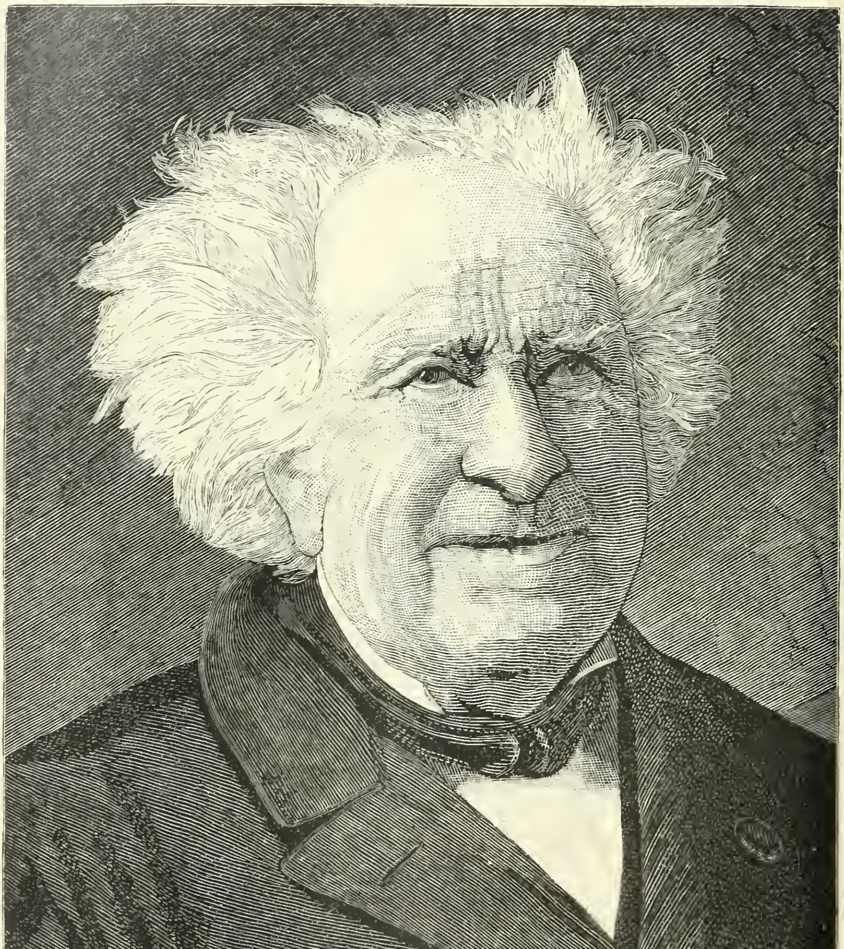
OBITUARY NOTES.

Among the deaths of the last few months in the scientific world is that of John Birmingham, astronomer, of Millbrook, Ireland, at the age of seventy-eight years.

In A. S. Uwarrow, who died a few months ago, Russia has lost one of its foremost archæologists and the founder of the Archæological Society of Moscow. He published works on the archæology of Southern Russia, the tumuli on the Oka (Vladimir), and the Finnish people of the Mesia, who inhabited the country before its colonization by the Russians.

Major F. J. Sidney Parry, one of the oldest members of the Entomological Society of London, died on the 1st day of February.

Titian Ramsay Peale, the last surviving son of Charles Wilson Peale, the portrait painter of Revolutionary times, died in Philadelphia, March 13th, in the eighty-sixth year of his age. He was a naturalist, and had fine collections of moths and butterflies; was one of the founders of the Philosophical Society of Washington; was a member of the United States Exploring Expedition of Commodore Wilkes; and was the only survivor of Colonel Long's Expedition to the Rocky Mountains.



MICHEL EUGÈNE CHEVREUL.

THE

POPULAR SCIENCE MONTHLY.

AUGUST, 1885.

CONCERNING THE SUPPRESSED BOOK.

By E. L. YOUMANS.

IT will be no news to the readers of this monthly that the volume entitled "The Nature and Reality of Religion; a Controversy between Herbert Spencer and Frederic Harrison," published by D. Appleton & Co. last March, has been suppressed by order of Mr. Spencer. This catastrophe was the result of a public correspondence carried on between these gentlemen in the columns of the London "Times." Fragments of the letters were cabled to this country as they appeared, and were widely disseminated by the newspapers, producing some suspense, and giving a confused impression of the affair. At length came the announcement that the disagreeable difference was happily composed; but with it came also a dispatch ordering the destruction of the book—copies, plates, and all—the damage to be charged to Mr. Spencer. This seemed a curious way of bringing an unpleasant difference between two authors to a harmonious termination; but, without waiting for explanations, the mandate was obeyed and the book suppressed. The letters themselves are now before us, and as they have not all been previously published in this country, they are herewith submitted to the reader in full:

THE SPENCER-HARRISON CORRESPONDENCE.

[*London Times, May 29, 1885.*]

A NEW FORM OF LITERARY PIRACY.

Mr. Frederic Harrrison has forwarded to us for publication the inclosed letter which he has addressed to Mr. Herbert Spencer:

"*May* 28, 1885.

"Dear Mr. Spencer: I can not admit that there is anything to justify you in being a party to the American reprint of articles of mine, without my knowledge or consent. I learn accidentally that a volume has appeared in New York, which consists of three recent articles of yours in the *Nineteenth Century*, printed alternately with three recent articles of mine, with an introduction, notes, and appendix. This re-issue of my articles was made without the knowledge of myself, or of the proprietor of the *Nineteenth Century*, and he tells me that it is a case of piracy.

"You now avow (in your letter to me of yesterday) that the volume was issued by your American publishers, and was edited by your friend Professor Youmans, after consultation with you, with your consent and assistance. You also avow that you furnished the editor with controversial comments on my articles, and requested him to append them in his own way—that is to say, you have abetted a clandestine reprint of three articles of mine, interpolated with notes supplied by yourself. I regard this, not only as an act of literary piracy, but as a new and most unworthy form of literary piracy. May I ask if it is proposed to hand you the profits of a book of which I am (in part) the author, or are these to be retained by your American publishers and friend?

"To justify this act you now write that you expected republication in America by my friends. This expectation rests, I can assure you, on a pure invention. No friend of mine, nor any person whatever in America or in England, has ever suggested to me the republication of my articles, nor have I ever heard or thought of such a project. You quote to me, as your authority, a letter from Professor Youmans, who simply says there is danger of its being done by others, and he adds that I am coming to lecture in America. Again, this is a pure invention. I have never thought of lecturing in America, or of going there, nor has any one on either side of the Atlantic suggested to me to do so. Those who 'convey' my writings will as readily invent my intentions. Inquiry would have shown that neither I nor my friends had any intention of reprinting any articles—much less yours. And I fail to see how an unverified report that they might be reprinted, coupled with an unverified report that I was going to lecture in America, could justify you in promoting and assisting in the unauthorized issue and sale of writings of mine.

"This is not a simple case of clandestine reprint. Those of us who do not take elaborate precautions are exposed to have what they write appearing in unauthorized American editions. But it does surprise me that an English writer should connive at this treatment of another English writer, with whom he had been carrying on an honorable discussion. It is, I think, something new, even in American piracy, to re-issue an author's writings behind his back, and sell them interlarded with hostile comment. Reprints, even while they plunder us, spare us the sight of our sentences broken on the same page with such amenities as 'he complacently assumes,' 'loose and misleading statements,' etc. You avow, in your letter of yesterday, that you supplied these comments to my articles; and if internal evidence did not show them to be yours, by your offer to me to republish them now in England, you treat them as yours. I know no instance of such a practice. It is as if I were piratically to reprint your 'Data of Ethics,' freely interspersed with a running commentary on your practice of ethics, and were to justify my act on the ground that I had had a controversy with you, and that I had heard your friends were about to reprint it.

"There is one minor point which serves to show the kind of publication in which you have chosen to take part. My articles in this volume are followed by a cutting from a newspaper account of what the editor calls 'The Little Bethel of the Comtists.' As the volume bears as its subtitle the words, 'A Controversy between Frederic Harrison and Herbert Spencer,' that newspaper paragraph would only be relevant if it referred to practices in which I had some part, or which I approved. It is well known that I have nothing to do with anything of the kind, and never countenanced it. Nothing of the sort has ever been heard in Newton-hall, where for years past I have presented Positivism as I understand it. The matter is a small bit of polemical mischief; those who are engaged in plunder are not likely to be fair. But I think it is quite unworthy of a place in a volume for which you are responsible, and which you have authorized and adopt.

"You now propose to me to republish this volume in England, where you admit it could not appear without the consent of all concerned. After what you have done I must decline to act with you. I leave your conduct to the judgment of men of sense and of honor.

"I am faithfully yours,

"Mr. Herbert Spencer. FREDERIC HARRISON."

[*Times, June 1st.*]

MR. FREDERIC HARRISON'S CHARGE.

To the Editor of the Times.

SIR: Will you oblige me by publishing the following letter, which is a copy of one to Mr. Harrison, referred to by him in his letter contained in *The Times* of Friday:

"38 Queen's Gardens, Bayswater, W., May 27, 1885.

"DEAR SIR: Here are my replies to the questions put in your note of yesterday.

"Just before the middle of January I received from my American friend, Professor Youmans, a letter dated January 2, containing, among others, the following paragraphs:

"'And now we have something of a new embarrassment upon which I must consult you. There is a pretty sharp demand for the publication of your controversy with Harrison in a separate form, and the publishers favor it. The question is not simply whether it is desirable, for we can not control it. There is danger that it will be done by others, and if that should occur it would be construed as a triumph of the Harrison party—the Spencerians having declined to go into it.

"'If I thought no one else would print the correspondence (*i. e.*, the *Nineteenth Century* articles), I should be in favor of our not doing it. In the first place, for general effect, rhetoric against reason counts as about ten to one. The Comtists are reviving—Harrison is coming over to lecture in this country, and much will be made of his brilliant conduct of the controversy. In the next place he has this advantage of you. Your main work bearing upon the issue is to be sought elsewhere, while Harrison had accumulated all the materials of his assault and gives his whole case, so that the popular effect could not fail to be much in his favor. To the narrower circle of readers who can really appreciate the discussion, the republication would undoubtedly be an excellent thing, and I suppose after all it is only these that we should much care for. On the whole it may be politic to reprint. What do you think about it?'

"There was thus raised a quite unexpected problem. I had supposed that the matter had ended with your letter to the *Pall Mall Gazette;* and having expressed (in the *Nineteenth Century*) my intention not to continue the controversy, I hoped it would drop. Here, however, came the prospect of a revival in another shape; and I had to choose between republication by my American friends or republication by your friends, with the implication that I was averse to it. Though I should have preferred passivity, yet, under the circumstances stated, I thought it best to assent to republication. One objection, however, became manifest. While in my replies to you I had pointed out sundry of your many misrepresentations, I passed over others—one reason being that I could not trespass too much on the space of the *Nineteenth Century* and the attention of its readers. Now, however, when it was proposed that the statements contained in your articles should be re-diffused, and take a permanent form instead of a temporary form, I felt that I could not leave unnoticed these other misrepresentations. Appearing in a volume issued by my American publishers, and edited by my American friend, the implication would have been that statements made by you to which no objection was raised were correct statements. If words in quotation marks tacitly ascribed by you to me had not been disowned by me (p. 112), it would, of course, have been assumed that I had used them, and that I stood convicted of the absurdity which you allege on the assumption that I had used them. If it had not been shown that an opinion you debit me with (p. 129) is wholly at variance with opinions which I have expressed in three different places, it would naturally have been concluded that I held the opinion. Hence it was clear that unless I was to authorize the stereotyping of these and other errors I must take measures to dissipate them. I therefore pointed out to Professor Youmans the statements which required notice, indicated the needful rectifications, and requested him to append these rectifications in his own way. At the same time I forwarded him a copy of the letter which you published in the *Pall Mall Gazette*, saying that 'if this reprint of the articles is published without this letter, he (you) will inevitably say that his final reply has been omitted. It is needful, therefore, that it should be included.' And along with your letter I sent indications of the points in it which should be noticed.

"Do you think I was not justified in this course? Do you think I ought to have withheld my consent to the republication by my friends, leaving your friends to republish? Do you think that, having assented to republication, I ought to have let pass without correction your misstatements previously uncorrected? If you think either of these things, I imagine that few will agree with you. There is, however, an easy way of bringing the question to issue. All the articles are copyright in England, and can not be republished here without the consent of all concerned. I do not suppose that Mr. Knowles will raise any difficulty; and if you agree to the re-issue of them here, I am quite willing that they should be re-issued. If you think that anything said in refutation of your statements should not have been said, we can easily include an appendix in which you can point out this; and then, if you wish it, copies of the volume can be sent round to the press.

"Of course I preserve a copy of this letter with a view to possible future use.

"Faithfully yours, "HERBERT SPENCER.

"Frederic Harrison, Esq."

I will add but two comments. Mr. Harrison had this letter before him when he wrote his statement. Does the reader find that his statement produced an impression anything like that which my letter produces? The other comment is this. Asking whether I have any share in the profits, Mr. Harrison not only by this, but by his title, "A New Form of Literary Piracy," tacitly suggests that

I have. Merely stating that the affair is purely the affair of the Messrs. Appleton, and that not even a thought about money ever entered my head concerning it, I draw attention to the readiness with which Mr. Harrison, without a particle of evidence, makes grave insinuations. And I do this because it will enable the reader to judge what need there probably was for taking the measures I did to prevent the wider and more permanent diffusion of Mr. Harrison's misrepresentations.

Concerning the newspaper extract describing a Comtist service I know nothing, and greatly regret that it was appended. I will at once ask to have it withdrawn. If three gentlemen, appointed in the usual way, decide that under the circumstances, as stated to me by Professor Youmans, I was not justified in the course I took, I will, if Mr. Harrison wishes it, request Messrs. Appleton to suppress the book and destroy the stereotype plates, and I will make good their loss to them.

I am, faithfully yours, HERBERT SPENCER.

May 29.

[*Times, June 2d.*]

MR. SPENCER AND MR. HARRISON.

To the Editor of the Times.

Sir: I will not pursue this matter further, nor will I insist on Mr. Spencer's fair offer to submit it to arbitration. It satisfies me if he will not claim any absolute and moral right to copyright in America my writings with rectifications of his own. I am accustomed to unauthorized reprints of what I write; and as I hear there is a brisk sale for these essays (*quorum pars minima fui*) I will only congratulate the Yankee editor on his 'cuteness. As Mr. Spencer, by his offer, now admits it to be possible that he made a mistake, I am ready to regard his share of it as an inadvertence. I know too well his great generosity in money matters to suppose that any question of profit crossed his mind. But it certainly crossed some one's mind; and I referred to it only to convince him that eager partisans had led him into a mistake. It is not easy at any time to get him to see this, and to open his eyes I used for once plain words. Conscious that I had conducted a philosophical debate with an old friend with all the deference and admiration that I really feel for his genius, it did pain me to find myself treated as the proverbial dog whom any stick is good enough to beat. The only arbitration I now desire is that of some common friend who may convince him that I wish nothing more than a return to the position of philosophic friends who agree to differ about their respective systems.

I am, &c.,

June 1. FREDERIC HARRISON.

[*Times, June 3d.*]

MR. SPENCER AND MR. HARRISON.

To the Editor of the Times.

Sir: Rather than have any further question with Mr. Harrison, and rather than have it supposed that I intentionally ignored his copyright claim, I have telegraphed to Messrs. Appleton to stop the sale, destroy the stock and plates, and debit me with their loss.

I am, faithfully yours,

Clovelly, June 2. HERBERT SPENCER.

[*Times, June 4th*]

MR. SPENCER AND MR. HARRISON.

To the Editor of the Times.

SIR: Allow me to supplement my letter telegraphed yesterday, partly to explain how the thing arose, and partly to correct an impression made by your leader of to-day. I was wrong in assenting to the re-publication by Messrs. Appleton. I ought to have borne passively the threatened evils of re-publication by other publishers, and, as my friend has been connected with publishing in New York for thirty years, I supposed his impression that these were coming was correct. But my decision was made in a hurry, without due thought. Believing there was no time to lose, I telegraphed reply, and by the next post indicated corrections to be made in the statements of my views. And here I wish to point out that the notes I indicated were not criticism of Mr. Harrison's opinions, but corrected versions of my own. Any others, if there are any, are Professor Youmans's. I go on to explain that my mind was so engrossed with the due presentation of the controversy that the question of copyright never occurred to me; and the thought that Mr. Harrison might not like his articles republished was excluded by the impression given me that others would republish them if the Appletons did not. Hence my error. But my error does not, I think, excuse Mr. Harrison's insult. By cancelling the rest of the edition and the plates I have done all that remains possible to rectify the effects of my mistake.

I am, faithfully yours,

Ilfracombe, June 3. HERBERT SPENCER.

[*Times, June 6th.*]

MR. HARRISON AND MR. SPENCER.

To the Editor of the Times.

SIR: May I once more trespass on your space by asking you to publish the following letter from Mr. Harrison?

I am, faithfully yours, HERBERT SPENCER.

"38, Westbourne-terrace, W., June 4, 1885.

DEAR MR. SPENCER: As you still appear to think (in spite of my public disclaimer) that I have brought against you a charge of desiring money profit out of this American reprint, I beg to say that I did not intend to make any such charge, and I do not believe that I have. I regret the use of any words which produced that impression on you.

"I am, yours faithfully, FREDERIC HARRISON.

"P. S.—You can use this letter as you think fit.

"Herbert Spencer, Esq."

[*Standard, June 10th.*]

MR. SPENCER AND MR. HARRISON.

To the Editor of the Standard.

SIR: The fact that the information to which it refers came through *The Standard* must be my excuse for asking you to publish the following letter, a copy of which I have inclosed to Mr. Harrison, requesting him to post it after reading it.

I am, Sir, your obedient servant,

HERBERT SPENCER.

"38, Queen's-gardens, Bayswater, London, W., June 9.

"My dear Youmans: I returned home last night, and only this morning learned that in *The Standard* of Saturday last there was, in a telegram from New York, a statement to the effect that Messrs. Appleton decline to destroy the stock and plates of the reprinted controversy (as I had telegraphed them to do), on the score that the book would be reprinted by some other publisher. In this expectation they are probably right. But a reprint would necessarily be without the notes; since these, as implied in your preface, are your copyright in America. Now, though these notes—or, at least, those which I pointed out as needful—are corrections of erroneous statements of my views, yet, rather than have it supposed that I wished to take any advantage of Mr. Harrison in making such corrections, I will submit to the evil of re-issue by another publisher without them; and I therefore repeat my request that the stock and stereo plates may be destroyed, and the loss debited to me.

"One word respecting the proposal of the Appletons to share the author's profits between Mr. Harrison and myself. If any have at present accrued, or if, in consequence of refusal to do as I have above requested, any should hereafter accrue, then I wish to say that having been, and being now, absolutely indifferent to profit in the matter, I shall decline to accept any portion of the returns.

"Ever sincerely yours,

"Herbert Spencer."

Several points in this correspondence, especially in its opening letter, require some notice in this place; but, before making the critical corrections that seem to be required, I desire to say a few words on the peculiar circumstances of American publication which have an important bearing on the present case.

Mr. Frederic Harrison took offense at the American reprint in a book of some review articles of his, and pronounces it "a case of piracy." The organs of English opinion, in commenting upon these letters, take the same view. The London "Times," after referring to the graceful and honorable termination of the disagreeable difference between Mr. Harrison and Mr. Spencer, devotes a leading editorial to the discussion of American piracy on the basis of the fresh and striking illustration of it here afforded. Speaking of the effect of the "tolerably rigid copyright law" of England, the "Times" says: "But so far as America is concerned it is different. To the English author that country seems to answer very much to Hobbes's idea of a state of nature. Foreign authors are fair prey; for them there is or need be no selling or buying of copyrights, and a good book is to be dealt with as a part of the common elements of nature. If any laws govern the matter, it is only those which regulate the capture and reduction into possession of wild animals." The case is certainly bad enough, but this is an exaggeration.

At the outset I admit that on the question of international copyright, or the claims of foreign authors to property in their books, the English are right and the Americans wrong, so flagrantly wrong as to justify much of the denunciation we receive. The position of our Government upon the subject I regard as wholly indefensible. Its policy is an outrage upon a class of men who are public benefactors, a disgrace to the country, and a scandal to civilization. Grover Cleveland's republic does not recognize that Frederic Harrison and Herbert Spencer have any right of property in the products of their brain-work. Their productions when brought to the United States belong neither to them nor to anybody else. They are not protected by law, and may be appropriated by anybody without violation of law. There are many in this country who realize the vice of this policy quite as vividly as the foreign victims of it, and who are laboring hard to put an end to it. But, without offering a word of apology for it, there is still something to be said in behalf of those who are compelled to act under a bad state of things which they reprobate, but are for the time powerless to remedy. It is certainly unjust to involve these in the indiscriminate condemnation of the vicious system. It is a good deal easier to denounce it at a distance than to fight it on the spot. Nor is it possible for authors, living under a government which so stringently protects them that they acquire the habit of regarding literary property as something peculiarly sacred, to fully appreciate the difficulties of publication and the course which business must take under entirely opposite circumstances, where literary property is without any legal protection. With no international copyright it is certainly impossible to act as if we had one. That the Government does not protect him, and that if protected at all it must be done by himself, is the first and vital fact that has to be taken into account when any publisher makes the venture of reissuing a foreign book in this country. The Government is, in fact, his enemy, and virtually calls upon everybody to make war upon him. However disposed he may be to treat a foreign author well, to bring out his work in respectable shape, and pay him for it fairly, he meets this ugly circumstance at the threshold of the transaction, that the money he puts into it may be sunk because anybody can reprint the work in cheaper form and without paying the author anything. Nor is this all: the more honorable he is, the worse it is for him. Any sense of liberality he may indulge works directly against him. If he publishes the book in good form, pays a decent royalty, and makes it properly known by advertising, all this is a temptation to other parties to take advantage of his outlay, and the reputation the book acquires by means of it, to fill the market with mean editions that kill the honest publication. The American publisher is therefore compelled to adopt a policy very different from that in England, where books are vigilantly and effectively protected by law. He has to conform to the necessities of a lawless state of things, and must be left to make the best he can of it.

But the indiscriminate charges of the London "Times" are not true; all American publishers are not freebooters and pirates. Although it is not possible for them to treat foreign authors with full justice in the absence of international copyright, yet it is false that these authors are preyed upon in the unqualified way asserted by the "Times." There are, of course, American publishers, and plenty of them, who are thoroughly unscrupulous; but there are others, and they are not a few, who do the best they can under the present demoralizing system to compensate foreign authors for their work. They pay them by voluntary arrangement, not the rates that they are accustomed to at home, and not always perhaps as much as they might, but often, as I happen to know, to their own loss, when books are reprinted by others and the market supplied by degraded editions on which the author receives nothing. In the absence of an international copyright law, this voluntary action of American publishers is the only thing practicable or possible to mitigate the barbarism of the situation. Imperfect as it may be, it is an honest procedure in behalf of the foreign author; and it is now practiced to an extent that should materially qualify those wholesale charges of piracy. The present case is to be regarded in the light of these considerations; and I think it will be found that the lesson to be drawn from it is quite different from that which has been drawn by the English press.

So far as the above correspondence is concerned, the motives that impelled me to take the share I had in bringing out the suppressed book are to be gathered only from a scrap in a hurried private letter to Mr. Spencer; but, as my act is now branded as piratical, I must be excused for stating more fully the reasons by which I was actually influenced in the course taken.

Mr. Harrison had an important controversy with Herbert Spencer on a grave subject, which was published in the "Nineteenth Century." In printing their papers I have the right to assume their purpose to be that they should be read as widely as possible. There was much interest in this country to follow this discussion, and we accordingly printed the articles in "The Popular Science Monthly."

But, when the controversy was finished, there was a call for its republication in a separate form, more convenient, accessible, and cheaper than in the pages of a magazine. The demand was reasonable, and I was anxious to comply with it, that the discussion might be disseminated as widely as possible. I, moreover, desired the republication for the same reason that I had urged Mr. Spencer to go on with the controversy with Mr. Harrison. Although knowing the low state of his working-power, and how important it was that he should not be interrupted by such side-issues in the prosecution of the great philosophical work upon which he has been engaged for many years, it seemed to me of greater importance that he should seize the opportunity offered by Mr. Harrison's attack to develop more fully his fundamental religious opinions. He had published but little upon that subject for a long time, his views had been much controverted and much misunderstood, and I knew there was a strong desire on the part of many to read everything he might say in further interpretation and elucidation of them. His distinctive doctrines were now vigorously and formally attacked by a sagacious adversary, long prepared by his special studies to put them to the severest test. For the same reason that I encouraged Mr. Spencer to give time to the discussion, I desired that his readers in this country should be put in ready possession of it when done. I may add that in this I was impelled by the same general motives that had prompted me for many years to do what I could to bring Mr. Spencer's ideas before the American people.

But there were special reasons which made me wish that the publication should be issued by D. Appleton & Co. This house had printed all of Spencer's works; and as a present statement of his religious views would be an important addition to them, and would naturally be called for in connection with them, it seemed important that his controversy with Harrison should be brought out in a reputable and permanent shape to take its place with his other books. Besides, there was a high degree of certainty that the discussion would be published by somebody. The names of the eminent contestants, and the interest felt by a large number of people in the subject, were evinced by a strong demand for the publication. The discussion in its separate form was called for by the friends of Mr. Harrison and by the friends of Mr. Spencer, and by others who were friends of neither. It was open to anybody to print it, and there was every probability that it would be picked up and issued in a cheap, catchpenny edition, which is now so common with publications of every kind. I desired, therefore, that the Appletons should bring it out in a respectable shape, and at a moderate price, that the book might be had at any time in a form suitable for preservation.

I protest that these considerations were not vitiated by any covetous desire or purpose whatever. Mr. Harrison says it is a case of "piracy"; but, so far as this involves the taking of his property without compensation, there was no thought of it. In his opening letter he virtually accused Mr. Spencer of collusion in the piracy of his articles, from a sordid intention. Judged by this extraordinary letter, Mr. Harrison's religion of humanity consists chiefly in imputing vile motives to his fellow-men. He said, "May I ask if it is proposed to hand you the profits of a book of which I am (in part) the author, or are these to be retained by your American publishers and friend?" Evidently the pecuniary consideration was uppermost in his own mind. But he had here gone too far. Everybody recognized the outrage. The reader will note the striking difference in tone, amounting to a collapse, between his first and his second letters. He withdrew the offensive insinuation so far as Mr. Spencer was concerned, saying, "I know too well his great generosity in money matters to suppose that any question of profit crossed his mind." But he knew this no better when he wrote his second letter than when he wrote the first. He sent Mr. Spencer a private note asking explanations about the book, and this Mr. Spencer answered, but said nothing respecting the copyright; this did not enter his mind, probably for the reason that the house which issued it had published his books for twenty-five years, paying him regularly on all of them from the first, and he had no care about it, knowing that the equitable thing would of course be done to all concerned. But the inadvertence gave Harrison his opportunity.

But while Mr. Harrison exonerates Mr. Spencer from all thought of making profit out of him, he adds, "But it certainly crossed some one's mind," referring of course to Mr. Spencer's "American publishers and friend." Yet there was not the slightest wish or design on the part of the publishers of the book to withhold from Mr. Harrison his proper share in its copyright proceeds. They have published the scientific and philosophical works of many English authors, on which they have paid the customary compensation allowed to American authors, and if Mr. Harrison doubts it he can satisfy himself by inquiring of his neighbors, Tyndall, Lecky, Huxley, Bain, Sully, or the Darwins, and there is surely no reason why they should not have compensated Mr. Harrison in the same way; and this was certainly their intention.

But perhaps the party who desired to plunder Mr. Harrison (he uses the significant word twice in his first letter) was Mr. Spencer's American friend, and that he supposed this "friend" capable of sharp practice is inferable from his remark, "I will only congratulate the Yankee editor on his 'cuteness." Yet the 'cute Yankee editor in this case was the only party to get nothing. Among the several stools occupied by authors and publishers, it was his fate to sit on the ground. Neither by stipulation nor expectation was he to have a cent for his labor in editing the volume, or his efforts in promoting its circulation. The reasons which actuated him have been already stated. But as the question is here raised of venal motives in the treatment of foreign authors, and as this transaction has been extensively paraded as a flagitious example of American piracy, the editor of the suppressed book is entitled to say that he has done his full share in a practical way toward promoting international equity in the payment of authors for their books. He gave nearly a year's labor to the organization of the "International Scientific Series" for the avowed purpose of securing more satisfactory compensation to scientific writers. The project was based upon the condition of the payment of copyright to each of the contributors from all the countries in which the books were issued. Nothing of the kind had ever been done or attempted before; and, in regard to its result, Dr. John W. Draper remarked, "Although there are international copyright regulations in Europe, and my various works have been translated into many foreign languages, I have never received anything from them except upon the volume I wrote for the 'International Series,' and on that I have been paid regularly by the English, French, German, and Italian, as well as by the American publishers." Fifty volumes have now appeared in that series, and the American publishers have voluntarily paid all the foreign contributors the same as if they had been citizens of the United States. And this they have done in spite of the fact that this honorable arrangement has been disregarded, and various of the volumes have been reprinted in shabby twenty-cent editions, on which, of course, the authors have received nothing.

This, then, is the way in which Mr. Harrison has been outraged. He had his articles brought out in good shape for such of his friends as desired to possess them in a separate form. He has been "plundered" by being protected against plunder on the part of those who might have issued a trivial and fugitive edition of his controversy, and allowed him nothing for it. He has been "pirated" by having voluntarily secured for him the substantial benefits of an international copyright law.

But Mr. Harrison's articles were used without his consent, and that is what the charge of "piracy" here amounts to. His consent was not asked, because it would have implied control of that over which he had no control. If he had refused, that would not have stopped the publication, but would have simply defeated the purposes of those who knew better than Mr. Harrison did what required to be done. He was not consulted for the simple reason, now obvious enough, that he would be unlikely to make allowance for a state of things utterly different from that to which he has been accustomed. He was not asked, because, while his assent would have done no good, his dissent would have done injury to himself, to Mr. Spencer, and to the public. And that Mr. Harrison would have withheld his consent is far from improbable. That the book was wanted here by many readers was nothing to him, as is shown by the fact that, when a word would have saved it from destruction, he declined to utter it. Something is of course due to courtesy, but I was not at all certain that courtesy would be met in the same spirit. The feeling of high-toned British authors toward American "pirates" is not usually vented in gracious expression. American experience with such authors is apt to engender diffidence in approaching them. Those gentlemanly and honorable publishers, the Messrs. Putnam, having special reasons recently to make overtures to Mr. Ruskin for the use of one of his articles (to be paid for, of course), were deterred from doing so because that author "absolutely declined to come into any relation with an American publisher." Mr. Harrison is understood to be a particular and punctilious man, and that he can, upon occasion, pretermit the requirements of amiable civility, and take to "plain words," is amply attested by his letter of May 29th to Herbert Spencer.

But, in the matter of "piracy," it is Mr. Spencer who comes in for Harrison's hottest indignation. He accuses him of having invented a new form of it, and aggravated the offense by its clandestine perpetration. Now, let us see what it was that Spencer did. After finishing the controversy in the "Nineteenth Century," Mr. Harrison transferred it to the "Pall Mall Gazette," in which he printed an additional article, addressed to a new audience, and filled with very objectionable misstatements. It would not do, in editing the volume which was intended to be a full presentation of the discussion, to leave this article out. But to print it without corrections would be unjust to Spencer, and to the readers of the book, who wanted and were entitled to the completest statement of the case. There was no call for anything more from Mr. Harrison, who had had his last word, and declared that he should pursue the controversy no further; but there *was* a need that corrections by Spencer should be supplied. He accordingly sent me the substance of some additions to be appended as notes, and which I inserted in their appropriate places. I deny the wrongfulness of this act, and the ado that has been made over it seems to me perfectly absurd. Mr. Spencer did what it was desirable and entirely proper that he should do. He had not only the right but it was his duty to defend himself against the erroneous representations of Mr. Harrison; and I insist that, if any apology was due either way, it was from Mr. Harrison to Spencer for making the misstatements, rather than from Spencer to Harrison for correcting them.

Mr. Spencer, as will be seen, prints two paragraphs from a private letter of mine giving reasons which induced him to favor the American reprint, and Mr. Harrison characterizes them as chiefly "inventions." I had said, "Harrison is coming over to lecture in this country," and Mr. Harrison says he never thought of it. I wrote carelessly; but my meaning was, that he is *expected* to come, and in this there was no "invention." It had been talked about, and there was nothing unlikely in it. The coming of eminent Englishmen to this country to lecture is certainly no unusual thing. Mr. Harrison is a lecturer, a man of ideas which he is interested in propagating, and is reputed to have means and leisure. He has many admirers in the United States, and a reputation which would be certain to secure him good audiences. As it turns out, "the wish was father to the thought," but the rumor was not improbable. I should have referred to it as a contingency, and I simply meant that it might be worth taking into account, with reference to the publication of the controversy.

Mr. Harrison says the idea that there was any danger of republication in this country by his friends rested also upon pure "invention." But I did not say this. I wrote to Spencer, "There is danger that it will be done by others, and if that should occur it would be construed as a triumph of the Harrison party." Mr. Spencer's interpretation of it was, "I had to choose between republication by my American friends or republication by your friends, with the implication that I was averse to it." And Mr. Spencer was here substantially right. Although there may have been no apprehension that Mr. Harrison's avowed friends would move in reprinting the book, yet, if it had been done by anybody but the Appletons, the inevitable inference would have been that their author had been so badly handled that they declined to back him. The book was looked for from Mr. Spencer's publishers, they had printed it in their magazine, they issued all his works, there was a demand for the volume which was certain to make it a safe business venture, and it represented two sides or schools of thought: if, under all these circumstances, D. Appleton & Co. had left the work for others to publish, the certain construction would have been that the book was abandoned to the party opposed to Mr. Spencer. This is the aspect of the case which he had to meet, and it is not at all affected by Mr. Harrison's statement that his friends had no idea of printing the controversy.

Another explanation seems here called for. Those who will refer to the second paragraph of my letter, quoted by Mr. Spencer, will observe both an indecision and a confusion in the statement. This was due, not only to hasty writing, but to some perplexity in my own mind. I said, "If I thought no one else would print the correspondence" (controversy), "I should be in favor of our not doing it"; and I then go on to give reasons for this conclusion, ending with the remark, "On the whole, it may be politic to reprint." Apparently this indifference to publication is inconsistent with the various reasons I have given for strongly desiring it. But there was a consideration not mentioned in the letter which weighed much with me at the time. I was in very bad health, and was urged by physicians and friends to go South without delay. It seemed therefore to be impracticable, if not impossible, for me to give that attention to the editing and publication of the volume which were prompted by my interest in it. But it will be noticed that, under this conflict of inclinations, though I gave some trivial reasons for non-publication, the conclusion favors reprinting. This shows the predominant feeling, even in a time of depression; and I must say, as a matter of fact that, though referring the matter as I did in a hurried note to Mr. Spencer, I had not for a moment really relinquished the purpose of bringing out the book. This explanation is necessary, that the responsibility may rest where it properly belongs. Mr. Harrison lays stress upon Spencer's agency in "promoting and assisting" in the production of "a volume for which you are responsible, and which you have authorized and adopt." But though Mr. Spencer chose to take the responsibility because he had assented to it, and furnished some notes for it, yet it was neither by his suggestion, procurement, nor desire that the book was issued; and truth requires me here to say that, if he had discouraged or even opposed it, the book would probably have been reprinted by D. Appleton &

Co. all the same. Mr. Spencer had, in reality, very little to do with the edition. For the Introduction, the bad taste with which the notes were embellished, and the newspaper quotation describing the doings in a branch of the positivist church in London which Mr. Harrison does not like, he is not to be held to account.

For his offense in correcting some injurious misrepresentations in a controversial volume published for the use of a people three thousand miles away, the London "Times" declares that Mr. Spencer has made the *amende honorable* by destroying the book; and this is the general English view. The equally general American view is, that this extreme proceeding was ridiculous, that it benefited nobody, and gratuitously deprived many readers in this country of a valuable work on an important subject. It is, at any rate, desirable that the responsibility for this result should be fixed where it justly belongs. Mr. Spencer made two proposals to Harrison looking to the preservation of the work, both of which were absolutely fair, but neither of which was accepted. Mr. Spencer would have been justified in making a stand upon either of these propositions, and refusing further concessions; but Mr. Harrison's rejection of his overtures left the matter in so unsatisfactory a shape that nothing remained for Mr. Spencer but to cut the knot by ordering the book suppressed.

GENIUS AND INSANITY.

By JAMES SULLY.

THE problems which have so long perplexed the thoughtful mind in presence of that dark yet fascinating mystery, the nature and origin of genius, have recently propounded themselves with new stress and insistence. Whatever may be said against Mr. Froude's neglect of the pruning-knife in publishing Carlyle's "Journals and Letters," the psychologist at least will be grateful to him for what is certainly an unusually full and direct presentment of the temperament and life of genius. Here we may study the strange lineaments which stamp a family likeness on the selected few in whose souls has burned the genuine fire of inspiration. These memoirs disclose with a startling distinctness the pathetic as well as the heroic side of the great man. In Carlyle we see the human spirit in its supreme strength jarred and put out of tune by the suffering incident to preternaturally keen sensibilities and an unalterably gloomy temperament.

In this strange record, too, we find ourselves once more face to face with what is perhaps the most fascinating of the fascinating problems surrounding the subject of intellectual greatness, that of its relation to mental health. Carlyle compels the attentive reader to propound to himself anew the long-standing puzzle, "Is genius something wholly normal and sane?" For there is surely a suggestion of temporary mental unsoundness in the idea of that lonely wanderer through the crowded streets of London suddenly seeing in the figures he met so many specters, and feeling himself to be but another "ghastly phantom haunted by demons." And, if all anger is a sort of madness, it is but natural that one should see something of a momentary mania in those terrible outbursts of a spirit of revolt against all things which now and again made desolate the Chelsea home, and wrung from the sage's wife the humiliating confession that she felt as if she were "keeper in a madhouse."

The idea that there is an affinity between genius and mental disease seems at first foreign to our modern habits of thought. In the one, we have human intellect rejoicing in Titanic strength; in the other, that same intellect disordered and pitiably enfeebled. Yet, as has been hinted, the belief in the connection of the two is an old and persistent one. In truth, the common opinion has always gravitated toward this belief. A word or two may make this clear.

To the multitude of men genius wears a double aspect. Superlative intellectual endowment is plainly something very unlike the ordinary type of intelligence. The relation of lofty superiority includes that of distance, and mediocrity in viewing the advent of some new spiritual star may adopt either the one or the other *manière de voir*. Which aspect it will select for special contemplation depends on circumstances. In general it may be said that, since the recognition of greatness presupposes a power of comprehension not always granted to mediocrity, the fact of distance is more likely to impress than the fact of altitude. It is only when supreme wisdom has justified itself, as in the predictions of the true prophet, that its essential rightness is seen by the crowd. Otherwise the great man has had to look for recognition mainly from his peers and the slightly more numerous company of those whose heads rise above the mists of contemporary prejudice.

It is easy to see that this vulgar way of envisaging genius as marked divergence from common-sense views of things may lead on to a condemnation of it as a thing unnatural and misshapen. For, evidently, such divergence bears a superficial likeness to eccentricity. Indeed, as has been well said, the original teacher has this much in common with the man mentally deranged, that he "is in a minority of one"; and, when pains are not taken to note the direction of the divergence, originality may readily be confounded with the most stupid singularity; and, further, a cursory glance at the constitution of genius will suffice to show that the originator of new and startling ideas is very apt to shock the sense of common men by eccentricities in his manner of life. A man whose soul is being consumed by the desire to discover some new truth, or to give shape to some new artistic idea, is exceedingly liable to fall below the exactions of conventional society in the matter of toilet and other small businesses of life. Among the many humorously pathetic incidents in the records of great men, there is perhaps none more touching than the futile attempt of Beethoven to dress himself with scrupulous conformity to the Viennese pattern of his day.

In contradistinction to this disparaging view, the admiring contemplation of the great man as towering above minds of ordinary stature seems directly opposed to any approximation of the ideas of genius and mental disorder. And this has undoubtedly been in the main the tendency of the more intelligent kind of reverence. At the same time, by a strange, eddy-like movement in the current of human thought, the very feeling for the marvelousness of genius has given birth to a theory of its nature which in another way has associated it with mental aberration. I refer to the ancient doctrine of inspiration as developed more particularly in Greece.

It may be worth while to review for a moment the general course of thought on this dark subject.

In the classic world, preternatural intellectual endowments were, on the whole, greeted with admiration. In Greece more particularly, the fine æsthetic sense for what is noble, and the quenchless thirst for new ideas, led to a revering appreciation of great original powers.* The whole manner of viewing such gifts was charged with supernaturalism. As the very words employed clearly indicate, such fine native endowment was attributed to the superior quality of the protective spirit (*δαίμων*, genius) which attended each individual from his birth. We see this supernaturalism still more plainly in the Greek notion of the process of intellectual generation. The profound mystery of the process, hardly less deep than that of physical generation, led to the grand supposition of a direct action of the Deity on the productive mind. To the Greeks the conception of new artistic ideas implied a possession (*κατοχή*) of the individual spirit by the god.

Now, it might naturally occur to one that such an inundation of the narrow confines of the human mind by the divine fullness would produce a violent disturbance of its customary processes. It was a shock which agitated the whole being to its foundation, exciting it to a pitch of frenzy or mania. The poet was conceived of as infuriated or driven mad by the god; and a somewhat analogous effect of divine intoxication was recognized by Plato as constituting the essence of philosophic intuition.† Hence Greek and Roman literature abounds with statements and expressions which tend to assimilate the man of genius to a madman. The "furor poeticus" of Cicero and the "amabilis insania" of Horace answer to the *θεῖα μανία* of Plato. And to

* Socrates is perhaps only an apparent exception, for the odium he excited seems to have been due to the essentially critical and destructive character of his mission.

† See the memorable passage in the "Phædrus," p. 244 A, etc. Plato went so far as to suggest that the name *μάντις*, seer, was derived from *μαίνομαι*, to rage or be mad.

the more scientific mind of Aristotle it appeared certain (according to Seneca) that there was no great intellect (*magnum ingenium*) without some mixture of madness (*dementiæ*).

It must be remembered, however, that in the eyes of the ancients genius was hardly degraded by this companionship with madness. Men had not yet begun to look on insanity as one of the most pitiable of maladies. So far from this, it was a common idea that the insane were themselves inspired by the action of deity. We have a striking illustration of the absence even among the educated Greeks of the modern feeling toward madness in the fact that Plato was able to argue, with no discoverable trace of his playful irony, that certain sorts of madness are to be esteemed a good rather than an evil.*

The influence of Christianity and of the Church served at first to brand mental derangement with the mark of degradation. The doctrine of possession now assumed a distinctly repellent form by the introduction of the Oriental idea of an evil spirit taking captive the human frame and using it as an instrument of its foul purposes. The full development of this idea of demoniacal possession in the middle ages led, as we know, to many cruelties. And, though Christianity showed its humane side in making provision for the insane by asylums, the treatment of mental disease during this period was, on the whole, marked by much harshness.†

This debasement of the idea of madness had, however, no appreciable effect in dissolving the companionship of the two ideas in popular thought. For the attitude of the Church was, for the most part, hostile to new ideas, and so to men of original power. In sooth, we know that they were again and again branded as heretics, and as wicked men possessed by the devil. And thus genius was attached to insanity by a new bond of kinship.

The transition to the modern period introduces us to a new conception both of genius and of insanity. The impulse of inquisitiveness, the delight in new ideas, aided by the historical spirit with its deep sense of indebtedness to the past, have led the later world to extol intellectual greatness. We have learned to see in it the highest product of Nature's organic energy, the last and greatest miracle of evolution. On the other hand, the modern mind has ceased to see in insanity a supernatural agency, and in assimilating it to other forms of disease has taken up a humane and helpful attitude toward it.

Such a change of view might seem at first to necessitate a sharp severance of the new ideas. For, while it places genius at the apex of

* "Phædrus," *loc. cit.* Mr. Lecky points out that the Greeks had no asylums for the insane ("History of European Morals," vol. ii, p. 90). On the other hand, Dr. Maudsley tells us that Greek scientific opinion on the subject was an anticipation of modern ideas ("Responsibility in Mental Disease," p. 6).

† See Lecky, *op. cit.*, vol. ii, p. 92, etc.; cf. Maudsley, *op. cit.*, p. 10.

evolution, it reduces madness to a form of disintegration and dissolution. Nevertheless, we meet in modern literature with an unmistakable tendency to maintain the old association of ideas. Genius is now recognized as having a pathological side, or a side related to mental disease. Among our own writers we have so healthy and serene a spirit as Shakespeare asserting a degree of affinity between poetic creation and madness :

> "The lunatic, the lover, and the poet,
> Are of imagination all compact," etc.
> *Midsummer-Night's Dream*, act v, sc. 1.

A more serious affirmation of a propinquity is to be found in the well-known lines of Dryden :

> "Great wits are sure to madness near allied,
> And thin partitions do their bounds divide." *

As might be expected, French writers, with their relish for pungent paradox, have dealt with special fullness on this theme. "Infinis esprits," writes Montaigne on a visit to Tasso in his asylum, "se trouvent ruinez par leur propre force et soupplesse." Pascal observes that "l'extrême esprit est voisin de l'extrême folie." In a similar strain Diderot writes : "Oh ! que le génie et la folie se touchent de bien près !" The French writer who most distinctly emphasizes the proposition is Lamartine. "Le génie," he observes in one place, "porte en lui un principe de destruction, de mort, de *folie*, comme le fruit porte le ver" ; and again he speaks of that "maladie mentale" which is called genius.

In German literature it is Goethe, the perfect ideal, as it would seem, of healthy genius, who dwells most impressively on this idea. His drama, "Tasso," is an elaborate attempt to uncover and expose the morbid growths which are apt to cling parasitically about the tender plant of genius. With this must be mentioned, as another striking literary presentment of the same subject, the two eloquent passages on the nature of genius in Schopenhauer's *opus magnum.*

Against this compact consensus of opinion on the one side we have only a rare protest like that of Charles Lamb on behalf of the radical sanity of genius.† Such a mass of opinion can not lightly be dismissed as valueless. It is impossible to set down utterances of men like Diderot or Goethe to the envy of mediocrity. Nor can we readily suppose that so many penetrating intellects have been misled by a passion for startling paradox. We are to remember, moreover, that this is not a view of the great man *ab extra*, like that of the vulgar already referred to ; it is the opinion of members of the distinguished fraternity themselves who are able to observe and study genius from the inside.

* "Absalom and Achitophel," part i, line 163.

† See his essay, "Sanity of True Genius," in the "Last Essays of Elia."

Still, it may be said, this is, after all, only unscientific opinion. Has Science, with her more careful method of investigating and proving, anything to say on this interesting theme? It is hardly to be supposed that she would have overlooked so fascinating a subject. And, as a matter of fact, it has received a considerable amount of attention from pathologists and psychologists. And here for once Science appears to support the popular opinion. The writers who have made the subject their special study agree as to the central fact that there is a relation between high intellectual endowment and mental derangement, though they differ in their way of defining this relation. This conclusion is reached both inductively by a survey of facts, and deductively by reasoning from the known nature and conditions of great intellectual achievement on the one hand, and of mental disease on the other.*

What we require first of all is clearly as many instances as can be found of men of genius who have exhibited intellectual or moral peculiarities which are distinctly symptomatic of mental disease. Such a collection of facts, if sufficient, will supply us with a basis for induction. In making this collection we need not adopt any theory respecting the nature either of genius or of mental disease. It is sufficient to say that we include under the former term all varieties of originative power, whether in art, science, or practical affairs. And as to the latter term, it is enough to start with the assumption that fully developed insanity is recognizable by certain well-known marks; and that there are degrees of mental deterioration, and a gradual transition from mental health to mental disease, the stages of which also can, roughly at least, be marked off and identified.

In surveying the facts which have been relied on by writers, we shall lay most stress on mental as distinguished from bodily or nervous symptoms. And of these we may conveniently begin with the less serious manifestations:

1. The lowest grade of mental disturbance is seen in that temporary appearance of irrationality which comes from an extreme state of "abstraction" or absence of mind. To the vulgar, as already hinted, all intense preoccupation with ideas, by calling off the attention from outer things and giving a dream-like appearance to the mental state, is apt to appear symptomatic of "queerness" in the head. But in order that it may find a place among distinctly abnormal features this absence of mind must attain a certain depth and persistence. The ancient story of Archimedes, and the amusing anecdotes of Newton's

* The principal authoritative utterances on the subject are Moreau, "La Psychologie morbide," etc.; Hagen, "Ueber die Verwandtschaft des Genies mit dem Irresein" ("Zeitschrift für Psychiatrie," Band 33); and Radestock, "Genie und Wahnsinn (Breslau, 1884). This last contains the latest review of the whole question, and is written in a thoroughly cautious scientific spirit. I have derived much aid from it in preparing this essay.

fits, if authentic, might be said perhaps to illustrate the border-line between a normal and an abnormal condition of mind. A more distinctly pathological case is that of Beethoven, who could not be made to understand why his standing in his night attire at an open window should attract the irreverent notice of the street boys. For in this case we have a temporary incapacity to perceive exterior objects and their relations ; and a deeper incapacity of a like nature clearly shows itself in poor Johnson's standing before the town clock vainly trying to make out the hour.

This same aloofness of mind from the external world betrays itself in many of the eccentric habits attributed to men and women of genius. Here, again, Johnson serves as a good instance. His inconvenient habit of suddenly breaking out with scraps of the Lord's Prayer in a fashionable assembly marks a distinctly dangerous drifting away of the inner life from the firm anchorage of external fact.

In the cases just considered we have to do with a kind of mental blindness to outer circumstances. A further advance along the line of intellectual degeneration is seen in the persistence of vivid ideas, commonly anticipations of evil of some kind, which have no basis in external reality. Johnson's dislike to particular alleys in his London walks, and Madame de Staël's *bizarre* idea that she would suffer from cold when buried, may be taken as examples of these painful delusions or *idées fixes*. A more serious stage of such delusions is seen in the case of Pascal, who is said to have been haunted by the fear of a gulf yawning just in front of him, which sometimes became so overmastering that he had to be fastened by a chain to keep him from leaping forward.

It is plain that in this last case we touch on the confines of sense-illusion. It is probable that hallucinations may occur as very rare experiences in the case of normal and healthy minds. Yet, though not confined to states of insanity, illusions of the senses are commonly, if not always, indicative of at least a temporary disturbance of the psycho-physical organism. And we have on record a considerable number of instances of eminent men who were subject to these deceptions. It is not only the religious recluse, with his ill-nourished body, and his persistent withdrawal from the corrective touch of outer things, who experiences them. Luther was their victim as well as Loyola. Auditory hallucinations—that is, the hearing of imaginary voices—appear to have occurred to Malebranche and Descartes, as they certainly did to Johnson. The instances of visual hallucinations are perhaps more numerous still. Pope, Johnson, Byron, Shelley, are said to have had their visions. Even so strong and well-balanced a mind as Goethe was not exempted. Nor has the active life of the soldier always proved a safeguard. The stories of the prognostic visions of Brutus and other generals of the old world are well known. Among modern ones, Napoleon is said to have had recurring visits from his guardian spirit or genius.

In the abnormalities just touched on, disturbance of intellectual function is the chief circumstance, though an element of emotional disturbance is commonly observable as well. In another class of cases, this last ingredient becomes the conspicuous feature. By this is meant such an accession of general emotional excitability, and along with this such a hypertrophy and absolute ascendency of certain feelings, as to constitute a distinct approximation to the disorganized psychical state which has been called moral insanity.

And here reference may first be made to that violence of temper and that extravagant projection of self and its concerns to the displacement of others' claims and interests which might be termed a kind of moral hallucination. How many names in the roll of English writers at once occur to the mind in this connection! Pope, Johnson, Swift, Byron, to which list must now be added Carlyle, may be taken as typical instances of the *genus irritabile vatum*. And among foreign deities we have Voltaire and Rousseau, Handel and Beethoven, and even philosophers like Herder and Schopenhauer.

Other emotional disorders take on more distinctly the aspect of moral obliquities. And here we have specially to do with poetic genius. Without adopting the slightly contemptuous opinion that poets are, as a rule, a "sensuous, erotic race," one must admit that an untamed wildness of amatory passion has been a not infrequent accompaniment of fine poetic imagination.*

For a clear illustration, however, of the morbid tendency of such irregularities, we must go, not to the comparatively regular life of a Goethe or a Shelley, but to the wild and lawless career of a Rousseau, of whom it was well said by a clever woman, "Quand la Nature forma Rousseau, la sagesse pétrit la pâte, mais la folie y jeta son levain."

To a tempestuous violence of sexual passion there has too commonly joined itself a feverish craving for physical stimulants; † and so the pure heavenly flame of genius has again and again had to contend with the foul, murky vapors which exhale from the lower animal nature. No need to tell again the gloomy story of splendid power eaten into and finally destroyed by the cancer of rampant appetite. In our own literature the names of Ben Jonson, Nat Lee, Burns, and others at once occur to the student. Edgar Allan Poe represents the same tragic fatefulness of genius in American letters. Among Frenchmen we have as conspicuous examples Villon and De Musset. Among Germans, Günther, Bürger, and numbers of those about Herder and

* Even the spiritual Dante has been found wanting in this matter by no more strait-laced an authority than Boccaccio.

† These include not only alcoholic drinks but opium, to the use of which Voltaire, Madame de Staël, Coleridge, and De Quincey, and probably others, were addicted. The excitement of gambling seemed in Lessing's case to fill the place of physical stimulants.

Goethe in the turbulent times of the *Sturm und Drang*, and Hoffmann, the novelist, suffered the same moral shipwreck.

2. We may now pass to another class of cases in which the pathological character is still more plainly discernible. Outbursts of fierce passionateness may perhaps be thought by some to be, after all, only marks of a certain kind of robust vitality. But no one will say this of the gloomy depression, the melancholy brooding on personal ills, ending sometimes in distinctly hypochondriac despondency, which have not unfrequently been the accompaniment of great intellectual power. It was remarked by Aristotle, who was a long way the shrewdest and most scientific observer of antiquity, that all men of genius have been melancholic or atrabilious.* He instances Empedocles, Socrates, and Plato, and the larger number of the poets. And the page of modern biographic literature would supply many a striking illustration of the same temperament. The pessimism of Johnson, Swift, Byron, and Carlyle, of Schopenhauer and Lenau, of Leopardi and of Lamartine, may perhaps be taken as a signal manifestation of the gloom which is apt to encompass great and elevated spirits, like the mists which drift toward and encircle the highest mountain-peaks.

In some cases this melancholy assumes a more acute form, giving rise to the thought and even the act of suicide. Among those who have confessed to have experienced the impulse may be mentioned Goethe in the Werther days, Beethoven during the depression brought on by his deafness, Chateaubriand in his youth, and George Sand also in her early days. The last, writing of her experience, says, "Cette sensation" (at the sight of water, a precipice, etc.) "fut quelquefois si vive, si subite, si bizarre, que je pus bien constater que c'était une espèce de folie dont j'étais atteinte." Johnson's weariness of life was, it seems certain, only prevented from developing into the idea of suicide by his strong religious feeling and his extraordinary dread of death, which was itself, perhaps, a morbid symptom.

In some cases this idea prompted to actual attempts to take away life. The story of Cowper's trying to hang himself, and afterward experiencing intense religious remorse, is well known. Another instance is that of Saint-Simon, whose enormous vanity itself looks like a form of monomania, and who, in a fit of despondency, fired a pistol at his head, happily with no graver result than the loss of an eye. Alfieri, who was the victim of the "most horrid melancholy," tried on one occasion, after being bled by a surgeon, to tear off the bandage in order to bleed to death. Among those who succeeded in taking away their life are Chatterton, whose mind had been haunted by the idea from early life, Kleist the poet, and Beneke the philosopher.

* "Cur homines qui ingenio claruerunt vel in studiis philosophiæ, vel in republicâ administrandâ, vel in carmine pangendo, vel in artibus exercendis, melancolicos omnes fuisse videamus?" *Prob.* xxx. Aristotle's authority on the point is quoted by Cicero, *Tuscul. disp.*, i, 33; *de divin.*, i, 38.

3. We may now pass to the most important group of facts—namely, instances of men of genius who have suffered from fully developed mental disease.

In certain cases this disruption of the organs of mind shows itself in old age, and here, it is evident, we have to distinguish what is known as senile dementia from the impairment of faculty incident to old age. A clear instance of cerebral disease is afforded by the botanist Linnæus, whose faculties gave way after a stroke. The mental stupor into which the poet Southey finally sank was a similar phenomenon. Swift's fatal disease, the nature of which has only recently been cleared up by science, was cerebral disorganization brought on by peripheral disease in the organ of hearing. Zimmermann, the author of the work on "Solitude," who had been a hypochondriac from the age of twenty, ended his life in a state of melancholy indistinguishable from insanity. The final collapse, under the pressure of pecuniary anxieties, of Scott's cerebral powers, is too well known to need more than a bare mention.

Besides these instances of senile collapse, there are several cases of insanity showing itself in the vigorous period of life. Sometimes, as in the instance of Richelieu, who had shown himself an erratic being from his childhood, the madness appeared as a sudden and transient fit of delirium. In other cases the disorder took a firmer hold on the patient. Charles Lamb, Handel, and Auguste Comte suffered from insanity for a time, and had to be put under restraint. Tasso, whose whole nature was distinctly tinged with the "insane temperament," had again and again to be confined as a madman. Donizetti was also for a time insane and confined in an asylum. Among those who became hopelessly insane were the poets Lenau and Hölderlin and the composer Schumann, the latter of whom had long been the victim of melancholy and hallucinations, and had before his confinement attempted to drown himself in the Rhine.

I have preferred to dwell on the physical aspect of the relation between genius and disease. But no adequate investigation of the subject is possible which does not consider the physical aspect as well. No one now, perhaps, really doubts that to every degree of mental disturbance and mental disorganization there corresponds some degree of deterioration and disorganization of the nerve-centers. Psychical disturbance and disruption proceed *pari passu* with physical.

This being so, it is pertinent to our study to remark that men of genius have in a surprising number of cases been affected by forms of nervous disease which, though not having such well-marked psychical accompaniments as occur in states of insanity, are known to be allied to these.

4. To begin with, it seems certain that a number of great men have died from disease of the nerve-centers. Among other names may be mentioned Pascal, who had all his life been the victim of nervous

disorders, and who succumbed, at the early age of thirty-nine, to paralysis accompanied by convulsions. Two of the greatest scientific men, Kepler and Cuvier, died, according to Moreau, from disease of the brain. Rousseau was carried off by an attack of apoplexy. Mozart's early death was due to brain-disease, showing itself in other ways by morbid delusions, fainting-fits, and convulsions. Another musician, Mendelssohn, succumbed to an attack of apoplexy. Heine's fatal malady, which kept him for seven years a prisoner in his "mattress-grave," was disease of the lower nerve-centers in the spinal cord.

Other men of genius have suffered from nervous disorders from time to time. Molière was the subject of recurring convulsions, an attack of which would prevent his working for fifteen days. Alfieri, to whose morbid mental symptoms reference has already been made, suffered when young from a disease of the lymphatic system, and was afterward liable to convulsions. Paganini, the musician, suffered from an attack of catalepsy when four years old, and later on was the victim of recurring convulsions; and Schiller, who was very delicate from youth, was also the subject of recurring fainting-fits and convulsions.

The lesser forms of nervous disorder—headache, *malaise*, and recurring periods of nervous prostration—are too common among all brain-workers to call for special notice here. The latest biography of a woman of genius strikingly illustrates this milder form of the penalty which mortals have to pay for daring to aspire to the ranks of the immortals. In George Eliot we have one more name added to the list of great ones to whom, to use the words of a French writer, has been granted "le funeste privilège d'entendre crier à toute heure les ressorts de leur machine."

5. One other significant group of facts remains to be touched on. In a considerable number of cases it has been ascertained that insanity or other form of nervous disorder has shown itself in the same family as genius, whether as its forerunner, companion, or successor. Chateaubriand's father is said to have died of apoplexy. Schopenhauer's grandmother and uncle were imbecile. Several distinguished men had insane sisters, among others Richelieu, Diderot, Hegel,* and Charles Lamb. One of Mendelssohn's sons became insane.†

I have endeavored in this brief review of the alleged facts to give an adequate impression of their variety and range. It now remains to inquire into their precise evidential value.

The first question that naturally arises here is whether the facts are well authenticated and accurately presented. A cautious mind will readily reflect that if genius as such is apt to assume an abnormal aspect to average common sense, biographers may easily have invent-

* That Hegel's sister was insane and drowned herself is asserted by Moreau, on the authority of an article in the "Revue des Deux Mondes," and quoted by Radestock.

† Symptoms of insanity are said by Moreau to have shown themselves in the families of several eminent rulers, including Peter the Great. (See Radestock, p. 4, *seq.*)

ed, or at least exaggerated, some of the alleged morbid characteristics of the great; and as a matter of fact there is good reason to suppose that this falsifying of the record of greatness has taken place. I may refer to the story of the madness and suicide of Lucretius, which is extremely doubtful, and may have grown out of a religious horror at the supposed tendency of his writings. The story of Newton's madness, again, which is given by a French biographer, and which is ably refuted by Sir David Brewster, may owe much of its piquancy to what may be called the unconscious inventiveness of prejudice. Very possibly the stories of the visions of Brutus, Cromwell, and others, have had a like origin.

Again, it will be said that even medical men—wishing like others to magnify their office—may have been too ready in spying out the symptoms of insanity. If they are fallible in dealing with the living subject, all of whose physical and mental characteristics are accessible to observation, how much more likely are they to err in diagnosing the minds of the dead by help of a few fragmentary indications only! I think the force of this objection, too, must be allowed. When, for example, a French alienist thinks it worth while to write a book in order to prove that the belief of Socrates in a controlling divinity (*τὸ δαιμόνιον*) was a symptom of mental disease, a layman may be pardoned for demanding a mode of investigation more in accordance with the proud claims of science to our absolute and unstinted confidence. A well-informed and critical reader of M. Moreau's tables of biographical facts will not fail to challenge more than one statement of his respecting the morbid characteristics of great men, ancient and modern.*

Allowing, however, for a margin of error, I do not think any candid mind will fail to see that such a body of facts as remains is sufficient to justify us in drawing a conclusion. If men of the highest intellectual caliber were not more liable to mental and nervous disorders than others, no such list out of the short roll of great names could have been obtained. No elaborate calculations are needed, I think, to show that mental malady occurs too often in the history of genius.†

One might perhaps try to evade the unpalatable conclusion by saying that there is genius and genius; that it is weakly, one-sided, and *bizarre* originality which exhibits these unhealthinesses, whereas the larger and more vigorous productiveness of an Aristotle, a Shakespeare, or a Goethe, is free from such blemishes.‡ I think, however,

* As when he sees in Swift's witty pamphlet on Ireland a distinct presage of oncoming insanity. In some cases he is inexact in stating his facts, as when he says that Saint-Simon committed suicide.

† The proportion is the more striking, because it is not known that insanity is particularly frequent among the more highly educated class of the community.

‡ This seems to be the idea of Dr. Oliver Wendell Holmes when he distinguishes between poets of "great sun-kindled constructive imagination" and those who have "a

that our facts will compel us to reject this saving clause. There is no question among competent critics of the splendid quality of genius of Swift, of Carlyle, or of Beethoven. Nor in cases of so-called healthy genius can it be said that nothing abnormal ever shows itself. The above references to Goethe may serve to indicate the liability to abnormal deviation even in the strongest and seemingly most stable type of genius. As for Shakespeare, the instance commonly referred to by Lamb and others who have come to the defense of genius, it is enough to say that our knowledge of his personality and life is far too meager to justify any conclusion on the point.*

And this brings us to another very important consideration. If too much has been made of the alleged positive instances, too much has been made also of the apparent contradictions or exceptions. The record of past greatness is far too scanty for the most plodding student to find all cases of morbid symptoms which have presented themselves. We who live in an age when a fierce light beats on the throne of intellect, when the public which genius serves is greedy of every trivial detail of information respecting its behavior in the curtained recess of private life, can hardly understand how our ancestors could have neglected to chronicle and to preserve the words and deeds of the greatest of men. Yet such is the case, and the further we go back the scantier the biographic page. Inasmuch, too, as many of the symptoms of nervous disease in the intellectual heroes themselves or their families would possess no significance to the ordinary lay mind, we may feel confident that in many cases where we have a fairly full record important data are omitted.

Another thought naturally occurs to one in this connection. Without indorsing the ancient proverb that the best men die in their youth, we may find good grounds for conjecturing that many endowed with the gift of genius have passed away before their powers culminated in the production of a great monumental work. The early collapse of so many who did attain fame suggests this conclusion. And among such short-lived and unknown recipients of the divine afflatus it seems reasonable to infer that there were a considerable number who succumbed to some of those forms of psycho-physical disease which have so often attacked their survivors.

It seems, then, to be an irresistible conclusion that the foremost among human intellects have had more than their share of the ills that flesh is heir to. The possession of genius appears in some way to be unfavorable to the maintenance of a robust mental health. And here arises the question how we are to view this connection. Is the

certain kind of moonlight genius given them to compensate them for their imperfection of nature," and who are invariably "tinged with melancholy" ("Autocrat of the Breakfast-Table," chap. viii).

* Even the little that we know does not all point one way. Against the fine business capacity, and so forth, we have to set the youthful excesses of which rumor speaks.

presence of the creative faculty to be regarded as itself an abnormal excrescence in the human mind? Or is it that the possession and fruition of the faculty are apt to be attended with circumstances which are injurious to perfect mental well-being?

In order to understand the precise relation between two things, we ought to know all about the nature and causes of each. But this we are very far from knowing in the present case. Science has, no doubt, done much to clear up the ancient mystery of madness. We now know that it has a perfectly natural origin, and we understand a good deal respecting the more conspicuous agencies, psychical and physical, predisposing and exciting, which bring about the malady. Yet so intricate is the subject, so complex and subtile the influences which may conspire to just disturb the mental balance, that in many cases, even with a full knowledge of an individual and his antecedents, the most skillful expert finds himself unable to give a complete and exhaustive explanation of the phenomenon.

With respect to genius the case is much worse. We may have a clearer intuition of its organic composition than the ancients; we may be able better than they to describe in psychological terms the essential qualities of the original and creative mind. But we have hardly advanced a step with respect to a knowledge of its genesis and antecedents. We do, no doubt, know some little about its family history. Mr. Galton, with his characteristic skill in striking out new paths of experimental research, has brought to light a number of interesting facts with respect to the hereditary transmission of high intellectual endowments. But these researches supply no answer to the supremely interesting question, How does the light of genius happen to flash out in this particular family at this precise moment? A preparation there may be, as Goethe somewhere hints, in the patient building up by the family of sterling intellectual and moral virtues. But this is hardly the beginning of an explanation. How much the better are we able to comprehend Carlyle's wondrous gift of spiritual clairvoyance for knowing that he came of a thoroughly sound stock, having more than the average, it may be, of Northern shrewdness? To trace the family characteristics in a great man is one thing, to explain the genius which ennobles and immortalizes these is another.*

In the present state of our knowledge, then, genius must be looked upon as the most signal and impressive manifestation of that tendency of Nature to variation and individuation in her organic formations which modern science is compelled to retain among its unexplained facts. Why we have a Shakespeare, a Michael Angelo, a Goethe here

* Much the same applies to what M. Taine and others have said about the larger preparation of the original teacher and the artist by the traditions of the community and the spirit of the age. See, for a careful treatment of the whole question of the antecedents of genius, an article by M. H. Joly, "Psychologie des Grands Hommes" (III) in the "Revue Philosophique," August, 1882.

and now, is a question that can not be answered. Our ignorance of the many hidden threads that make up the inextricable skein of causation forces us to regard each new appearance of the lamp of genius with much of the wonder, if with something less of the superstition, with which the ancients viewed it.

This being so, we must be content with a very tentative and provisional theory of the relations between genius and mental disease. We can not, for example, follow M. Moreau in his hardy paradox that genius has as its material substratum a semi-morbid state of the brain, a neuropathic constitution which is substantially identical with the "insane temperament" or "insane neurosis."* For, first of all, the facts do not support such a generalization. If the "genial temperament" involved a distinct constitutional disposition to insanity, the number of great men who had actually become insane would certainly be much greater than it is. And, in the second place, this proposition reposes on far too unsubstantial a basis of hypothetical neurology. We know too little of the variations of nerve structure and function to pronounce confidently on the essential identity of the nervous organization in the case of the man of genius and of the insane." †

A more modest and possibly more hopeful way of approaching the question appears to offer itself in the consideration of the psychical characteristics of genius. We may inquire into those peculiarities of sensibility and emotion, as well as of intellect, which are discoverable in the typical psychical organization of the great man, and may trace out some of the more important reflex influences of the life of intellectual production on his mind and character. What we all recognize as genius displays itself in some large original conception, whether artistic, scientific, or practical. And it seems not improbable that by a closer investigation of the conditions and the results of this large constructive activity of mind we may find a clew to the apparent anomaly that grand intellectual powers are so frequently beset with mental and moral infirmity. These lurking-places of abnormal tendencies will, we may expect, betray themselves more readily in the case of artistic and especially poetic genius, which has, indeed, always been viewed as the most pronounced form, and as the typical representative of creative power.

No careful student of genius can fail to see that it has its roots in a nervous organization of exceptional delicacy. Keenness of sensibility, both to physical and mental stimuli, is one of the fundamental attributes of the original mind. This preternatural sensitiveness of nerve has been illustrated in the two latest records of poetic genius. Car-

* *Op. cit.*, p. 463, *seq.*

† Dr. Maudsley is more guarded, contenting himself with saying, "It is truly remarkable how much mankind has been indebted for special displays of talent, if not of genius, to individuals who themselves, or whose parents, have sprung from families in which there has been some predisposition to insanity" ("Responsibility in Mental Disease," p. 47).

lyle's lively impressibility to sounds and other sensuous agents is familiar to all.* And of George Eliot it has been well said that "her nerves were servile to every skyey influence." And what a range and intensity of emotion are at once suggested by names like Milton, Dante, Shelley, Heine!

This fineness of the sentient fiber stands in the closest relation to the intellectual side of genius. It is not so much an accompaniment of the creative imagination as its vitalizing principle. The wide and penetrating vision of the poet is the correlative of his quick, delicate, and many-sided sensibility. And the stimulus which ever urges him toward the ideal region, which makes him devote his days to the pursuit of some ravishing idea, has its origin in his rare, almost superhuman, capacity of feeling. The modest limits of the real world fail to slake his thirst for the delight of beauty, for the raptures of the sublime. Hence the impulse to fashion new worlds of his own. And by such ideal activities the emotional sensibilities which prompted them are deepened and intensified.

It is easy to see, from this glance at the fundamental conditions of imaginative creation, that it has one of its main impulses in uncommon experiences of suffering. The fine nervous organization, tremulously responsive to every touch, constitutes in itself, in this all too imperfect world of ours, a special dispensation of sorrow. Exquisite sensibility seems to be connected with a delicate poise of nervous structure eminently favorable to the experience of jarring and dislocated shock. And it is this preponderance of rude shock over smooth, agreeable stimulation—of a sense of dissonance in things over the joyous consciousness of harmony—which seems to supply one of the most powerful incitants to the life of imagination. Hence the dark streak of melancholy which one so often detects in the early years of the great man.

Such an attitude of mind must entail suffering in other ways, As the biography of the man of genius often tells us, he is apt to become aware, at a painfully early date, that his exceptional endowments and the ardent consuming impulses which belong to them collide with the utilities and purposes of ordinary life. The soul intent on dreaming its secret dream of beauty is unfit for the business which makes up the common working life of plain, prosaic men. The youth to whom the embodiment of a noble artistic idea or the discovery of a large, fructifying, moral truth is the one absorbing interest, will be apt to take a shockingly low view of banking, schoolmastering, and the other respectable occupations of ordinary citizens.

It follows that the man of genius is, by his very constitution and vocation, to a considerable extent a solitary. He is apt to offend the world into which he was born by refusing to bow the knee to its conventional deities. His mood of discontent with things presents itself

* Goethe, Schopenhauer, and other great men, were particularly sensitive to sounds.

as a reflection on their contented view. On the other hand, his peculiar leanings and aspirations are incomprehensible to them, and stamp him as an alien. "Il y a peu de vices," says Chamfort, with a grim irony, "qui empêchent un homme d'avoir beaucoup d'amis, autant que peuvent le faire de trop grandes qualités." Hence the profound solitude of so many of the earth's great ones, which even the companionships of the home have not sufficed to fill up. And it must be remembered that the ardent emotions of the man of genius bring their extra need of sympathy. Even the consciousness of intellectual dissent from others may become to a deeply sympathetic nature an anguish. "I believe you know" (writes Leopardi to a friend), "but I hope you have not experienced, how thought can crucify and martyrize any one who thinks somewhat differently from others."

Such isolation is distinctly unfavorable to mental health. It deprives a man of wholesome contact with others' experience and ideas, and disposes to abnormal eccentricities of thought. It profoundly affects the emotional nature, breeding melancholy, suspicion of others, misanthropy, and other unwholesome progeny. The "strange interior *tomb* life" of which Carlyle speaks is a striking example of the influence of this isolation in fostering the minute germs of morbid delusion.

If now we turn to the process of intellectual origination, we shall find new elements of danger, new forces adverse to the perfect serenity of mental health. If the rich biographical literature of modern times teaches us anything, it is that original production is the severest strain of human faculty, the most violent and exhausting form of cerebral action. The pleasing fiction that the perfectly-shaped artistic product occurs to the creative mind as a kind of happy thought is at once dispelled by a little study of great men's recorded experience. All fine original work, it may be safely said, represents severe intellectual labor on the part of the producer, not necessarily at the moment of achievement, but at least in a preparatory collection and partial elaboration of material. The rapidity with which Scott threw off his masterpieces of fiction is only understood by remembering how he had steeped his imagination for years in the life, the scenery, and the history of his country.

It is to be remembered, too, that this swift and seemingly facile mode of creation is by no means an easy play of faculty, akin to the spontaneous sportiveness of witty talk. It involves the full tension of the mental powers, the driving of the cerebral machine at full speed. According to the testimony of more than one man of genius, this fierce activity is fed and sustained by violent emotional excitement.*

* Byron, Goethe, Dickens, and others attest to this. Compare what George Eliot says about the way in which the third volume of "Adam Bede" was produced ("Life," vol. ii, p. 155).

The notion of producing a work of high imaginative power in a state of perfect cold blood is, as Plato long ago pointed out, absurd. Spiritual generation only takes place when the soul burns and throbs as with a fever. At the moment of productive inspiration the whole being is agitated to its depths, and the latent deposits of years of experience come to the surface. This full spring-tide of imagination, this cerebral turmoil and clash of currents, makes the severest demands on the controlling and guiding forces of volition. And it is only when the mind is capable of the highest effort of sustained concentration that the process of selecting and organizing can keep pace with the rapid inflow of material. Hence, though the excitement may in certain cases be intensely pleasurable, it is nearly always fatiguing and wearing.

But great artistic works are not always flashed into the world by this swift electric process. Some books that men will not let die have been the result of lengthened toil troubled by many a miserable check and delay. The record of Carlyle's experience sufficiently illustrates the truth that there is no necessary relation between rapidity of invention and execution and artistic value of result.* Much depends on the passing mood, more still on the temperament of the individual artist. There are others besides Carlyle to whom spiritual parturition has been largely an experience of suffering, the pangs being but rarely submerged in the large, joyous consciousness that a new idea is born into the world. And when this is so there is another kind of strain on the mental machine. The struggle with intellectual obstacle, the fierce passionate resolve to come *in's Reine* which every student experiences in a humble way, becomes something for the spectator to tremble at.

Is it surprising that such states of mental stress and storm should afterward leave the subject exhausted and prostrate? The wild excitement of production is apt to dull the sense still further to the prosaic enjoyments with which ordinary mortals have to content themselves. More than this, the long and intense preoccupation with the things of the imagination is apt to induce a certain lethargy and stupor of the senses, in which the sharp outlines of reality are effaced in a misty, dream-like phantasmagoria. The reader of Carlyle's "Memoirs" need not be reminded how plainly all this appears in his experience. Even the warm and gladdening ray of dawning prosperity failed to cheer him in these hours of spiritual collapse. And he exclaims in one place that there is no other pleasure and possession for him but that of feeling himself working and alive.†

* M. Joly illustrates the same fact by the experience of Voltaire, "Revue Philosophique," November, 1882, pp. 496, 497.

† "Thomas Carlyle," vol. ii, p. 129. Probably one reason why painters so rarely show morbid mental traits is that in their case the function of the senses can never be so completely overborne by the weight of imagination.

In addition to these adverse forces, which have their origin in the common conditions of the life of genius, there are others which, though less constant, present themselves very frequently in co-operation with the first. It has often been remarked that the man of decided originality of thought, being as it were one born out of due time, has to bear the strain of production for a while uncheered by the smile of recognition. And when there is great originality, not only in the ideas, but in the form of expression, such recognition may come too slowly to be of any remunerative value. Neglect or ridicule is the form of greeting which the world has often given to the propounder of a new truth ; and where, as frequently happens, the want of instant recognition means the pressure of poverty, which chafes with unusual severity the delicate fibers of sensitive men, we have a new and considerable force added to the agencies which threaten to undermine the not too stable edifice of the great man's mental and moral constitution. Johnson, Lessing, Burns, Leopardi, and many another name, will here occur to those familiar with the lives of modern men of letters.

In view of this combination of threatening agencies, one begins to understand the many eloquent things which have been said about the fatality of great gifts. Thus one finds a meaning in the definition of poetic genius given by Lamartine when speaking of Byron—" a vibration of the human fiber as strong as the heart of man can bear without breaking."

It is not meant here that even when all these destructive elements are present a distinctly pathological condition of mind must necessarily ensue. Their effect may be fully counteracted by other and resisting agencies. Of these the two most important are bodily energy and health on the one hand, and strength of will or character on the other. Where these are both found in a high degree of perfection, as in Goethe, we have a splendid example of healthy genius. On the other hand, if either, and still more if both of these are wanting, we have a state of things which is exceedingly likely to develop a distinctly pathological state of mind.*

How, it may be asked, does it commonly fare with the world's intellectual heroes with respect to these means of defense? As to the physical defense, it is known that a number of great men have had a physique fairly adequate to the severe demands made on the nervous organization. They were men of powerful frame, strong muscles, and good digestion. But such robustness of bodily health seems by no means the common rule. The number of puny and ill-formed men who have achieved marvelous things in intellectual production is a fact which has often been remarked on. So common an accompaniment of great intellectual exertion is defective digestion, that an in-

* That is, quite apart from any inherited physical predisposition to nervous disease.

genious writer has tried to show that the maladies of genius have their main source in dyspepsia.* No Englishman, in thinking of this question, can fail to recollect that the three of his countrywomen who have given most distinct proof of creative power—Charlotte Brontë, Mrs. Browning, and George Eliot—were hampered with a physical frame pitiably unequal to support the cerebral superstructure.†

Coming now to the moral defense, the thought at once suggests itself that, according to the testimony of more than one writer, genius consists in preternatural force of will more than in anything else. It is, we are told, only the man with an infinite capacity to take pains who is truly great. The prolonged, intense concentration of mind which precedes the final achievement is a severe exertion and striking manifestation of will.

At the same time, a moment's thought will show us that this patient mental incubation is no proof of the higher qualities of will and moral character.‡ The appropriateness of the old way of speaking of creative inspiration as a possession is seen in the fact that the will has little to do with bringing on the condition. "The author," said Lord Beaconsfield, on one occasion, "is a being with a predisposition which with him is irresistible, a bent which he can not in any way avoid, whether it drags him to the abstruse researches of erudition, or induces him to mount into the feverish and turbulent atmosphere of imagination." This sense of a *quasi*-exterior pressure and compulsion is attested by more than one child of genius. In some cases, more particularly, perhaps, among "tone-poets," we find this mastery of the individual mind by the creative impulse assuming the striking form of a sudden abstraction of the thoughts from the surroundings of the moment. And, throughout the whole of the creative process, the will, though, as we have seen, exercised in a peculiarly severe effort, is not exercised fully and in its highest form. There is no deliberate choice of activity here. The man does not feel free to stop or to go on. On the contrary, the will is in this case pressed into the service of the particular emotion that strives for utterance, the particular artistic impulse that is irresistibly bent on self-realization. There is nothing here of the higher moral effort of will, in choosing what we are not at the

* R. R. Madden, "On the Infirmities of Genius."

† Schopenhauer, in the passages of his work already referred to, discusses in a curious and characteristic way the physical basis of genius. Moreau quotes approvingly the remark of Lecanus, that men of the finest genius were "of a feeble constitution and often infirm." On the other hand, Mr. Galton, in his "Hereditary Genius," contends that the heroes of history are at least up to the average of men in physical strength. It is to be remarked, however, that the reference to university statistics is apt to mislead here. Senior wranglers can hardly be taken as representative of creative power.

‡ It is evident that only speculative, as distinguished from practical genius, is here referred to. The man of great constructive powers in affairs—the statesman, general, and so forth—requires will in the higher and fuller sense. And it has been remarked that these organizing intellects rarely exhibit pathological symptoms.

moment inclined to, and resisting the seductive force of extraneous excitants.*

These fragmentary remarks may help us to understand the facts of the case. A certain proportion of great thinkers and artists have shown moral as well as intellectual heroism. Men who were able to take the destruction of a MS. representing long and wearisome research, as Newton and Carlyle took it, must have had something of the stuff of which the stoutest character is woven. The patient upbearing against hardship of men like Johnson and Lessing is what gives the moral relish to the biography of men of letters. More than one intellectual leader, too, has shown the rare quality of practical wisdom. Goethe's calm strength of will, displaying itself in a careful ordering of the daily life, is matter of common knowledge. Beethoven managed just to keep himself right by resolute bodily exercise. In George Eliot an exceptional feeling of moral responsibility sufficed for a nice economizing of the fitful supply of physical energy.

At the same time, our slight study of the ways of genius has familiarized us with illustrations of striking moral weaknesses. We have seen a meaning in Rochefoucauld's paradox, that "il n'appartient qu'aux grands hommes d'avoir de grands défauts." The large draught of mental energy into the channels of imaginative production is apt to leave the will ill-provided in working out the multifarious tasks of a temperate and virtuous life.

Our conclusion is, that the possession of genius carries with it special liabilities to the action of the disintegrating forces which environ us all. It involves a state of delicate equipoise, of unstable equilibrium, in the psycho-physical organization. Paradoxical as it may seem, one may venture to affirm that great original power of mind is incompatible with nice adjustment to surroundings, and so with perfect well-being. And here it is that we see the real qualitative difference between genius and talent. This last means superior endowment in respect of the common practical intelligence which all men understand and appraise. The man of talent follows the current modes of thought, keeps his eye steadily fixed on the popular eye, produces the kind of thing which hits the taste of the moment, and is never guilty of the folly of abandoning himself to the intoxicating excitement of production. To the original inventor of ideas and molder of new forms of art this intoxication is, as we have seen, everything. He is under a kind of divine behest to make and fashion something new and great, and at the moment of compliance recks little of the practical outcome to himself. And such recklessness is clearly only one form of imprudence, and so of mal-adaptation.

* This fact of the absence of choice, and the ordinary co-operation of the personal will in artistic production, is illustrated further in the rapidity with which the mind casts off and ignores its offspring. "Est-ce bien moi qui ai fait cela ?" asked Voltaire once, on seeing one of his dramas acted. George Eliot attests to this strange unmaternal feeling toward her literary children.

But, if improvident, he is improvident in a high cause. Emerson and others have taught us the uses of the great man. The teacher of a new truth, the discoverer of a higher and worthier form of artistic expression, is one in advance of his age, who, by his giant exertions, enables the community, and even the whole race, to reach forward to a further point in the line of intellectual evolution. He is a scout who rides out well in advance of the intellectual army, and who by this very advance and isolation from the main body is exposed to special perils. Thus genius, like philanthropy or conscious self-sacrifice for others, is a mode of variation of human nature which, though unfavorable to the conservation of the individual, aids in the evolution of the species.

If this be a sound view of the nature and social function of the man of genius, it may teach more than one practical lesson. Does it not, for example, suggest that there is room just now for more consideration in dealing with the infirmities of great men? There is no need of exonerating intellectual giants from the graver human responsibilities. We do well to remember that genius has its own special responsibilities, that *noblesse oblige* here too. At the same time we shall do well also to keep in mind that the life of intellectual creation has its own peculiar besetments, and that in the very task of fulfilling his high and eminently humane mission, and giving the world of his mind's best, the great man may become unequal to the smaller fortitudes of every-day life. To judge of the degree of blameworthiness of faults of temper is a nice operation, which may even transcend the ability of a clever and practiced critic. Perhaps the temper most appropriate to the contemplation of genius, and most conducive to fairness of moral judgment, is one in which reverence is softened by personal gratitude, and this last made more completely human by a touch of regretful pity.—*Nineteenth Century.*

AN EXPERIMENT IN PRIMARY EDUCATION.

By Dr. MARY PUTNAM-JACOBI.

I.

In modern times education has been recognized to be something more than an elegant luxury, designed exclusively for the benefit of the "upper classes." It is a force, and a potent and indisputable means, not only for the training but for the evocation of forces. It is able, not only to convey information, but to increase power. It is not simply a social convention, but a real means for attaining real ends. The final ends of education are efficiency and repose. The educated person is he who knows how to get what he wants, and how to enjoy it when he has got it.

When a "higher education" is demanded, for any class of persons—as women—it means that it has become desirable to train their faculties for more difficult work than that traditionally assigned to them, and also that it is desirable to enable them to get more enjoyment out of any work that they do. The necessary correlative of the possession of powers is the opportunity for their exercise. The existence of a larger class of effectively educated women must increase their demand for a larger share in that part of the world's work which requires trained intelligence. Of this, literature and other art is one and only one portion. The work of the professions, of the upper regions of industry, commerce, and finance, the work of scientific and of political life, is the work appropriate to the intelligences which have proved themselves equal to a course of training at once complex and severe. A person destined to receive a superior education is expected to develop more vigorous mental force, to have a larger mental horizon, to handle more complex masses of ideas, than another. From the beginning, therefore, he must not merely receive useful information, but be habituated to perform difficult mental operations, for only in this way can the sum of mental power be increased. The order, arrangement, and sequence of the ideas he acquires must be as carefully planned as is the selection of the ideas themselves, because upon this order and internal proportion his mental horizon depends. He must be trained in feats of sustained attention, and in the collocation and association of elementary ideas into complex combinations. Since ideas are abstractions from sense-perceptions, he must be exercised in the acquisition of accurate, rapid, far-reaching, and delicate sense perceptions, in their memorization, and in the representative imagination which may recall them at will, and be able to abstract from them, more or less remotely, ideas. Habits of rich association of ideas must be formed, and of pleasure in their contemplation. And very early must be offered to the child problems to be solved, either by purely mental exertion, or by that combined with manual labor. And all this care must be taken for girls as well as for boys, so soon as it is seriously agreed that girls may be admitted to a superior as well as to a primary education.

The first intellectual faculties to be trained are perception and memory. The subjects of the child's first studies should therefore be selected, not on account of their ultimate utility, but on account of their influence upon the development of these faculties. What sense is there, then, in beginning education with instruction in the arts of reading and writing? If literature were the main business of life, or if, as was at one time supposed, education meant nothing else but acquaintance with literature, there would be some logic in the extraordinary prominence habitually assigned in education to the study of modes of literary expression. But, from the modern stand-point, that education means such an unfolding of the faculties as shall put the mind into the widest and most effective relation with the entire world of things—spiritual and material—there is an exquisite absurdity in the time-honored method. To study words before things tends to impress the mind with a fatal belief in their superior importance. To study expression before subjects of thought have been accumulated, is to cultivate the habit, always prevalent in civilized life, of talking fluently without having anything to say. To direct attention to sets of arbitrary signs before attention has been trained by contemplation of real objects, teaches the mind to place conventional and contingent facts on the same level with necessary truths. We thus weaken in advance the power of belief in necessity and reality. Without such power the mind becomes inevitably the prey to a skepticism generated much less by contradictions in the outside world, than by the weakness of its internal organism. What other result should logically be produced, when, to the opening mind, as it turns eagerly to the wonderful world in which it awakens and finds itself, we offer for contemplation, exercise, and earliest sustenance, the alphabet, the abstruse structure of words to be spelled, the grammar of sentences to be construed, the complex gymnastics of copies to be written? When to the reading, writing, spelling, grammar, and composition in English, we add that of similar exercises in two or three other languages, we evidently describe the education, first, of the children in our public schools, then of those of the so-called "upper classes"; and show that all is a prolonged study of words.

Words are fossils, which, according to the understanding had of them, are a heap of meaningless stones, or the incarnation of a bygone life. When the child has once learned to handle present existences, he will be prepared to understand the reflections of a past life in language. When he has had some experience in framing complex abstractions, he can then appreciate the complex abstractions of speech. But, until then, language should not be to him an object of thought, but only an organ of thought. It is not to be driven *into* him, but only *out* of him, through the urgent consciousness that something must be said. The inflections, intonations, and emphasis of speech, uttered or written—and which include grammar, rhetoric, punctuation, style—must arise spontaneously, as natural clothing of the idea, which insists upon making itself understood. An idea which is once sufficiently vivid in the child's mind can hardly fail to "climb to a form in the grass and flowers" of picturesque baby-speech.

On this principle it might be useful to precede study of either spoken or written language by study of gestures and signs. At all events, in my own experiment, the child was taught algebraic signs as a means of concisely expressing certain relations, long before any attempt was made to learn how to write. Thus the important, fundamental idea was early conveyed to her mind that all arts of expression were subordinate in importance to the subject expressed. Deliberate study of the arts of expression, which is equivalent to the study of literature, rhetoric, and style, was reserved until after many years of study of things should have accumulated impressions and ideas which spontaneously sought an outlet. Further, the child was taught to draw in simple combinations of lines for many months before attempting to write. When this difficult and complex muscular exercise was approached, she began it with unusual ease, and in a few weeks, at the age of six, already commanded a firm and legible handwriting. Further, and for the same purpose, no set copy-book was used from which meaningless sentences could be imitated ; but the child proceeded at once to utilize the art of writing in precisely the same way that humanity has done in passing from barbarism with spoken traditions, to civilization with a recorded history. She recorded at first with printed, afterward with script characters, the history of a group of hyacinths, whose development she watched from birth to death. The writing, though compelled to be carefully done, was recognized as no end in itself, but as a means to preserve a connected history of a series of interesting events, otherwise liable to lapse into oblivion. The art was thus approached as all arts should be, from the stand-point of its real genesis, and tended to place itself in the same relative position in the child's mind that it had occupied in the real history of the world.

Study of the pathological conditions of writer's cramp, and of the numerous brain-lesions which have so marvelously dissected the faculty of comprehending verbal and written signs, has revealed a hitherto unsuspected complexity in the muscular movements involved in writing, and of the mental processes necessary to language.* The discovery has not yet modified the glaring crudity of the educational methods which persist in beginning mental training with a forced drill in these complex processes and gymnastics.

Not speech abstractions, the highest conquest of the mind, but the development of the visual conceptions, which are its earliest spontaneous achievement, should be the first object of systematic training. Forms and colors are the elements of all visual impressions ; and these are, moreover, susceptible of a scientific classification which can, from the beginning, be rendered appreciable to the child. It is upon forms and colors, therefore, that both perception and memory must first be exercised. The visual impression should be amplified up to the point at which it is able to fix itself on the mind by its own momentum ; therefore, without conscious effort. When the mind has accumulated a stock of reminiscences which *can not* be forgotten, it will, by so much, have enriched its structure and enlarged its furniture. It is then prepared for voluntary efforts at recollection.

The amplification of the impression is effected in two ways : 1. The impression may be associated with an action on the part of the child,

* See Kussmaul, "Stoerungen der Sprache" ; also, Lichtheim on "Aphasia" ("Brain," January, 1885). The literature on these two subjects is already immense.

as when he arranges building-blocks into definite forms. 2. The outlines of the object itself may be magnified, and at the same time roughened, by being copied with sticks, as may be done in the first attempts at map-drawing. The copy substitutes a schematic outline for the real one, but by the very fact blends a mental conception with the simple visual image. This necessity for amplification is very important, and, as it seems to me, very often overlooked. It is strictly in accordance with the physiological law in neuro-dynamics, that a stimulating impression must vary in intensity inversely to the susceptibility of the nerve-element to be impressed. The more developed and vigorous the mind, the slighter the object that is perceived and remembered ; and, as Mr. Froude remarks, men of genius always have tenacious memories. Conversely, the relatively feeble mind of the young child requires a large object to awaken its prehensile faculties. If the memory of children for what has once impressed them is often remarkable, it is because the infantile period of mental development bears much analogy with the character of genius.

It seems to me that for several years no abstract statements should be made to a child, except such as may be, at least schematically, represented by tangible objects, and at every new point of even advanced studies recurrence to such schemas may be usefully made.

Perception and memory should be indissolubly associated. There are two prevalent errors of method which I have noticed : to expect a child to remember what it has never perceived ; and to allow it to perceive without any systematic representation of the object in memory. In the earliest training, contemplation of an object is insufficient to fix its outlines on the mind : it must be handled as well as seen. In my own experiment with a child of four, Froebel's building-blocks were used to construct definite models ; but these, once framed, were repeated from memory. Sometimes the details of an exciting story, as that of "Blue-Beard," were associated with the different details of the model, so that these were more vividly remembered.

By building in succession the different rooms in which the various acts of the tragedy were supposed to have occurred, the child learned, on the one hand, mathematical outlines ; on the other hand, to remember history by, in a degree, acting history herself. The principle of this method is applicable to much more advanced studies.

President Hill, in his eloquent little book on the "True Order of Studies," emphatically insists on the necessity for a selection of studies which differ widely from the conventional programme. "We awake to consciousness," he observes, "through the fact of motion which reveals to us an outer world, and a universe of space and time in which that world of matter moves. These space and time relations are the earliest objects of distinctly conscious intellection ; the first objects concerning which our knowledge takes a scientific form. This was true of the race, and it is true of the individual. Before the child has a clearly intellectual life on any other subjects, it attains a very definite power to distinguish the square, the circle, the oval, the spiral ; and also to recognize the rhythm of verse and music. Out of space and time arise through the suggestions of the material world three principal sciences : geometry, arithmetic, algebra. In considering space we are led to imitate the act of the Divine Intellect, which has geometrized from eternity. Geometry is the earliest and simplest of all possible sciences." The writer proceeds to point out that "the earliest abstraction from the idea of form is that of number, and out of this idea is evolved the earliest of the truly abstract sciences, namely, arithmetic. But because this science is based upon an abstraction, and not upon a direct perception, it should be made to follow, and not, as is usually the case, precede geometry." Again, "the earliest suggestions of motion reveal to us time as well as space. But space is external to the mind ; time enters into our spiritual consciousness, and measures our flow of thought."

To this might be added the anatomical consideration that the formation of space conceptions is the function of the cerebrum, from the impressions furnished by the optic nerve ; while the conceptions of time are elaborated in the cerebellum from the experience in successions of events furnished by the auditory nerve. Space conceptions are objective, static ; time conceptions, from the beginning subjective, are at first successive, then become progressive, finally causal, dynamic—when the conception of cause arises from consideration of the sum of antecedent events. Thus this second series of conceptions soon impinges upon moral considerations ; the first remains within the sphere of perceptive intelligence. To space, or optic nerve conceptions, belongs symmetry; to time, or auditory nerve conceptions, belong harmony and rhythm.

These ultimate ramifications of the primary psychic phenomenon must be held in mind at the moment of beginning to systematize the visual and auditory perceptions which lie at their basis.

All object-teaching may be made useful as a means of training to independent observation. But the study of ordinary, i. e., of complex objects, is necessarily empirical, whereas geometric forms can be at once submitted to scientific generalizations, can therefore at once initiate the child into scientific method. Dr. Hill recommends the study of geometry to be begun at the age of eight. The child upon which my own experiment was performed began the study of geometric elements before she was four. Some details of her education may perhaps be quoted as the best way of illustrating certain abstract principles. At the age of four and a half she had learned the following elements : straight, curved, slanting, and half-slanting lines, also to distinguish perpendicular and horizontal lines, and to draw either straight or curved lines parallel to each other. She was well acquainted with all forms of the triangle, equilateral, isosceles, right angle, and scalene. She knew a rectangle and a square, and the relations to each of the slanting and half-slanting line. She knew also, and was especially fond of, the trapezium, trapezoid, the pentagon, hexagon, etc., the circle and semicircle ; and, in solid figures, knew the cube and its apparent relations to the square. She did not merely know the names of these things, but to her eye the whole perceptible universe arranged itself spontaneously into these fundamental forms ; for she was incessantly disentangling them from the complex appearances of surrounding objects. Thus a horse-railroad interested her as an illustration of parallel straight lines which never met, the marks of carriage-wheels as parallel curved lines, the marks of horseshoes, as "dear little curves." She learned that the curved line was the line of living things, and that straight lines belonged exclusively to artificial objects. At dinner she divided her cake into squares or cubes, and made pentagons and octagons with the knives and forks. She learned that by increasing the number of sides a plane figure gradually progressed from a triangle to a circle ; and thus, on first seeing a cylinder, at once compared it to a circle, because "it had ever and ever so many sides," and not to a prism with which the superficial resemblance might be supposed to be more striking.

The habit of looking for the forms of things led the child to the spontaneous observation of the alphabet, which she taught herself by incessantly copying the letters until she was familiar with them.* It was at this time that her education devolved upon me, and I began to effect the transition from a simple descriptive study of geometric forms toward some conception of their necessary relations. At first the purely descriptive study of geometric forms was continued, and, for several months and by the help of wooden models, extended from plane to solid figures. Later, when she was five and a half, some necessary relations were taught. Thus the child learned that three was the smallest number of straight lines which could include a space, by building with colored sticks an imaginary fence around a field in which a goat was to be inclosed. It was obvious that, when only two sides of the fence were completed, the goat would be able to run out and wreak all the destruction in the garden which might be anticipated from a reckless and unrestrained goat. An indissoluble association of ideas was thus established between a geometric necessity and the logic of events.

The second axiom taught was the equality of any two objects which were demonstrably equal to the same third. This was learned when the child was five years old ; and illustrated in the first place by its applicability to the solution of problems otherwise insoluble. Thus, if it became necessary to compare the height of two girls, one of whom lived in Syracuse and the other in Boston, but unable to visit

* This first year of the child's education was carried on in the Kindergarten of Mrs. Walton.

each other, a common measure was suggested in the person of a third girl living in New York, of more peripatetic habits, and able to travel from one place to another. By the same device the lesser difficulty was overcome, of comparing the length of a floor and the ceiling of a room through the medium of the wall. Ultimately the problem was illustrated by the less conspicuous mechanisms of colored sticks, and then the first algebraic signs of equality and inequality were taught, thus preceding all knowledge of writing. When the idea had been thus copiously illustrated and perfectly grasped, the verbal axiom ("things equal to the same things," etc.) was, by exception, given, and learned with ease. This was proved by the child's remark on one occasion of applying the axiom, "I knew what I was *thereforeing*." In a similar way were taught some other axioms—thus, that equals being added to equals the wholes are equal, and that the whole is equal to the sum of its parts. The last axiom was illustrated graphically by observation of a large complex fungus which the child happened to pick up during a walk. Each part was apparently independent, yet so inseparable from the whole in which it inhered, and the whole was so obviously composed of these aggregated segments, that the axiom in question seemed to the child simply descriptive of the object.

Thus the mind was early initiated into the recognition of necessary truths, however few, lest otherwise it should never acquire that sense of reality and necessity which is essential to all forcible mental and moral action.

At the beginning of the year, the child being four and a half, the study of elementary colors was added to that of form. It was begun logically with observation of the rainbow. The child was led to notice and distinguish its colors in their regular order, and subsequently to reproduce this order exactly by means of colored sticks. As this was a fundamental observation among those furnished by the universe of things, it was constantly allowed to recur in different combinations in the same way as the original theme of a musical symphony. Thus at first the colored sticks were laid parallel to each other in a simple package. Subsequently the study of form and color was combined by using the same colored sticks to construct angular geometric figures from the triangle to the decagon. Each figure consisted of seven of different sizes and colors, placed concentrically to each other, in the rainbow order. After several months a third complication was introduced, by imagining that each color represented a lineal bed of flowers, the flowers having been previously gathered by the child and their colors compared. At this time solid figures would be placed in the center of the innermost plane figure outlined by the sticks, thus bringing out clearly the relations of the sides of such solids to certain planes. Thus a cube would stand in a square, a tetrahedron or pyramid in the center of a triangle. This last case offered the occasion for a somewhat wide reach of fancy: for pictures were shown exhibiting pyramids in the Egyptian Desert, to imitate which the table was strewed with sand. Then the different triangles were outlined with sticks, representing successive beds of flowers breaking the desolation of the desert—thus, roses and pinks, then marigolds, then yellow snap-dragons, jonquils, and laburnums, then a bed of green leaves, another of periwinkles and blue bells, a sixth of hyacinths and a seventh of violets. Thus the entire exercise embraced conceptions of form, and of the relations of plane to solid geometric figures, conceptions of color, discovery of the origin of these in a grand cosmic phenomenon, utilization of colors as one means of classification in a new science, that of botany, impressions of beauty from the actual color combinations, and from reference, partly actual, partly from memory, to the lovely flowers suggested; finally, a large imagination of a distant land more or less distinctly suggested by the picture. The exercise was thus both orderly and complex; it required a prolonged effort of sustained attention, and implied the association of quite a number of different ideas into a single massive conception. Finally, none of these ideas were represented by a verbal formula, but each as the scarcely removed abstraction from a tangible object, that the child could freely handle. The exercise was thus a typical illustration of the methods which I have defined as suited to develop a higher order of intellectual capacity.

The second step in the study of cosmic phenomena, which had been begun by observation of the rainbow, consisted in study of the points of the compass. The child was first taught to construct, from Kindergarten tablets, figures which might serve to indicate the points of the compass; afterward she was obliged to recognize these points out-of-doors by reference to the rising and setting sun. Every morning she ascertained the direction of the winds and waves. She was then taught the points on a real compass, and how to direct her country walks by means of this instrument. This was her first initiation into the use of instruments of precision. It was gradually extended during the year by means of practical experiments with the mathematical compass, ruler, spirit-level, pulley, wedge, and balance. The use of the last instrument, together with that of measures, greatly simplified and abridged the labor ordinarily devoted in arithmetic to learning about weights and measures. The child was taught the metric system first, because it was logical, because it assimilated readily with American decimal currency, and because the mutual interconversion of weight and capacity practically demonstrated—e. g., by showing that a cubic centimetre of water weighed a gramme—prepared the way for the great idea, to come later, of scientific correlations. The English weights and measures were learned afterward, as historical accidents, not logical, but of some practical convenience, as purely contingent knowledge to be learned practically as the occasion presented itself. She was sent to the grocer's to buy a bushel of apples, compared quarts, pecks, etc., together, and was never troubled with the senseless memorization of tables.

After knowledge of the rainbow and the points of the compass, the third cosmic notion acquired was that of perspective. This was first learned by watching ships passing over the water near which the child was playing, and observing their diminution of size as the distance increased. This observation made a profound impression upon the child ; it was, perhaps, the first time that she learned that appearances do not always correspond to the reality of things, and that simple perceptions must be constantly controlled by an effort of the reasoning intellect. A year later, thus, when the child was five years old, the subject of perspective was reviewed in a different connection. She tried to draw a cube, and was shown the device by which a slanting line is made to represent a retreat from the foreground to a distance. This new discovery proved as exciting as the first had been, and it was speedily tested on all the pictures hanging in the room. On the first occasion, perspective had appeared like a great and astonishing fact of the external universe ; on the second, like an immense achievement of the human intellect, which had thus contrived to accomplish the apparently impossible—namely, the representation of solid objects on a flat surface. The lifting of such large horizons makes epochs in the history of the intellect ! The study was not confined to the form or line, but extended to observation of the effect of light and shade—the darkness of a receding surface, the brightness of the nearest point of a spherical surface, etc. Then the child reproduced these effects in her own drawing.

At this time the child began the study of geographical maps, as another method of emphasizing space conceptions. For so young a child the dissecting map was much simpler than would have been the attempt to make actual surveys of familiar localities, as is sometimes recommended. These were deferred till a little later. By the aid of the dissecting map, the child learned the outline of each of the United States, and their exact relations to each other, while still quite unable to read the names printed upon the models. In putting the map together, the compass was again brought into requisition, and the table on which the map was constructed turned until it faced the real north. The relative situation of places was always learned by reference to the compass, and not by arbitrary signs.

With so young a child it was impossible to associate much real information with these unknown states whose geometrical outlines she studied ; therefore, every facility was offered to establish associations of fantasy, either with the shape of the pieces or with the names, association which the child usually discovered for herself. Thus, she described Virginia as a kneeling camel ; Texas, for some reason which I could not appreciate, as a man leaning on his pipe ; Maine, as a dog's head ; Tennessee, as a boy's sled, etc.

The study of the one dissecting map was pursued uninterruptedly for six months. In a few weeks the child had learned to identify and name each piece, either on her model or on other maps, and could put each in its place. Before she left the map she was able to bound any State with the models, or verbally; also to make strips of successive States, beginning at any point and running in any direction. With the entrance upon her second year, at the age of five and a half, the child began the study of maps from "Cornell's Geography." But in a very little while these were exchanged for a large relief-globe. From the time the child began the study of this globe it became difficult for me to understand how any other method could ever be employed. The picturesque effect of the distinctly outlined continents, visible at a considerable distance, separated by vast tracts of desolate ocean, in which, as the child remarked, "one could easily drown," the mutual relations of parts whose perception need never be disturbed, as is incessantly done when the pupil passes from map to map—all these effects and impressions can be obtained from nothing else but from a globe of adequate size and in relief. The child, when just six, began to draw maps from this globe. On a single very large piece of paper would be represented whatever outlines were discoverable at the maximum distance and at a certain aspect of the globe. The latter was then revolved somewhat, the child remaining at the same distance, and a new map outlined as before, and so on until the entire globe had been, in the major outlines, copied by the child. It was reserved for months of future study to fill in the details in proportion to their successive natural, not political, importance.

Four different spheres of thought were prepared for by this study. First, and most obviously, the foundations were laid for all knowledge of physical geography. This foundation was laid in vivid sense impressions, and unalloyed with the singular mess of political, historical, and commercial details, with which even the best geographical text-books for children are filled, and which are quite irrelevant to the main issue. When the child could with her finger trace the water-courses all around the world, she received a large fundamental impression not easily forgotten. Incidentally in this tracing she learned the value of canals at the Isthmuses of Suez and Panama. Secondly, a solid foundation was laid for history. The first map drawn was of Africa, on account of its simplicity of outline; but this involved the basin of the Mediterranean. The second map, passing eastward, took in the strongly accentuated outlines surrounding the Indian Ocean, and indicated the Himalaya and the high table-lands of Northern India. In the future it was intended, with these same outlines under the eye, and the picture of them deeply graven on the brain, to indicate the descent of Aryan ancestors from these table-lands toward the Mediterranean basin—the germinal spot of our historical world; thence the further spread westward to the new hemisphere. The conception of an historical germinal spot was again prepared for in advance, by showing the child the cicatricule of a hen's egg, lying like the Mediterranean basin, on a globe. Thirdly, study of the systematized topography of the globe constituted the best initiation into the study of all topographical relations, including those involved in animal anatomy, and therefore this consideration was not among the least important. Fourthly, an important elementary philosophical training was obtained, as the child learned to analyze into their details the largest pictures offered by the globe, and to arrange these details into orders of successive degrees of generalization. Great care was taken that all pictures or outlines of the same magnitude, and hence visible at the same distance, should be studied at the same time, and not associated with less conspicuous details that required more minute attention. This rule of following successive degrees of generalization in geographical analysis is most imperfectly observed in text-books. It imposes itself in study of the relief-globe.

[*To be continued.*]

ON LEAVES.

By Sir JOHN LUBBOCK.

II.

WE have hitherto been considering, for the most part, deciduous trees. It is generally supposed that in autumn the leaves drop off because they die. My impression is that most persons would be very much surprised to hear that this is not altogether the case. In fact, however, the separation is a vital process, and, if a bough is killed, the leaves are not thrown off, but remain attached to it. Indeed, the dead leaves not only remain *in situ*, but they are still firmly attached. Being dead and withered, they give the impression that the least shock would detach them ; on the contrary, however, they will often bear a weight of as much as two pounds without coming off.

In evergreen species the conditions are in many respects different. When we have an early fall of snow in autumn, the trees which still retain their leaves are often very much broken down. Hence, perhaps, the comparative paucity of evergreens in temperate regions, and the tendency of evergreens to have smooth and glossy leaves, such as those of the holly, box, and evergreen-oak. Hairy leaves especially retain the snow, on which more and more accumulates.

Again, evergreen leaves sometimes remain on the tree for several years ; for instance, in the Scotch pine three or four years, the spruce and silver-fir six or even seven, the yew eight, *A. pinsapo* sixteen or seventeen, araucaria and others even longer. It is true that during the later years they gradually dry and wither; still, under these circumstances they naturally require special protection. They are, as a general rule, tough, and even leathery. In many species, again, as is the case with our holly, they are spinose. This serves as a protection from browsing animals; and in this way we can, I think, explain the curious fact that, while young hollies have spiny leaves, those of older trees, which are out of the reach of browsing animals, tend to become quite unarmed.

In confirmation of this I may also adduce the fact that while in the evergreen-oak the leaves on well-grown trees are entire and smooth-edged like those of the laurel, specimens which are cropped and kept low form scrubby brushes with hard prickly leaves.*

Mr. Grindon, in his "Echoes on Plant and Flower Life" (p. 30), says that "the occurrence of prickles only here and there among plants shows them to be unconnected with any general and ruling requirement of vegetation. We can only fall back upon the principle laid down at the outset, that they are illustrations of the unity of design in Nature, leading us away from the earth to Him who is 'the end of problems and the font of certainties.'" Surely, however, it is obvious that the existence of spines and prickles serves as a protection.

Another point of much importance in the economy of leaves is the presence or absence of hairs. I have already observed that most evergreens are glossy and smooth, and have suggested that this may be an advantage, as tending to prevent the adherence of snow, which might otherwise accumulate and break them down.

The hairs which occur on so many leaves are of several different types. Thus, leaves are called silky when clothed with long, even, shining hairs (silver-weed); pubescent or downy, when they are clothed with soft, short hairs (strawberry); pilose, when the hairs are long and scattered (herb-robert); villous, when the hairs are rather long, soft, white, and close (forget-me-not); hirsute, when the hairs are long and numerous (rose-campion); hispid, when they are erect and stiff (borage); setose, when they are long, spreading, and bristly (poppy); tomentose, when they are rather short, soft, and matted; woolly, when long, appressed, curly, but not matted (corn-centaury); velvety, when the pubescence is short and soft to the touch (foxglove); cobwebby, when the hairs are long, very fine, and interlaced like a cobweb (thistle, cobwebby houseleek). The arrangement of the hairs is also interesting. In some plants there is a double row of hairs along the stem. In the chickweed only one. This, perhaps, serves to collect rain and dew, and it is significant that the row of hairs is always opposite to the flower-stalk, which also has a single row. Now, the flower-stalk is for a considerable part of its life turned downward, with the row of hair outward. This, perhaps, may account for the absence of hairs on that side of the stem.

* Bunbury, "Botanical Fragments," p. 320.

Many leaves are clothed with woolly hairs while in the bud, which afterward disappear. Thus, in the rhododendron, horse-chestnut, and other species, the young leaves are protected by a thick felt, which, when they expand, becomes detached and drops off. Many leaves are smooth on the upper side, while underneath they are clothed with a cottony, often whitish, felt. This probably serves as a protection for the stomata. In some cases the hairs probably tend to preserve the leaves from being eaten. In others, as Kerner has suggested, they serve to keep off insects—apparently with the special object of preventing the flowers from being robbed of their honey by insects which are not adapted to fertilize them. Fritz Müller, to whom we are indebted for so many ingenious observations, gives an interesting case. The caterpillar of *Eunomia eagrus*, when about to turn into the chrysalis (Fig. 20), breaks off its hairs and fastens them to the twig which it has selected, so as to form on each side of itself about half a dozen stiff fences, to protect it during its helpless period of quiescence.

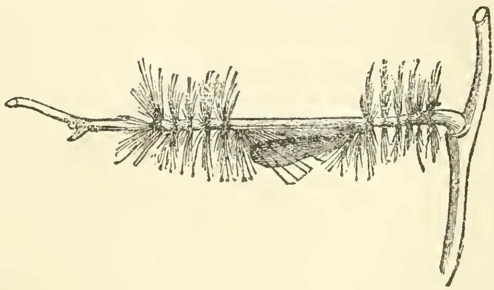


Fig. 20.

Vaucher long ago observed, though he gave no reason for the fact, that among the *Malvaceæ* (mallows) the species which produce honey are hairy, and those which do not are glabrous.

If we make a list of our English plants, marking out which species have honey and which have hairs, we shall find that we may lay it down as a general rule that honey and hairs go together. The exceptions, indeed, are very numerous, but when we come to examine them we shall find that they can generally be accounted for. I have made a rough list of the species in the English flora which have honey and yet are glabrous. It does not profess to be exactly correct, because there are some species with reference to which I was unable to ascertain by personal examination, or by reference to books, whether they produced honey or not. My list, however, comprised 110 species.

Now, in the first place, of these 110 species, in sixty the entrance to the honey is so narrow that even an ant could not force its way in; twenty are aquatic, and hence more or less protected from the visits of ants and other creeping insects; thus we shall frequently find that, if, in a generally hairy genus, one or more species are aquatic, they are also glabrous—as, for instance, *Viola palustris*, *Veronica anagallis*, *V. beccabunga*, and *Ranunculus aquatilis*. *Polygonum amphibium* is peculiarly interesting, because, as Kerner has pointed out, aquatic specimens are glabrous; while in those living on land the base of the leaf produces hairs. Half a dozen are early spring plants which flower before the ants are roused from their winter sleep; about the same number are minute ground-plants to which hairs could be no protection; three or four are night flowers; there still remain a few to be accounted for, which would have to be considered individually, but probably the evidence is sufficiently complete to justify the general inference.

Lastly, I must not omit to mention the hairs which have a glandular character.

The next point to which I would call attention is the remarkable manner in which certain forms repeat themselves. In some cases, there seems much reason to suppose that one plant derives a substantial advantage from resembling another. For instance, *Chrysanthemum inodorum*, the scentless mayweed, very closely resembles the camomile in leaves, flowers, and general habit. The latter species, however, has a strong, bitter taste, which probably serves as a protection to it, and of which also, perhaps, the scentless mayweed may share the advantage. These two species, however, are nearly allied to one another, and I prefer, therefore, to take as an example of mimicry the stinging-nettle (*Urtica*) and the common dead-nettle (*Lamium album*). These two species belong to totally different families; the flowers are altogether unlike, but the general habit and the form of the leaves are extremely similar.

How close the similarity is may be seen by the illustration (Fig. 21), taken from an excellent photograph made for me by Mr. Harman, of Bromley. The plants on the right are true stinging-nettles; those on the left are the white dead-nettle, one of which is in flower. So close was the resemblance that, after getting the photograph, I went back to the spot on which they were growing to assure myself that there was no mistake. It can not be doubted that the true nettle is protected by its power of stinging; and, that being so, it is scarcely less clear that the dead-nettle must be protected by its likeness to the other. Moreover, though I was fortunate in lighting on so good an illustration as that shown in the figure just when I had the opportunity of photographing it, still every one must have observed that the two species are very commonly found growing together. Assuming that the ancestor of the dead-nettle had leaves possessing a faint resemblance to those of the true nettle, those in which the likeness was greatest would have the best chance of survival,

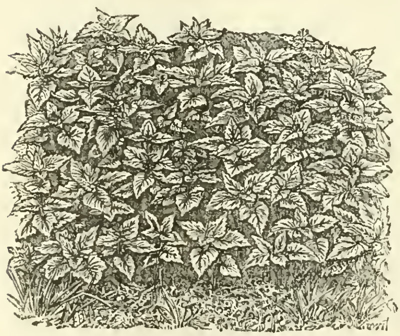


Fig. 21.

and consequently of ripening seeds. There would be a tendency, therefore, according to the well-known principles of Mr. Darwin, to a closer and closer resemblance. I am disposed to suggest whether these resemblances may not serve as a protection, not only from browsing quadrupeds, but also from leaf-eating insects. On this part of the subject we have as yet, however, I think, no sufficient observations on record.

Ajuga chamæpitys, the yellow bugle, has leaves crowded and divided into three linear lobes, the lateral ones sometimes again divided. They differ, therefore, greatly from those of its allies, and this puzzled me much until one day I found it growing abundantly on the Riviera among *Euphorbia cyparissias*, and I was much struck by the curious likeness. The Euphorbia has the usual acrid juice of the genus, and it struck me that the yellow ajuga was perhaps protected by its resemblance.

Leaves which float on the surface of still water tend to be orbicular. The water-lilies are a well-known illustration. I may also mention *Limnanthenum nymphæöides*, which, indeed, is often taken for a water-lily, though it really belongs to the family of gentians, and *Alisma natans*, a species allied to the plantains. In running water, on the contrary, leaves tend to become more or less elongated.

Subaqueous leaves of fresh-water plants have a great tendency either to become long and grass-like or to be divided into more or less hair-like filaments. I might mention, for instance, *Myriophyllum; Hippuris*, or mare's-tail, a genus which among English plants comes next to *Circæa*, the enchanter's nightshade; *Ranunculus aquatilis* a close ally of the buttercup; and many others.

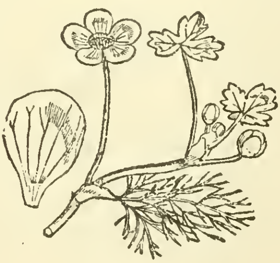


Fig. 22.

Some, again, which, when mature, have rounded, floating leaves, have long, narrow ones when young. Thus in *Victoria regia* the first leaves are filiform, then come one or more which are sagittate, and then follow the great orbicular leaves.

Another interesting case is that in which the same species has two forms of leaf (Fig. 22)—namely, more or less rounded ones on the surface, and a second series which are subaqueous and composed of more or less linear or finely divided segments.

Mr. Grant Allen has suggested that this tendency to subdivision in subaqueous leaves is due to the absence or paucity of carbonic acid. I have ventured to suggest a different explanation. Of course it is important to expose as large a surface as may be to the action of the water. We know that the gills of fish consist of a number of thin plates, which while in water float apart, but have not sufficient consistence to support even their own weight, much less any external force, and consequently collapse in air. The same thing happens with thin, finely cut leaves. In still water they afford the greatest possible extent of surface with the least expenditure of effort in the formation of skeleton. This is, I believe, the explanation of the prevalence of this form in subaqueous leaves.

Again, in still air the conditions, except so far as they are modified by the weight, would approximate to those of water; but the more the plant is exposed to wind the more would it require strengthening. Hence, perhaps, the fact that herbs so much oftener have finely cut leaves than is the case with trees. In the *Umbellifers*, for instance, almost all the species have the leaves much divided—more, I need hardly say, than is the case with trees. Shrubs and trees are characterized by more or less entire leaves, such as those of the laurel, beech, hornbeam, lime, or by similarly shaped leaflets, as in the ash, horse-chestnut,' walnut.

There are, however, many groups of plants which, while habitually herbaceous, contain some shrubby species, or *vice versa*. Let us take some groups of this description in which the herbaceous species have their leaves much cut up, and see what is the character of the foliage in the shrubby species.

The vast majority of *Umbellifers*, as I have just observed, are herbaceous, and with leaves much divided, the common carrot being a typical example. One European species, however, *Bupleurum fructicosum*, is a shrub attaining a height of more than six feet, and has the leaves (Fig. 23) coriaceous, and *oblong-lanceolate*.

Fig. 23.

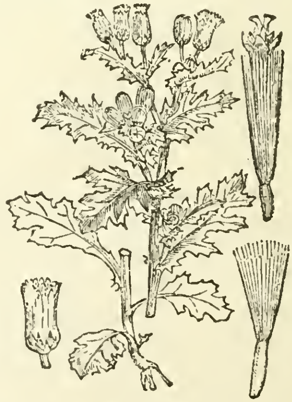


Fig. 24.

The common groundsel (Fig. 24), again, is a low herb with much cut leaves. Some species of *Senecio*, however, are shrubby, and their leaves assume a totally different character, *Senecio laurifolius* and *S. populifolius* having, as their specific names denote, leaves respectively resembling the laurel and poplar. In the genus *Oxalis*, again, to which the shamrock belongs, there is a shrubby species, *O. laureola*, with leaves like those of a laurel.

I would venture, then, to suggest these considerations as throwing light on the reason why herbaceous plants so often have their leaves much cut up.*

Next let me say a few words on the reasons why some plants have broad and some narrow leaves. Both are often found within the limits of a single genus. I have ventured to indicate the distance between the buds as a possible reason in certain cases. It would not, however, apply to herbaceous genera such as *Plantago* or *Drosera.* Now, *Drosera rotundifolia* (Fig. 25) has the leaves nearly orbicular,

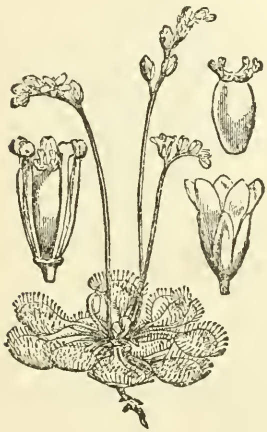


FIG. 25.

FIG. 26.

while in *D. anglica* (Fig. 26) they are long and narrow. *Plantago media* (Fig. 27) has ovate leaves, while in *P. lanceolata* (Fig. 28) they are lanceolate, and in *P. maritima* nearly linear. More or less similar cases occur in *Ranunculus.*

These differences depend, I believe, on the attitude of the leaf, for it will be found that the broad-leaved ones are horizontal, forming a rosette more or less like that of a daisy, while the species with narrower leaves carry them more or less erect. In the daisy the rosette lies on the ground, but in other cases, as in *Daphne* (Fig. 29), it is at the end of a branch.

Any one who has looked with an observant eye at the vegetation of hot, dry countries must have noticed how much the general character of the vegetation differs from that which prevails in a climate like ours. There is a marked increase of prickly, leathery, and aromatic species. The first two characteristics evidently tend to protect the leaves. As regards the third, Mr. Taylor,† in his charming book on

* Mr. Grant Allen, who had been also struck by the fact that herbaceous plants so often have their leaves much cut up, has suggested a different explanation, and thinks it is due to "the fierce competition that goes on for the carbon of the air between the small matted undergrowth of every thicket and hedge-row."

† Page 311.

"Flowers," has pointed to the power which, as Tyndall has shown, the spray of perfume possesses to bar out the passage of heat-rays, and has suggested that the emission of essential oils from the leaves of many plants which live in hot climates may serve to protect themselves against the intensely dry heat of the desert sun.

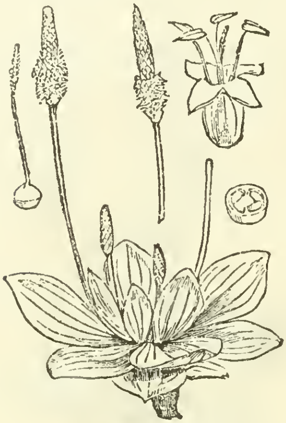


Fig. 27.

Fig. 28.

I am rather disposed to think that the aromatic character of the leaves protects them by rendering it less easy for animals to eat them.

In still drier regions, such as the Cape of Good Hope, an unusually large proportion of species are bulbous. These, moreover, do not belong to any single group, but are scattered among a large number of very different families: the bulbous condition can not, therefore, be explained by inheritance, but must have reference to the surrounding circumstances. Moreover, in a large number of species the leaves tend to become succulent and fleshy. Now, in organisms of any given form the surface increases as the square, the mass as the cube, of the dimensions. Hence, a spherical form, which is so common in small animals and plants, and which in them offers a sufficient area of surface in proportion to the mass, becomes quite unsuitable in larger creatures, and we find that both animals and plants have orifices leading from the outside to the interior, and thus giving an additional amount of surface. But in plants which inhabit very dry countries it is necessary that they should be able to absorb moisture when opportunity offers, and store it up for future use. Hence, under such circumstances fleshy

Fig. 29.

stems and leaves are an advantage, because the surface exposed to evaporation is smaller in proportion than it would be in leaves of the ordinary form. This is, I believe, the reason why succulent leaves and stems are an advantage in very dry climates, such as the Canaries, Cape of Good Hope, etc.

The genus *Lathyrus,* the wild pea, contains two abnormal and interesting species, in which the foliaceous organs give the plant an appearance very unlike its congeners. Fig. 30 represents *L. niger,* with leaves of the ordinary type. In the yellow pea (*L. aphaca,* Fig. 31), the general aspect is very different, but it will be seen on a closer

FIG. 30.

FIG. 31.

inspection that the leaves are really absent, or, to speak more correctly, are reduced to tendrils, while the stipules, on the contrary, are, in compensation, considerably enlarged. They must not, therefore, be compared with the leaves, but with the stipules of other species, and from this point of view they are of a more normal character, the principal difference, indeed, being in size.

The grass pea (*L. nissolia,* Fig. 32) is also a small species. It lives in meadows and the grassy borders of fields, and has lost altogether, not only the leaves, but also the tendrils. Instead, however, of enlarged stipules, the functions of the leaves are assumed by the leaf-stalks, which are elongated, flattened, linear, ending in a fine point, and, in fact, so like the leaves of the grasses among which the plant lives that it is almost impossible to distinguish it except when in flower. For a weak plant growing among close grass, a long linear leaf is, perhaps, physically an advantage ; but one may venture to suggest that the leaves would be more likely to be picked out and eaten if they were more easily distinguishable, and that from this point of view also the similarity of the plant to the grass among which it grows may also be an advantage.

In looking at foliage I have often been much puzzled as to why the leaves of some species are tongue-shaped, while others are lobed. Take, for instance, the black bryony (*Tamus communis*) and the common bryony (*Bryonia dioica*). Again, why are the veins in some leaves pinnate, like those of the beech and elm, and others palmate, as in the maple and sycamore?

Fig. 32.

My first idea was that this might have reference to the arrangement of the woody fibers in the leaf-stalk. If we make a section of the stalk of a leaf, we shall find that in some cases the woody fibers are collected in the middle, while in others there are several distinct bundles, separated by cellular parenchyma. My first idea was that each of the primary ribs of a leaf might represent a separate woody fiber in the leaf-stalk, so that leaves with a single bundle of woody fibers would be pinnate; those with several distinct bundles, palmate.

The first species which I examined favored this view. The melon, geranium, mallow, cyclamen, and other species with palmate leaves, had, sure enough, several woody fibers; while, on the contrary, the laurel, rhododendron, privet, beech, box, castanea, arbutus, phillyrea, and other leaves with pinnate veins, had one central bundle. But I soon came across numerous exceptions, and had to give up the idea.

I then considered whether the difference could be accounted for by the mode of growth of the leaf, and I am still disposed to think that it has some bearing on the subject, though this requires further study.

The next suggestion which occurred to me was that it might be connected with the "prefoliation" or arrangement of the leaves in the bud. The first palmate leaves which I examined were what is called "plicate," or folded up more or less like a fan; while the leaves with pinnate veins were generally "conduplicate," or had the one half applied to the other. But, though this was true in many cases, it was not a general rule, and I was obliged to give up this idea also.

It then occurred to me to take climbing plants, and see whether I could find any relation between palmate and tongue-shaped leaves on the one hand and the mode of growth on the other—whether, for instance, the one turned generally up, the other down; whether the one were generally twining and the other clasping, or *vice versa*. All these suggestions one by one broke down.

Among monocotyledons, however, the tongue-shaped preponderates greatly over the palmate form of leaf. With very few exceptions, the forms of the leaves of climbing monocotyledons are in fact just such as would be obtained by widening more or less the linear, grass-like leaf which is so prevalent in the class.

This, then, raises the question whether the heart-shaped leaf is the older form from which the palmate type has been gradually evolved. Let us see whether we can find any evidence bearing on this question in what may be called the embryology of plants. The furze, with its spiny prickles, belongs to a group of plants which, as a general rule, have trifoliate or pinnate leaves. Now, if we examine a seedling furze (Fig. 33), we shall find that the cotyledons are succeeded by several trifoliate leaves, with ovate leaflets. These gradually become narrower, more pointed, and stiffer, thus passing into spines. Hence, we can hardly doubt that the present furze is descended from ancestors with trifoliate leaves. I have already referred to other cases in which the young plants throw light on the previous condition of the species (*ante*, p. 12).

Fig. 33.

Now we shall have no difficulty in finding cases where, while in mature plants the leaves are more or less lobed and palmate, the first leaves succeeding the cotyledons are heart-shaped. This would seem to point to the fact that when in any genus we find heart-shaped and lobed leaves, the former may represent the earlier or ancestral condition.

The advantage of the palmate form may perhaps consist in its bringing the center of gravity nearer to the point of support. Broad leaves, however, are of two types : cordate, with veins following the curvature of the edge ; and palmate or lobed leaves, with veins running straight to the edge. The veins contain vascular bundles which conduct the nourishment sucked up by the roots, and it is clearly better that they should hold a straight course, rather than wind round in a curve. As the nourishing fluids pass more rapidly along these vascular bundles, the leaf naturally grows there more rapidly, and thus assumes the lobed form, with a vein running to the point of each lobe.

On the whole, we see, I think, that many at any rate of the forms presented by leaves have reference to the conditions and requirements of the plant. If there was some definite form told off for each species, then, surely, a similar rule ought to hold good for each genus. The species of a genus might well differ more from one another than the varieties of any particular species ; the generic type might be, so to say, less closely limited ; but still there ought to be some type characteristic of the genus. Let us see whether this is so. No doubt there are many genera in which the leaves are more or less uniform, but in them the general habit is also, as a rule, more or less similar. Is this the case in genera where the various species differ greatly in habit? I have already incidentally given cases which show that this is not so, but let us take some group—for instance, the genus *Senecio*, to which the common groundsel (Fig. 24) belongs, as a type well known to all of us—and look at it a little more closely.

The leaves of the common groundsel I need not describe, because they are familiar to us all. This type occurs in various other species of more or less similar habit. On the other hand, the fen *Senecio* (*S. paludosus*) and the marsh *Senecio* (*S. palustris*), which live in marshy and wet places, have long, narrow, sword-shaped leaves, like those of so many other plants which are found in such localities. The field *Senecio* (*S. campestris*, Fig. 34), which lives in meadows and pastures, has a small terminal head of flowers springing from a rosette of leaves much like those of a common daisy (*Bellis perennis*); a Madagascar species, as yet I believe unnamed, is even more like a daisy. *Senecio junceus* looks much like a rush; *S. hypochœrideus*, of South Africa, strikingly resembles a *hypochœris*, as its name denotes. A considerable number of species attain to a larger size and become woody so as to form regular bushes. *S. buxifolius* has very much the general look of a box, *S. vagans* of a privet, *S. laurifolius* of a laurel, *ericæfolius* of a heath, *pinifolius* of a fir, or rather a yew.

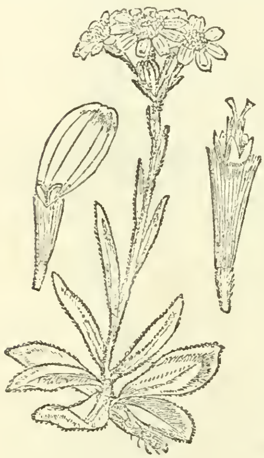


Fig. 34.

Again, some species are climbers: *S. scandens* and *S. macroglossus* have leaves like a bryony; *S. araneosus* and *S. tamoides* like a smilax or (yam) tamus; *S. tropæolifolius* like a tropæolum.

Among the species inhabiting hot, dry regions are some with swollen, fleshy leaves, such as *S. haworthii*, from the Cape of Good Hope, and *S. pteroncura*, from Magador. *Senecio rosmarinifolius*, of the Cape, is curiously like a rosemary or lavender.

Lastly, some species may almost be called small trees, such as *S. populifolius*, with leaves like a poplar; and *S. amygdaloides*, like an almond.

I might mention, if space permitted, many other species which, as their names denote, closely resemble forms belonging to other groups—such, for instance, as *Senecio lobelioides*, erysimoides, bupleurioides, verbascifolius, juniperinus, ilicifolius, acanthifolius, linifolius, platanifolius, graminifolius, verbenefolius, rosmarinifolius, coronopifolius, chenopodifolius, lavanderiæfolius, salicifolius, mesembryanthemoides, digitalifolius, abietinus, arbutifolius, malvæfolius, erodiifolius, halimifolius, hakeæfolius, resedæfolius, hederæfolius, acerifolius, plantigineus, castaniæfolius, spiræifolius, bryoniæfolius, primulifolius, and many more. These names, however, indicate similarities to over thirty other perfectly distinct families.

It seems clear, then, that these differences have reference not to any inherent tendency, but to the structure and organization, the habits and requirements, of the plant. Of course, it may be that the present form has reference not to existing, but to ancient, conditions, which renders the problem all the more difficult. Nor do I at all intend to maintain that every form of leaf is, or ever has been, necessarily that best adapted to the circumstances, but only that they are constantly tending to become so, just as water always tends to find its own level.

But, however this may be, if my main argument is correct, it opens out a very wide and interesting field of study, for every one of the almost infinite forms of leaves must have some cause and explanation. —*Contemporary Review.*

THE FUTURE OF NATIONAL BANKING.

By E. R. LELAND.

THE ever-recurring question as to the methods which should be adopted for supplying the country with currency promises soon again to demand attention, and to be beset with all its old-time perplexities. It is the riddle which is presented in turn to each civilized nation, and, although the penalty of default is severe, no satisfactory answer has as yet been found.

The national banking system, which has frequently been declared to be the best yet devised, can not be said to offer a solution, for, although it served its temporary purpose very well, it lacks, so far as its currency is concerned, the essential element of permanency, being based upon a public debt that, fortunately, is not a perpetuity. Recently grave concern has been felt and expressed over the prospective contraction, if not total withdrawal, of the national-bank circulation which is likely to result from the diminished supply of Government bonds. The prospect is generally deplored. Sundry bills were introduced into the late Congress, looking to a mitigation or postponement of the consequent evils, but no conclusive action was taken, nor is there much reason to expect that the subject will receive serious congressional consideration until it compels attention.

It is true that the advocates of a let-alone policy might justify their course by pointing out that the danger of a currency contraction does not appear so imminent as it did nine months ago. Owing to diminished revenue, there have been no recent bond calls, and the reduction of the debt is for the time arrested. But the prices of bonds have so enhanced as substantially to rob the business of issuing notes of profit, and, even were the banks willing to keep out their circulation for the small recompense which now comes to them, little reliance can be placed upon a continuance of the present conditions. The reduction of the Government debt will be resumed, nor is the delay likely to give more time than will be needed in which to devise and put into operation some other plan for furnishing a currency supply.

There are many men—so many as to constitute a party considerable in number—who have an ever-ready remedy to administer for this or any similar trouble which threatens our financial system; that is, an additional supply of legal-tender notes. It is not intended here to discuss this proposition. The evils which are certain to attend an unlimited or largely increased issue of legal tenders have so often been shown, and the greenback clamor has so far died away, that there are grounds for the hope, which let us cherish, that a majority will not call for a Government paper circulation, albeit the United States Supreme Court has decided that Congress has uncontrolled power to create and regulate such an issue. For the purpose of this paper, therefore, it will be assumed that resort will not be had to legal-tender notes for a supply of paper money when the bond-secured national-bank notes shall be withdrawn.

There is a school of economists—a title that can not properly be applied to the greenbackers—who hold that it is radically unsound and productive of evil for banks to assume the function of furnishing money; who maintain that there should be no money other than a metallic currency, or one which would in all respects act precisely as a metallic currency acts, because not only based upon but actually representing specie of a like amount deposited and held for its redemption. This school would doubtless regard the time of the retirement of national-bank notes as presenting an opportunity for inaugurating their system too good to be lost. Very recently suggestions in this line have been made and widely considered as, perhaps, offering solutions of both the paper currency and the silver problems; and, indeed, if the experiment were a wise one, it never could be made with less prospect of serious disturbance during the transition period, for the process is already begun by the issue of gold and silver certificates which could be increased, if specie were forthcoming, as bank-notes were withdrawn. If any plan embodying this idea were adopted, we should then have a system somewhat similar to that by which England has been supplied with paper money since the adoption of Peel's act in 1844. Under that act the Bank of England is now authorized to issue notes to the amount of fifteen million pounds sterling upon Government securities; beyond this sum the amount of circulation is determined solely by the amount of bullion which the public chooses to deposit, for the bank is bound to buy gold bullion at the mint price, whenever offered. The banking department and the issue department are separately managed, and of the latter the directors have no control. Professor Price says that it is not a department of the bank in any sense ; that "it is a self-acting institution of the state, working on the bank's premises, by rules laid down by the state, and absolutely beyond the control of the directors."

If the terms of Peel's act were at all times rigidly adhered to, this description of the operation of the issue department would be correct. As a matter of fact, however, they are not adhered to, but are suspended in times of financial stress, and the directors assume control of the issue department for the relief of the strain upon the banking department and the business community. Three times since the adoption of the act has its operation been suspended. The supposition that a "suspension of the act" involves a suspension of specie payments is, perhaps, still common enough to warrant an explanation of its true nature.

The Bank of England is the custodian of the principal portion of the reserve of all the banks and bankers of England, and to it the latter must look for money to meet the excessive and unusual demands that are made upon them in time of panic. At such times, therefore, a rapid inroad is made upon the bank's supply of gold, and, if the act of 1844 continues in force, a point is soon reached where the directors are compelled, for self-protection, to cease discounting even upon the best securities. Whenever the strain becomes unendurable, an appeal is made to the Government, through the Chancellor of the Exchequer, to suspend the act. If granted, the legal restrictions upon the bank's note-issues are removed, and the directors are authorized largely to increase their issue without reference to the amount of bullion in their vaults ; the effect of which is that for the time both departments of the bank are under the management and control of the directors. They are not likely to use this privilege recklessly, for the obligation to redeem their notes in gold on demand remains in full effect. Moreover, for some reason not wholly apparent, it has become a custom—so far as three instances can make a custom—for the Government to stipulate that the bank shall charge a very high rate of interest, say ten or twelve per cent, upon the extra note-issues, the profit thereon to go to the state. The result of this is, that prudence and self-interest combine to make the directors use the powers conferred upon them most sparingly, and they do so. In but one instance has there been an over-issue. This was in 1857, and to the extent of eight hundred thousand pounds. In 1847 and in 1866 the fact of suspension proved sufficient to allay the panic and to avert, at least, its worst consequences.

A recent writer recommends the mechanical and local separation of the issue department from the Bank of England to a Government office, as tending to the propagation of clearer ideas on the subject of note currency. No suggestion is offered as to the way in which relief could be afforded in emergencies similar to those which have heretofore been met by extending the bank's powers, nor is it obvious how any could be given except through the agency of the bank.

Extending the comparison between the English system and that of the United States, with the national-bank notes retired, the legal tenders, although much greater in volume, might be likened to the seventy-five million dollars that the Bank of England issues against its securities, while the bank's specie-secured issues would find their parallel in the gold and silver certificates. These now amount to something more than two hundred and fifty million dollars. They have not very far to go before they would equal the national-bank notes outstanding, and the expediency of largely increasing the issue is freely discussed.

But in the workings of the two systems here compared there would be an important difference.

When the act of 1844 was being urged, its advocates recognized that in extreme cases a rigid adherence to its provisions might be mischievous, and special governmental interference be found necessary. Experience has shown that such compelling emergencies do arise. Warned by this, Mr. Lowe, Chancellor of the Exchequer, introduced into the House of Commons in 1873 a bill providing for automatic suspension, so to speak. He proposed that the Government might lawfully suspend the bank act when certain conditions obtained, conditions presumed to be indicative of a panic; but the bill was not received with favor, and was withdrawn. What the effect of a strict adherence to the act in time of panic would be, it is difficult to predict—it has never been tried.

It is not easy to see how, even if it were made lawful, relief could be given in the case of a strictly governmental issue, consisting, for example, of specie certificates and legal tenders. If additional issues of the latter were authorized, how, in time of peace, would they be put afloat? Certainly few would be willing to have the Treasury Department take up the business of banking and make advances on miscellaneous securities. But the time would certainly come when the temporary relief given by clearing-house certificates would be found to be, or at least be thought to be, inadequate, and an increase of currency be demanded. Could there be any assurance that the power to make such increase resting in Government officials would be exercised with the caution shown by the Governor and Company of the Bank of England, who are restrained by considerations both of prudence and profit? An illustration of the course likely to be pursued was furnished in 1872–'73, when forty-four million dollars of legal tenders, which had been retired by Secretary McCulloch, were dubbed a reserve, the reissue of which was demanded and granted to the extent of twenty-six million dollars. There are ample grounds for the fear that any system under which the Government should furnish, in whatever form, the whole supply of the paper money of the country, would keep us constantly on the lee-shore of an inconvertible paper currency, the capacity of which for working mischief has often been pointed out.

It is not probable, however, that there will be any wide departure from existing methods. Outside of the straggling ranks of the greenbackers the national-bank notes are regarded with favor. It can not be gainsaid that the period during which they have been in existence has been a very comfortable one, so far as a good currency for the people could make it so. Whatever theoretical objections there may be to the system, it has worked singularly well, is justly popular, and it is easy to understand why its probable restriction and ultimate discontinuance should be looked forward to with concern.

There has been little or nothing in the way of suggestion as to what can be done to perpetuate the national-bank issues. Various plans have been proposed for prolonging their existence; but closely adhering, as all these plans do, to the theory of a bond-secured currency, they are confined within narrow limits.

Secretary Folger and Secretary McCulloch, Comptrollers Knox and Cannon, have substantially agreed in their reports for two years past in recommending—1. The removal of the tax on bank circulation; 2. An increase of the percentage of currency which the banks may issue against bonds deposited; 3. The conversion of long bonds into three, or two and a half per cents, the latter being less likely to be withdrawn for reasons having no reference to the amount of circulation needed; and bills were introduced in both Houses of the last Congress providing for the practical application of these recommendations. Their adoption would, however, afford but temporary relief. It would have the merit, no small one it may be said, of enabling us to travel along the well-known road for a while longer, but it would only postpone the day when a solution of the currency problem must be confronted.

The true solution has, by some of the gentlemen referred to, been declared to be a reduction of the redundant revenue sufficient to retard the retirement of bonds, and finally to arrest it when their volume shall have reached, or closely approached, the amount requisite to secure the national-bank circulation.

To retard the payment of the public debt by reducing taxation would probably be expedient, it certainly would be popular; but wholly to arrest payment, and, for such a purpose, maintain the debt at a fixed sum, would be another and a very questionable matter. Moreover, a currency thus regulated as to volume would lack the important element of adaptability, or, as it is sometimes called, elasticity, for it is not likely that any one would go so far as to suggest that the bond debt should be increased and decreased in accordance with the demands for currency—a method which, if not otherwise questionable, would be so clumsy and tardy in its operation as to serve but poorly. Who in such case should decide what amount of currency and consequently of bonds would be needful? The Secretary of the Treasury or the congressional committee who should be called upon to determine this point would require the same degree of omniscience that would be required to fix the proper limit of irredeemable legal tenders. The objections to any arbitrary regulation of the volume of currency have been so often pointed out as to make needless their recital in this connection.

To maintain, for the purposes of bank-note security, a Government debt anything in excess of the Government's needs, would be, in effect, to levy a tax upon the community at large for distribution as a bounty on bank-note circulation. It may be said that the benefits inuring to the issuers would be slight and incidental—a not undue reward for the service rendered—and that the real purpose would be the protection of the note-holder, which protection would be worth more than its cost. Thus stated, the proposition would be to make the note-holders a preferred class of creditors, secured at the public cost. It would be pertinent to ask here, By what logical method is the conclusion reached that this preference should be given to the note-holders alone? Are there not other classes of creditors with equal claims for protection? The depositors in savings-banks, the beneficiaries of life-insurance policies, and divers other corporate and private trusts, are now very largely secured by Government bonds, and it is not easy to see why, if the note-holders are to have special protection, these can not with perfect justice ask that they too shall continue to be cared for by the Government. That such demands should be acceded to few will assert, but it would be quite as proper for the Government to furnish security for all as for a part. But it is idle to discuss this proposition at length. Whatever differences of opinion there may be as to the rate at which reduction of the debt should go on, there is little difference as to the general principle that it should be reduced as fast as may be consistent with a proper distribution of the burden. The proposition that it is a good thing to pay one's debts, when abundantly able to do so, is sound, and it applies to an aggregate of individuals—the state—precisely as it does to a single individual. Public opinion will doubtless demand, it certainly would be right in demanding, that the volume of the public debt shall be regulated without reference to national-bank-note issues; the idea that it should, or might with propriety, be regulated with reference to their needs, is radically unsound. Nor, it may be added, are there any reasons, economic or political, for a resort to such strained methods.

That a paper currency is one of the requirements of a great commercial country is generally admitted. That such a currency can best be furnished by banks of issue, if not so generally admitted, would seem to be demonstrated by universal custom among civilized nations. The issuance of circulating notes is a legitimate, if not necessary, function of the business of banking. It is one of the forms of the complicated system of credit which has made commercial growth possible, nor is there any reason why this particular form of banking obligation, constituting, as it does, but a minor part of the total, should, when created, have other or better safeguards than the remainder. The security furnished by the capital of the banks, by the ability and integrity of their management, aided by governmental supervision, which must needs serve for the greater part of their liabilities, should be adequate for the whole. The checks and precautions, the discrimination, which are applied to the use of credit in other branches of banking, the protection which is found to answer for depositors and holders of checks and drafts, should also be sufficient for the holders of that particular class of "memoranda of claims" known as bank-notes. That this protection can be made practically efficient is amply proved by the history of the national banking system in the United States. During an experience of more than twenty years the average annual loss to depositors has been only one twentieth of one per cent of the total.

The public have become so accustomed to the use of a bond-secured currency, and have so generally credited the satisfactory results to the feature of special security, that the suggestion of an unsecured currency, or, rather, a currency not secured by special deposits, is not likely, at the outset, to be received with favor. To many it will recall the days of wild-cat banking, when the country was flooded with money that was practically irredeemable, and wide-spread and serious loss was inflicted on the community, especially upon the poorer classes, by having worthless issues forced upon them. But there is little danger and no need of a revival of that vicious system.

The lessons of the past have not been wasted; nor are we a "nation of rascals," in spite of sundry recent revelations of rascality and weakness. More and more, as civilization advances, does the tendency of people to trust each other increase. Yearly the average of prudence and trustworthiness grows larger. If not because of a stronger sense of moral obligation, then because of a better appreciation of the necessity therefor in the conduct of business, men show a growing respect for each other's rights, and place a greater reliance upon the relations of contract.

Mr. Spencer says, "Given a nation of perfectly honest men, and nearly all trade among its members may be carried on by memoranda of claims." We have not, it is needless to say, reached an ideal state of perfect honesty—far from it. The adoption, therefore, of an absolutely free banking system, without limitations or restrictions, would be an experiment too hazardous to be tried. There is, however, a degree of honesty which suffices to maintain a credit system of great extent and complexity, involving the use of enormous sums of promises to pay, and the extension of that system to cover the use of the particular form of promises to pay known as bank-notes is logical, natural, and, with proper restrictions, safe.

It is true that notes which pass from hand to hand as money are not scanned as closely as are other evidences of debt, nor can there be the same discrimination exercised in their use. They must, if circulated in small denominations, of necessity be taken by many who have no means of forming correct conclusions as to the soundness of the issues, and who can least afford to suffer loss. But the circulation of small notes of any sort is to be deprecated. Adam Smith pointed out the difference in the forms of money required for dealers and for consumers; that for the uses of the latter, paper money is not fitted, no matter what its form or security. The soundness of this view has been largely discussed since his time, but the preponderance of opinion has been in its favor. Mr. McCulloch, in his recent report, recommended the discontinuance of small notes. It would bring out a large amount of silver and small gold, which furnish the best kind of money for the smaller transactions of trade, and afford the best possible protection for the small dealers, the wage-earners—men, women, and children—who suffer most from a defective currency.* If small notes were retired, the smaller savings, the stocking-hoards, would consist of gold and silver, and obviously it is best that this part of the country's reserve—no inconsiderable part—should be of specie. The aggregate issue of legal-tender and national-bank notes of denominations under ten dollars is about two hundred and twenty million dollars. It is probable that nearly this entire amount could be replaced with gold and silver before the point of specie saturation would be reached. Such a volume of hard money would supply the best obtainable guarantee against currency disturbances.

That, if relieved from the function of furnishing wage and pocket money, a bank currency, suited for the larger operations of trade, and yet not handicapped with the obligation of special bond deposits, could be established with safety, may be asserted. That banks of issue can be safely conducted and furnish a sound currency has been sufficiently shown under conditions far more unfavorable than now obtain in the United States. The Scotch banks are examples. So well have they been conducted that Professor Jevons admitted that their system would be an excellent one for general adoption, "if we were all Scotchmen." It may be fairly doubted, however, whether the satisfactory results in Scotland are wholly due to exceptional integrity, sagacity, and caution on the part of Scottish managers. May it not be that the bank-currency system, properly conducted, has had a fairer trial in Scotland than elsewhere?

One does not need to be very old to remember when this country, especially the West, was dependent upon a paper currency that was, for the most part, of a very trashy kind; and to remember, also, that

* That the forced circulation of a debased coinage, by this or any other method, is not intended to be advocated, need hardly be explained; but a discussion of the silver question is no part of this paper.

even then, and in that region, there were notable exceptions. Bank officials will remember how a stray note of the ugly issues of the State Bank of Indiana, or the Wisconsin Marine and Fire Insurance Company, coming in with a pile of gaudy wild-cats, used to "shine out like a good deed in a naughty world," and was promptly sorted out and laid away as a part of the reserve. Those banks, with a few others, having relatively very large issues, were conducted safely through the vicissitudes of those days, promptly redeeming their notes on the advent of the national system without the loss of a dollar to the holders. But the honestly and prudently conducted banks of that period were not numerous nor strong enough to redeem the vices nor avert the evils of paper-money banking as it was then carried on. The story of recklessness, fraud, and suffering does not need to be retold, and no one would be willing to see the way opened for a repetition of its experiences.

The conditions now are very different. The operation of the national banking system for twenty years has brought to its management a class of trained and educated bankers, who are, for the most part, fit custodians of the people's money, and to whom might be intrusted the work of furnishing paper money for the country with greater economy and less risk of loss than would attend the adoption of any other system. The machinery is at hand, is in excellent working order, and would need but slight modifications to fit it to perform its work after the obligation to deposit Government bonds against note-issues had been canceled. There are now over twenty-six hundred national banks in operation. They have been organized and located, not with reference to issuing currency, but to supply the legitimate needs of the business community. To guard against the formation of banks for purposes of circulation only, the right to issue might for the present be confined to those now in existence, with a permanent provision that such right should be extended to new banks only after three or five years of successful operation: no permits to be granted except under the conditions now imposed as to location, ratio of capital to population, and of circulation to paid-up capital. A Government bureau should continue its supervision, and should engrave, print, and furnish the note impressions as a precaution against the possibility of over-issues; this and any other labor or expense imposed upon the bureau to be paid for by a continuance of the tax on currency. Existing regulations as to reports, examinations, and control in cases of bankruptcy should be maintained, and it might be well to give preference to the claims of note-holders. Notes should, of course, be redeemed in coin or legal tenders on demand, with provision for central redemption. At present there is, practically, no redemption except of mutilated notes. Under the system suggested redemption would be real, and the amount of note circulation be, as it should be, regulated by trade requirements, with no danger of a sudden and unnecessary increase, such as has been seen in the former history of free banking.

The question of the constitutional power of Congress to authorize such a system can only be alluded to. It would very likely be raised; but it may be assumed that it would not prove an insuperable objection. It might be made a condition of granting charters or licenses to banks that they should be required to lend a certain percentage of their capital to the Government whenever called upon, and also under proper restrictions be made depositories of public moneys; thus, as has been suggested, doing away with the expensive and primitive system of local sub-treasuries.

Bankers to make money on their issues must keep them in circulation, which could be done by the same means, and those only, that are employed to build up a line of deposits; that is to say, they must establish their credit by promptly performing their engagements. Governmental interference should be exercised solely with reference to insistence upon such performance.

That in some cases there would be mismanagement, dishonesty, and consequent loss, in the future as in the past, is certain; but the control and supervision of banking should not, any more than that of other branches of business, be regulated upon the hypothesis of fraud. The losses which might come would be comparatively small, would follow quickly upon their causes, would have the advantage of being directly traceable, and so permit the prompt application of remedial measures. With the existing means of swift communication, with the wide distribution of national banks, and the watchfulness which they employ toward each other, and, finally, with the smaller transactions carried on by means of specie, the losses upon bank-notes would not only be small, but would, for the most part, fall upon the banks themselves, they being the constant custodians of the greater part of the currency; and they could be trusted to see to it that only such circulated as was worthy to have circulation.

This brings us to a suggestion which is put forth with much hesitation, and only as a suggestion, notwithstanding it is believed that it is sound in principle, and might be made safe in practice. It is simply that the banks should assume the risk, and, as a whole, undertake to protect the rest of the community from loss upon note-issues. To effect this it would only be necessary, so far as legislation is concerned, to continue in force that provision of the existing law which makes national-bank notes a legal tender to national banks. It would seem to be well-nigh certain that the banks could assume this risk of loss, whatever it might prove to be, and still the business of issuing notes afford a larger margin of profit than it now does. For this would be but an application of the insurance principle to one class of the accidents to which the banking business is liable. The banking interest, as a whole, would undertake to indemnify the public against losses arising from the failure of individual banks to redeem their notes. As to the nature and extent of such losses, they already have a much better basis for estimating them than was available to life or fire and marine insurance companies in their inception. A perfectly trustworthy "table of experience" is supplied by the record of the losses to depositors in national banks for the last twenty years; these, as before stated, have been only one twentieth of one per cent per annum. This interval covers two periods of panic and consequent depression, and may be presumed to have included most, if not all, of the vicissitudes of the business. If from abundant caution the estimate of probable loss should be put at tenfold that which past experience with the national system has shown, and the present Government tax on currency be added, we should have a total of one and a half per cent on the volume of currency to cover losses and expenses. The premium out of which to pay this charge would be the interest on the excess of the average amount of currency in circulation over the reserve required to be held against it, or say from three to seven per cent, varying with the state of the money market and the location of the banks. This certainly offers an ample margin.

The idea is not altogether novel even in its application. It was adopted in the case of the various branches of the State Bank of Indiana, and worked satisfactorily. Slightly modified, it is applied by the guarantee companies, which, for a much smaller premium, guarantee employers against the fraud and insolvency of their servants. The suggestion may be somewhat startling to bankers, who, as a class, are proverbially and properly conservative, but the soundness of the principle which underlies it has been demonstrated by long experience and is constantly finding wider application. Bankers daily risk, without thought of fear, far larger sums than such an insurance of currency would involve upon guarantees that are much less stable, that is upon the indemnity furnished by insurance companies, which, both as regards sums at risk and premiums charged, conduct their business on comparatively small margins. Should the liability seem too great if extended commonly to all the banks, geographical districts might be created with redemption centers, the mutual guarantee of the banks not to extend beyond the limits of their districts.

Objection may be taken that such a system of currency would increase the profits of banking. That it would do so, in some degree, is probable, but it is not in the interest of that business that the suggestion is made. The public have the deepest interest in the avoidance of perturbations or disturbance in the currency supply. If the principles presented be sound, and their application correct, it would seem to be clear that the existing banks could continue their present circulation, and guarantee it, with safety to themselves and their noteholders; and that thus might be accomplished the desideratum of paying off the Government bonds, when the time comes, without canceeling the bank circulation. If, later, need should arise for a greater volume of currency, arrangements might be devised for increasing the circulation of existing banks or creating new ones. Obviously, the banks themselves should, in such event, have a voice in determining the methods by which this should be done, and in the selection of the persons or corporations to whom the right of issue should be extended. Similarly, in regard to examinations; thoroughness should be assured, nor need this be difficult. When the banks of a clearing-house are called upon to care for some embarrassed member, a brief inspection enables them correctly to determine the real condition of the applicant; they have a direct interest in getting at the facts. Examiners should be chosen, or at least nominated, by the banks.

The bureau which supervises the other operations of the banks could, with but little addition of labor or responsibility, conduct the redemption of the notes of insolvent banks, and levy and collect whatever assessments might be needed to make good deficiencies.

But it is needless to enter into an elaboration of details; they would present no serious difficulties when, if ever, it became necessary to deal with them.

It may be said of any suggestions in this connection, that, whatever opinion may be held of their worth, they are not premature, nor without value, if they provoke the attention of men who are able to do better thinking. The occasional desertion of national banks to the ranks of state institutions, and the contemplated separation of others, as well as the prospect of enforced relinquishment of circulation by all, indicate, plainly enough, that it is none too soon to consider some modification of the national banking system, if it is to be maintained, and it has worked too well to be needlessly abandoned.

It would probably be assuming too much to expect that any system of bank issues without special security, however surrounded by safeguards, would find present favor with our national legislators, or indeed secure many adherents. A few years ago, some of our ablest financiers, both in and out of Congress, predicted that free banking would follow swift upon the resumption of specie payments; but present indications do not point that way. More crude and less scientific expedients are likely first to be tried—and to fail. But it seems not over-presumptuous to predict that ultimately resort will be had to some form of that system. Its convenience and economy are obvious, and will assert themselves. The evils which it involves are such, and such only, as are inherent in the general conduct of business, such as will inhere so long as honesty and mutual confidence are imperfect; as these improve, the risks will lessen. While the causes exist, the losses will fall; there can be no perfect safeguards, nor of such as are possible can a paternal government afford the best: they must be looked for at the hands of the people themselves.

THE MECHANICS OF HANGING.

By JAMES BARR, M. D.

AS the subject of the mode of carrying out executions has recently engaged public attention, the present is perhaps an opportune time for discussing the question in its scientific and humane bearings, so that some more definite ideas may prevail as to the best method of hanging, and that the details may not be entirely left to the caprice of the executioner. When the law requires the death-sentence to be meted out at the end of a hempen rope, the dictates of humanity demand that all the details should be carried out in "decency and in order," and with a minimum amount of suffering to the culprit, and from this stand-point I shall treat the subject.

The mode of carrying out the sentence of the law, "be hanged by the neck until you are dead," has usually been left to the discretion of the hangman, the law taking no cognizance as to what is to be the proximate cause of death. Calcraft invariably adopted the short drop of about two feet and a half; and if I may judge from some specimens of his ropes, which are still to be seen at Kirkdale, death must have been produced by a slow process of asphyxia. Marwood adopted what is generally known as the long drop, of which he was supposed by many to be the originator, though it was used long before his time, both in Paris and in Ireland.

To Professor Haughton we are indebted for a scientific exposition * of the *rationale* of the long drop, and of the mode in which death takes place. Dr. Haughton also gives an elaborate explanation of the American method, which is a scientific modification of the old naval method of running the culprit up to the yard-arm.

Having now briefly referred to the different modes of hanging which have been adopted in executing criminals, we will be better able to judge which is the best and most practical method when we have considered the various causes of death. Professor Tidy † says that "in hanging, as in drowning, death does not always take place in exactly the same way. Thus, it may result from—(1) asphyxia; (2) cerebral hyperæmia; (3) a combination of asphyxia with apoplexy; (4) syncope; (5) injury to the spinal cord and pneumogastrics (neuro-paralytic death)."

Professor Hoffmann, ‡ of Vienna, says that, "in hanging, the noose does not press directly on the larynx and the trachea, but almost always slips between the larynx and the chin. In these cases the basis of the tongue is pushed upward, and pressed against the posterior wall

* "Principles of Animal Mechanics," 1873. † "Legal Medicine," part ii, p. 385.

‡ "British Medical Journal," December 21, 1878, and May 10, 1879.

of the pharynx, completely closing it. The most important agent, however, in this kind of death is the compression of the larger vessels and the cervical portion of the vagus nerve, the upper portion of the carotid being pressed against the transverse processes of the cervical vertebræ before it branches off into the external and internal carotids, and the inner coat of the vessel being ruptured. The jugular veins are compressed at the same time, and the brain can neither receive any more blood nor allow that which it contains already to flow away; its irritability is therefore extinct. The very important part which both the vagus and the vessels take in causing death by hanging is clearly shown through the following observations: 1. Loss of consciousness following immediately the compression caused by the rope at the moment when the noose is drawn tight by the weight of the body. The truth of this assertion is proved by the fact that no person who commits suicide by hanging ever attempts to rid himself of the rope which throttles him, although he might do so easily by standing upright, as the body is not always suspended above the surface of the ground. 2. The rapidity with which death ensues and the beating of the heart stops. The few struggling respirations which generally occur in asphyxia shortly before death have not been observed in persons who have been hung. It is also well known how difficult it is to restore such patients to life. Death by hanging is, then, complex. It results from the occlusion of the respiratory tubes, from the sudden interruption of the passage of blood into the brain, and possibly from arrest of the circulation determined by the compression of the vagi nerves." These observations of Professor Hoffmann obviously refer to cases of constriction of the neck without dislocation of the vertebræ, and show how death should take place rather than how it does in cases of the short drop. The constriction of the neck is not usually so complete as he has assumed; the carotids are not completely obliterated, as shown by the pulse in the temporal artery, and by the gradual increasing congestion of the head—owing to the obstruction to the venous return—until at last the tongue is protruded out of the mouth; nor is the vagus much pressed upon, as evidenced by the long continuance of the heart's beats in many cases. It shows rather a paucity of reasoning to infer immediate loss of consciousness because no suicide "ever attempts to rid himself of the rope which throttles him." A suicide is a very unlikely individual to change his purpose during the short period which elapses between suspension and loss of consciousness.

Dr. Taylor * states that "death from hanging appears to take place very rapidly, and without causing any suffering to the person. Professor Tidy, also, speaks of the painless nature of death from hanging; while Professor Haughton, in his paper read before the Surgical Society of Dublin, says that "the old system of taking a convict's life

* "The Principles and Practice of Medical Jurisprudence," 1865, p. 651.

by suffocation is inhumanly painful, unnecessarily prolonged, and revolting to those whose duty it is to be present." Those who speak of the painless nature of death by strangulation arrive at this conclusion from the fact that many cases of suicide are not completely suspended, and that if they wished they could easily relieve the constriction by assuming the erect posture, and in other cases of recovery from attempted suicide by hanging there is no recollection of any suffering. It should be remembered, however, that there is a great difference between the mental attitude of the suicide and one who is about to suffer the extreme penalty of the law. In the former case he is regardless, and perhaps also not very sensitive, of a little suffering, while in the latter every nerve is braced up to resist the inevitable result. Moreover, in those cases of recovery the loss of recollection of suffering does not prove that there was none. It might almost as well be said that, because in many cases of recovery from meningitis there was no remembrance of any suffering, therefore there was none. No doubt, the pain in hanging can under no circumstances be very acute, yet when we see a culprit heaving his chest and almost raising the whole body in his struggles for breath we must conclude that there is at least a considerable amount of mental torture.

While death from asphyxia as ordinarily brought about by the short drop is a barbarism which should not be tolerated in this humanitarian age, yet it might be accomplished without much suffering. If this mode of death be determined upon, then the constriction should be complete, and the compression of the blood-vessels, both veins and arteries, and if possible also the nerves, is of even more importance in the production of rapid unconsciousness than the occlusion of the windpipe. In accomplishing this object the position of the noose is of importance ; it should never be placed over the larynx, as the rigidity of that organ prevents complete compression and also shields the blood-vessels. Below the larynx would perhaps be the best position, but then there would always be the danger of the noose shifting up to the least desirable spot, therefore the most suitable position would seem to be between the hyoid bone and lower jaw. The rope should be thin and pliable, and not very elastic (a silk rope would perhaps be the best), the ring should be placed under the lower jaw, and the drop should be long enough to compress windpipe, blood-vessels, and nerves. If a half-inch silk rope were used I should think a drop of from four to six feet, according to the weight of the prisoner, would be sufficient. As to deaths from cerebral hyperæmia, and its combination with asphyxia, they are merely modifications of the latter form of death, and result from incomplete constriction, the windpipe not being quite occluded, while the venous return is obstructed, but not the arterial supply. They are thus rather slow forms of death, and consequently not desirable. Death from syncope may be associated with any mode of hanging, but is perhaps most frequently connected with the long drop. It is about the most rapid and least painful, though perhaps the rarest form of death. In a case of syncope, I have seen the heart's action cease in two minutes from the time the bolt was drawn. Fear largely contributes to this mode of death.

It now remains for us to consider death by dislocation or fracture of the cervical vertebræ, with consequent laceration of the spinal cord. It is frequently supposed that the injury arises from rupture of the transverse ligament of the atlas and pressure on the cord by the odontoid process, but, if ever this does occur, it must be extremely rare. Rupture of the transverse ligament could only take place when the rope was adjusted very high in the neck, with the ring directly in front or behind. And even then the odontoid process would be more likely to break than the ligament. The destructive effect occurs at the point on which the strain is brought to bear, and so the seat of injury varies in different cases. I have seen it take place in the following situations: Complete separation between the second and third cervical vertebræ and fracture of the odontoid process at its junction with the body of the axis; oblique fracture through the body of the axis, leaving the upper fragment with attached odontoid process *in situ*, and fracture of the arch separating it from the body of the axis; complete separation between the second and third cervical vertebræ above the intervertebral disk, also slight separation and tearing of ligaments between the atlas and the axis; and complete dislocation between the fifth and sixth cervical vertebræ. In this latter case the ring hitched on the chin, and the opposite part of the noose was low in the neck, so that the long leverage action determined the low position of the injury. In every case the vertebræ were separated at the point of injury for at least an inch, the spinal cord was severed, and the vertebral arteries and all the ligaments were torn across.

The shock to the nervous system produces an immediate loss of consciousness, with complete paralysis of all the voluntary muscles. It takes a body moving under the influence of gravity three quarters of a second to fall through the space of nine feet; and, owing to the velocity acquired, according to the law of uniformly accelerated motion, the time occupied in the last seven inches—during which the stretching and tightening of the rope occurs—is only ·0225 of a second. If to this we add, say, ·0275 for the elasticity of the rope, then the whole time during which the shock could be felt is only ·05, or one twentieth of a second. Even from this we must deduct the time which it takes for the nervous impression to travel to the sensorium and back, but, as the nerve-current travels at the rate of one hundred feet per second, this is so slight that, like the atmospheric resistance to the falling body, it may be left out of account. Although loss of consciousness, and it is with this that humanitarians are chiefly concerned, is instantaneous, yet death, as evidenced by the cessation of the heart's action, does not take place so rapidly. It is possible in some cases that the cardio-inhibitory center may be stimulated, or the vagi compressed, so as to immediately arrest the beat of the heart, yet I am convinced that this is the exception, and not the rule. The respiratory and vaso-motor centers are at once paralyzed. I have never seen even the faintest involuntary gasp, and the arteries feel at once to have lost tone. The excito-motor ganglia of the heart keep up its action, in the majority of cases, for some minutes independently of the central nervous system, and its arrest is probably brought about by a process of asphyxia. The immediate cessation of all respiratory movements deprives the heart of all assistance in carrying on the circulation, and prevents the lungs from becoming surcharged with blood, as in ordinary cases of asphyxia, but the other signs of death from that cause are usually present, such as turgescence of the right side of the heart and general venous system ; great lividity of the face ; swelling, and perhaps protrusion, of the tongue. It should be remembered that these latter signs are best observed during suspension, because when the body is taken down hypostasis occurs quickly owing to the great fluidity of the blood, the tongue recedes within the mouth, and the general lividity on the upper surface of the body disappears, to reappear in the most dependent parts. The right side of the heart soon becomes incapable of driving the unoxidized blood through the lungs ; the left ventricle at first readily propels the blood into the lax arteries, but soon the supply is diminished and the contraction becomes feeble, and at the same time the blood is accumulating in the venous system, and thus tending to equalize the pressure, and so at last the left ventricle is unable to drive its modicum of blood through the systemic capillaries. We have thus at the same time both sides of the heart unable to perform their work, and cessation of the cardiac action is the result. The time during which I have observed the heart's action after dislocation of the cervical vertebræ has ranged from two to thirteen minutes. As Professor Haughton has shown, the destructive effect on the neck of the criminal is in proportion to the *vis viva* which is acquired by the weight of the culprit and length of the drop ; and, if the drop be long enough, the vertebræ are certain to be dislocated, no matter what be the position of the ring or thickness of the rope. The *vis viva* in any case is equivalent to half the mass multiplied by the square of the terminal velocity. Let W represent the weight of the criminal, and S the length of the drop, then the formula will be :

$$\frac{1}{2} M V^2 = \frac{1}{G}\frac{W}{2} 2 G S = W S,$$

or the weight of the criminal multiplied by the length of the drop expresses in foot-pounds the amount of work expended on the neck of the criminal. I have not complicated the formula with the co-efficient of the elasticity of the rope—which is very slight—as we will devote some attention to the character of the rope further on. I would now modify Dr. Haughton's rules by substituting, say, 1,260 foot-pounds for 2,240. If the neck of the criminal be small and delicate, or the rope very fine, then it would be well to calculate on a lower basis—say, 1,120 foot-pounds. Thus, a man weighing 140 pounds would require a drop of nine feet ($1,260 \div 140 = 9$), and one weighing 120 pounds should have ten feet and a half ($1,260 \div 120 = 10\frac{1}{2}$). The rope should not be too thick nor too elastic, otherwise the abrupt shock will be broken, and the advantages of the long drop lost; but, on the other hand, it should not be too thin nor too inelastic, as then there is not merely the risk of the rope breaking, but also of snapping the head off the culprit. The rope should be of the finest and best hemp, pliable, and capable of bearing a strain of at least a ton and a half. About three fourths to seven eighths of an inch in diameter will be found a convenient thickness, and every rope should be tested before being used. I have been told by the master of a ship that, if in the manufacture of the rope the hemp be run through oil, it makes the rope much more pliable. It would certainly prevent it from becoming stiff when exposed during a wet morning. The iron hooks and couplings to which the rope is attached should be inspected on each occasion.

There has been a great difference of opinion regarding the position of the ring; Professor Haughton recommends that it be placed under the chin, while Dr. Barker, of Melbourne, would have it on the nape of the neck. When the ring is placed in the latter position, the chin naturally falls forward on the sternum, and the rope has no leverage action whatever to assist in dislocation; and, moreover, the noose does not tighten well on the neck, but the ring lies against the occiput; so this position is not only the worst for producing luxation, but also for strangulation. When the ring is under the jaw or chin there is a leverage of several inches, the head is thrown back or to one side, and the noose firmly constricts the neck. In the stretching of the rope the noose tightens several inches; if, therefore, the ring be placed under the angle of the lower jaw on either side, and directed forward, it will be drawn under the chin in the act of tightening. The noose should be placed as high in the neck as possible, and drawn just sufficiently tight to prevent it slipping out of position while the body is falling.

If those in authority would lay down a few simple rules as to the manner in which executions should be performed, then it would not require much *science* to carry them out. These rules might perhaps also have the effect of relegating the executioner more into obscurity, and dispel all illusionary ideas as to his being the possessor of a *mystic* craft, or one to be fêted by the populace and interviewed by the press in order to satisfy a morbid public taste.—*Lancet.*

DIET IN RELATION TO AGE AND ACTIVITY.

By Sir HENRY THOMPSON.

[*Concluded.*]

ANOTHER agent in the combination to maintain for the man of advancing age his career of flesh-eater is the dentist. Nothing is more common at this period of life than to hear complaints of indigestion experienced, so it is affirmed, because mastication is imperfectly performed for want of teeth. The dentist deftly repairs the defective implements, and the important function of chewing the food can be henceforth performed with comfort. But, without any intention to justify a doctrine of final causes, I would point out the significant fact that the disappearance of the masticating powers is mostly coincident with the period of life when that species of food which most requires their action—viz., solid animal fiber—is little, if at all, required by the individual. It is during the latter third of his career that the softer and lighter foods, such as well-cooked cereals, some light mixed animal and vegetable soups, and also fish, for which teeth are barely necessary, are particularly valuable and appropriate. And the man with imperfect teeth who conforms to Nature's demand for a mild, non-stimulating dietary in advanced years will mostly be blessed with a better digestion and sounder health than the man who, thanks to his artificial machinery, can eat and does eat as much flesh in quantity and variety as he did in the days of his youth. Far be it from me to undervalue the truly artistic achievements of a clever and experienced dental surgeon, or the comfort which he affords. By all means let us have recourse to his aid when our natural teeth fail, for the purpose of vocal articulation, to say nothing of their relation to personal appearance: on such grounds the artificial substitutes rank among the necessaries of life in a civilized community. Only let it be understood that the chief end of teeth, so far as mastication is concerned, has in advancing age been to a great extent accomplished, and that they are now mainly useful for the purposes just named. But I can not help adding that there are some grounds for the belief that those who have throughout life from their earliest years consumed little or no flesh, but have lived on a diet chiefly or wholly vegetarian, will be found to have preserved their teeth longer than those who have always made flesh a prominent part of their daily food.

Then there is that occasional visit to the tailor, who, tape in hand, announces in commercial monotone to the listening clerk the various measurements of our girth, and congratulates us on the gradual increase thereof. He never in his life saw you looking so well, and "fancy, sir, you are another inch below your armpits"—a good deal below—"since last year!" insidiously intimating that in another year or so you will have nearly as fine a chest as Heenan! And you, poor deluded victim, are more than half willing to believe that your increasing size is an equivalent to increasing health and strength, especially as your wife emphatically takes that view, and regards your augmenting portliness with approval. Ten years have now passed away since you were forty, and by weight twelve stone and a half—a fair proportion for your height and build. Now you turn the scale to one stone more, every ounce of which is fat; extra weight to be carried through all the labors of life. If you continue your present dietary and habits, and live five or seven years more, the burden of fat will be doubled; and that insinuating tailor will be still congratulating you. Meantime you are "running the race of life"—a figure of speech less appropriate to you at the present moment than it formerly was—handicapped by a weight which makes active movement difficult, upstair ascents troublesome, respiration thick and panting. Not one man in fifty lives to a good old age in this condition. The typical man of eighty or ninety years, still retaining a respectable amount of energy of body and mind, is lean and spare, and lives on slender rations. Neither your heart nor your lungs can act easily and healthily, being oppressed by the gradually gathering fat around. And this because you continue to eat and drink as you did, or even more luxuriously than you did, when youth and activity disposed of that moiety of food which was consumed over and above what the body required for sustenance. Such is the import of that balance of unexpended aliment which your tailor and your foolish friends admire, and the gradual disappearance of which, should you recover your senses and diminish it, they will still deplore, half frightening you back to your old habits again by saying, "You are growing thin: *what can be the matter with you?*" Insane and mischievous delusion!

It is interesting to observe that the principle I have thus endeavored to illustrate and support, little as it is in accordance with the precept and practice of modern authority, was clearly enunciated so long ago as the sixteenth century. The writings of Luigi Cornaro, who was born of noble family in Venice soon after the middle of the fifteenth century, and was contemporary for seventy years with Titian, wrote his first essay on the subject of regimen and diet for the aged when eighty-three years of age, producing three others during the subsequent twelve years.* His object was to show that, with increasing age and diminished powers, a corresponding decrease in the quantity

* "*Discorsi della Vita Sobria*, del Signor Luigi Cornaro." An English edition, with translation, was published by Benjamin White, at Horace's Head, in Fleet Street, London, 1768. Cornaro's first work was published in Padua in 1558. In his last, a letter written to Barbaro, Patriarch of Aquileia, he gives a description of his health and vigor when ninety-five years old. A paper in the "Spectator" was one of the first notices of him in this country. See vol. iii, No. 195.

of food must be taken in order to preserve health. He died at Padua "without any agony, sitting in an elbow-chair, being above one hundred years old."

Thus he writes:

There are old lovers of feeding who say that it is necessary they should eat and drink a great deal to keep up their natural heat, which is constantly diminishing as they advance in years; and that it is, therefore, their duty to eat heartily, and of such things as please their palate, be they hot, cold, or temperate; and that, were they to lead a sober life, it would be a short one. To this I answer that our kind mother, Nature, in order that old men may live still to a greater age, has contrived matters so that they should be able to subsist on little, as I do, for large quantities of food can not be digested by old and feeble stomachs. . . . By always eating little the stomach, not being much burdened, need not wait long to have an appetite. It is for this reason that dry bread relishes so well with me; and I know it from experience, and can with truth affirm, I find such sweetness in it that I should be afraid of sinning against temperance, were it not for my being convinced of the absolute necessity of eating of it, and that we can not make use of a more natural food. And thou, kind parent Nature, who actest so lovingly by thy aged offspring, in order to prolong his days, hast contrived mattters so in his favor, that he can live upon very little; and, in order to add to the favor, and do him still greater service, hast made him sensible, that as in his youth he used to eat twice a day, when he arrives at old age he ought to divide that food, of which he was accustomed before to make but two meals, into four; because, thus divided, it will be more easily digested; and, as in his youth he made but two collations in the day, he should, in his old age, make four, provided, however, he lessens the quantity as his years increase.

And this is what I do, agreeably to my own experience; and, therefore, my spirits, not oppressed by much food, but barely kept up, are always brisk, especially after eating, so that I am obliged then to sing a song, and afterward to write.

Nor do I ever find myself the worse for writing immediately after meals, nor is my understanding ever clearer, nor am I apt to be drowsy, the food I take being in too small a quantity to send up any fumes to the brain. Oh, how advantageous it is to an old man to eat but little! Accordingly I, who know it, eat but just enough to keep body and soul together.

Cornaro ate of all kinds of food, animal as well as vegetable, but in very small quantity, and he drank moderately of the light wine of his country, diminishing his slender rations as age increased. I am quite aware that I am reciting a story which must be familiar to some of the readers of this review. But it is by no means widely known, and is too apt an example of the value of the law under consideration not to be referred to here.

It must now be clearly understood, as a general rule for men at all ages, that the amount of food ingested ought to accord within certain narrow limits with the amount of force employed for the purposes of daily life. But there is a certain qualification, apparent but not real, of the principle thus enunciated which must be referred to here, in order to prevent misunderstanding or misinterpretation of my meaning in relation to one particular. It is right and fitting that a certain amount of storage material, or balance, should exist as a reserve in the constitution of every healthy man. Every healthy individual, indeed, necessarily possesses a stored amount of force, which will stand him in good stead when a demand arises for prolonged unusual exertion, or when any period of enforced starvation occurs, as during a lingering fever or other exhausting disease. The existence of this natural and healthy amount of reserved force is of course presupposed throughout all my remarks, and its extreme value is taken for granted. That undue amount of stored nutriment, that balance which has been referred to as prejudicial to the individual, is a quantity over and above the natural reserve produced by high health; for, when augmented beyond that point, the material takes the form of diseased deposit, and ceases to be an available source of nutriment. Even the natural amount of store or reserve is prone to exceed the necessary limit in those who are healthy or nearly so. Hence it is that in all systems of training for athletic exploits—which is simply a process of acquiring the highest degree of health and strength attainable, in view of great or prolonged exertion—some loss of weight is almost invariably incurred in developing a perfect condition. In other words, almost any man who sets himself to acquire by every means in his power the best health possible for his system does in the process necessary thereto throw off redundant materials, the presence of which is not consistent with the high standard of function required. Thus what is sometimes called "overtraining" is a condition in which the storage is reduced too much, and some weakening is incurred thereby; while "undertraining" implies that the useless fatty and other matters have not been sufficiently got rid of, so that the athlete is encumbered by unnecessary weight, and is liable to needless embarrassments, telling against his chances in more ways than one. The exact and precise balance between the two conditions is the aim of the judicious trainer.

We are thus led to the next important consideration, namely, that although broad rules or principles of diet may be enunciated as applicable to different classes of people in general, no accurate adaptation to the individual is possible without a knowledge of his daily habits and life, as well as to some extent of his personal peculiarities. No man, for example, can tell another what he can or ought to eat, without knowing what are the habits of life and work—mental and bodily—of the person to be advised. Notwithstanding which, no kind of counsel is more frequently tendered in common conversation by one stranger with another, than that which concerns the choice of food and drink. The adviser feels himself warranted, by the experience that some particular combination of nourishment suits his own stomach, to infer without hesitation that this dish will be therefore acceptable to the stomachs of all his neighbors. Surely the intelligence of such a man is as slender as his audacity and presumption are large. It would not be more preposterous if, having with infinite pains obtained a last representing precisely the size and the peculiarities in form of his own foot, he forthwith solemnly adjured all other persons to adopt boots made upon that model, and on none other! Only it may be assumed that there is probably more difference between stomachs and their needs among different individuals than among the inferior extremities referred to for the purpose of illustration. Thus, in regard of expenditure of food, how great is the difference between that of a man who spends ten or twelve hours of the day at the work of a navvy, as an agricultural laborer in harvest-time, or in draining or trenching land, as a sawyer, a railway porter, or a bricklayer's laborer, or let me add that of an ardent sportsman, as compared with the expenditure of a clerk who is seated at the desk, of individuals engaged in literary and artistic pursuits, demanding a life mostly sedentary and spent in-doors, with no exercise but that which such persons voluntarily take as a homage to hygienic duty, and for a short period borrowed at some cost from engagements which claim most of their time and nearly all their energies! While the manual laborers rarely consume more food than they expend, and are, if not injured by drink, or by undue exposure to the weather, mostly hale and hearty in consequence, the latter are often martyrs to continued minor ailments, which gradually increase, and make work difficult, and life dreary. Few people will believe how easy it is in most instances to meet the difficulty by adopting appropriate food, and that such brain-workers can really enjoy a fair degree of health and comfort by living on light food, which does not require much force to digest, and much muscular activity to assimilate—a diet, moreover, which is important to some of these from another point of view—the financial one—inasmuch as it is at least less costly by one half than the conventional meals which habit or custom prescribes alike to large classes of men in varied conditions of life. But there is another and more important economic gain yet to be named, as realizable through the use of a light and simple dietary. It is manifested by the fact that a greater expenditure of nerve-power is demanded for the digestion of heavy meat meals than for the lighter repasts which are suitable to the sedentary; from which fact it results of course that this precious power is reserved for more useful and more delightful pursuits than that of mere digestion, especially when this is not too well performed.

But those who have little time for exercise, and are compelled to live chiefly within-doors, must endeavor to secure, or should have secured for them as far as possible by employers, by way of compensation, a regular supply of fresh air without draughts, an atmosphere as free from dust and other impurities as can be obtained, with a good supply of light, and some artificial warmth when needed. These necessities granted, cereal foods, such as well-made bread in variety, and vegetable produce, including fruits, should form a great part of the diet consumed, with a fair addition of eggs and milk if no meat is taken, and little of other animal food than fish. On such a dietary, and without alcoholic stimulants, thousands of such workers as I have briefly indicated may enjoy with very little exercise far better health and more strength than at present they experience on meat and heavy puddings, beer, baker's bread, and cheese. Of course there are workers who belong to neither of the two extreme classes indicated, and whose habits can not be described as sedentary, but who occupy a middle place between the two. For such, some corresponding modification of the dietary is naturally appropriate. But it is a vulgar error to regard meat in any form as necessary to life; if for any it is necessary, it is for the hard-working out-door laborers above referred to, and for these a certain proportion is no doubt desirable. Animal flesh is useful also as a concentrated form of nutriment, valuable for its portability; and, for the small space it occupies in the stomach, unrivaled in certain circumstances. Like every other description of food, it is highly useful in its place, but is by no means necessary for a large proportion of the population. To many it has become partially desirable only by the force of habit, and because their digestive organs have thus been trained to deal with it, and at first resent a change. But, this being gradually made, adaptation takes place, and the individual who has consumed two or three meat meals daily with some little discomfort, chiefly from being often indisposed to make active exertions, becomes, after sufficient time has elapsed, stronger, lighter, and happier, as well as better tempered, and manifestly healthier, on the more delicate dietary sketched. People in general have very inadequate ideas of the great power of habit alone in forming what they believe to be innate personal peculiarities, or in creating conditions which are apparently part of a constitutional necessity, laws of their nature and essential to their existence. Many of these peculiarities are solely due to habit, that is, to long continuance in a routine of action, adopted it may be without motive or design; and people are apt to forget that, if a routine of a precisely opposite character had been adopted, precisely opposite conditions would have been established, and opposite peculiarities would have become dominant, as their contraries are now. Alterations in the dietary, especially of elderly persons, should be made gradually and with caution. This condition fulfilled, a considerable change may be effected with satisfactory results, when circumstances render it necessary. To revert once more to the question of flesh-eating, it should be remarked that it appears to be by no means a natural taste with the young. Few children like that part of the meal which consists of meat, but prefer the pudding, the fruit, the vegetables, if well dressed, which unhappily is not often the case. Many children manifest great repugnance to meat at first, and are coaxed and even scolded by anxious mothers until the habit of eating it is acquired. Adopting the insular creed, which regards beef and mutton as necessary to health and strength, the mother often suffers from groundless forebodings about the future of a child who rejects flesh, and manifests what is regarded as an unfortunate partiality for bread and butter and pudding. Nevertheless, I am satisfied, if the children followed their own instinct in that matter, the result would be a gain in more ways than one. Certainly, if meat did not appear in the nursery until the children sent for it, it would be rarely seen there, and the young ones would as a rule thrive better on milk and eggs, with the varied produce of the vegetable kingdom.

A brief allusion must be made to the well-known and obvious fact that the surrounding temperature influences the demand for food, which therefore should be determined as regards quantity or kind according to the climate inhabited, or the season of the year as it affects each climate. In hot weather, the dietary should be lighter, in the understood sense of the term, than in cold weather. The sultry period of our summer, although comparatively slight and of short duration, is nevertheless felt by some persons to be extremely oppressive ; but this is mainly due to the practice of eating much animal food or fatty matters, conjoined as it often is with the habit of drinking freely of fluids containing a small quantity of alcohol. Living on cereals, vegetables, and fruits, with some proportion of fish, and abstaining from alcoholic drinks, the same person would probably enjoy the high temperature, and be free from the thirst which is the natural result of consuming needlessly substantial and heating food.

There is a very common term, familiar by daily use, conveying unmistakably to every one painful impressions regarding those who manifest the discomforts indicated by it—I mean the term indigestion. The first sign of what is so called may appear even in childhood ; not being the consequence of any stomach disorder, but solely of some error in diet, mostly the result of eating too freely of rich compounds in which sugar and fatty matters are largely present. These elements would not be objectionable if they formed part of a regular meal, instead of being consumed as they mostly are between meals, already abounding in every necessary constituent.

Sugar and fat are elements of value in children's food, and naturally form a considerable portion of it, entering largely into the composition of milk, which Nature supplies for the young and growing animal. The indigestion of the child mostly terminates rapidly by ejection of the offending matter. But the indigestion of the adult is less acutely felt and is less readily disposed of. Uneasiness and incapacity for action, persisting for some time after an ordinary meal, indicate that the stomach is acting imperfectly on the materials which have been put into it. These signs manifest themselves frequently, and, if Nature's hints that the food is inappropriate are not taken, they become more serious. Temporary relief is easily obtained by medicine; but if the unfortunate individual continues to blame his stomach, and not the dietary he selects, the chances are that his troubles will continue, or appear in some other form. At length, if unenlightened on the subject, he becomes "a martyr to indigestion," and resigns himself to the unhappy fate, as he terms it, of "the confirmed dyspeptic."

Such a victim may perhaps be surprised to learn that nine out of ten persons so affected are probably not the subjects of any complaint whatever, and that the stomach at any rate is by no means necessarily faulty in its action—in short, that what is popularly termed "indigestion" is rarely a disease in any sense of the word, but merely the natural result of errors in diet. For most men it is the penalty of conformity to the eating habits of the majority; and a want of disposition or of enterprise to undertake a trial of simpler foods than those around them consume probably determines the continuance of their unhappy troubles. In many instances it must be confessed that the complaint, if so it must be called, results from error, not in the quality of the food taken, but in the quantity. Eating is an agreeable process for most people, and under the influence of very small temptation, or through undue variety furnishing a source of provocation to the palate, a considerable proportion of nutritious material above what is required by the system is apt to be swallowed. Then it is also to be remembered that stomachs which vary greatly in their capacity and power to digest may all nevertheless be equally healthy and competent to exercise every necessary function. In like manner we know that human brains which are equally sound and healthy often differ vastly in power and in activity. Thus a stomach, which would be slandered by a charge of incompetence to perform easily all that it is in duty bound to accomplish, may be completely incapable of digesting a small excess beyond that natural limit. Hence, with such an organ an indigestion is inevitable when this limit is only slightly exceeded. And so when temptations are considerable, and frequently complied with, the disturbance may be, as it is with some, very serious in degree. How very powerful a human stomach may sometimes be, and how large a task in the way of digestion it may sometimes perform without complaint, is known to those who have had the opportunity of observing what certain persons with exceptional power are accustomed to take as food, and do take for a long time apparently with impunity. But these are stomachs endowed with extraordinary energy, and woe be to the individual with a digestive apparatus of moderate power who attempts to emulate the performance of a neighbor at table who perchance may be furnished with such an effective digestive apparatus!

But, after all, let not the weaker man grieve overmuch at the uneven lot which the gods seem to have provided for mortals here below in regard of this function of digestion. There is a compensation for him which he has not considered, or perhaps even heard of, although he is so moderately endowed with peptic force. A delicate stomach which can just do needful work for the system and no more, by necessity performs the function of a careful door porter at the entrance of the system, and like a jealous guardian inspects with discernment all who aspire to enter the interior, rejecting the unfit and the unbidden, and all the common herd.

On the other hand, a stomach with superfluous power, of whom its master boastfully declaims that it can "digest tenpenny nails," and that he is unaccustomed to consult its likes and its dislikes if it have any, is like a careless hall porter who admits all comers, every pretender, and among the motley visitors many whose presence is damaging to the interior. These powerful feeders after a time suffer from the unexpended surplus, and pay for their hardy temerity in becoming amenable to penalty, often suddenly declared by the onset of some serious attack, demanding complete change in regimen, a condition more or less grave. On the other hand, the owner of the delicate stomach, a man perhaps with a habit of frequently complaining of slight troubles, and always careful, will probably in the race of life, as regards the preceding pilgrim, take the place of the tortoise as against the hare. It is an old proverb that "the creaking wheel lasts longest," and one that is certainly true as regards a not powerful but nevertheless healthy stomach which is carefully treated by its owner; to whom this fact may be acceptable as a small consolation for the possession of a delicate organ.

For it is a kind of stomach which not seldom accompanies a fine organization. The difference is central, not local—a difference in the nervous system chiefly; the impressionable mental structure, the instrument of strong emotions, must necessarily be allied with a stomach to which the supply of nerve-power for digestion is sometimes temporarily deficient and always perhaps capricious. There are more sources than one of compensation to the owner of an active, impressionable brain, with a susceptible stomach possessing only moderate digestive capabilities—sources altogether beyond the imagination of many a coarse feeder and capable digester.

But it is not correct, and it is on all grounds undesirable, to regard the less powerful man as a sufferer from indigestion, that is, as liable to any complaint to be so termed. True indigestion, as a manifestation of a diseased stomach, is comparatively quite rare, and I have not one word to say of it here, which would not be the fitting place if I had. Not one person in a hundred who complains of indigestion has any morbid affection of the organs engaged in assimilating his food. As commonly employed, the word "indigestion" denotes, not a disease, but an admonition. It means that the individual so complaining has not yet found his appropriate diet; that he takes food unsuited for him, or too much of it. The food may be "wholesome enough in itself," a popular phrase permitted to appear here, first, because it conveys a meaning perceived by every one, although the idea is loosely expressed; but, secondly and chiefly, for the purpose of pointing out the fallacy which underlies it. There is no food "wholesome in itself," and there is no fact which people in general are more slow to comprehend. That food only is wholesome which is so to the individual, and no food can be wholesome to any given number of persons. Milk, for example, may agree admirably with me, and may as certainly invariably provoke an indigestion from my neighbor; and the same may be said of almost every article of our ordinary dietary. The wholesomeness of a food consists solely in its adaptability to the individual, and this relation is governed mainly by the influences of his age, activity, surroundings and temperament or personal peculiarities.

Indigestion, therefore, does not necessarily, or indeed often, require medicine for its removal. Drugs, and especially small portions of alcoholic spirit, are often used for the purpose of stimulating the stomach temporarily to perform a larger share of work than by nature it is qualified to undertake; a course which is disadvantageous for the individual if persisted in. The effect on the stomach is that of the spur on the horse: it accelerates the pace, but "it takes it out" of the animal, and, if the practice is long continued, shortens his natural term of efficiency.

It is an erroneous idea that a simple form of dietary, such as the vegetable kingdom in the largest sense of the term furnishes, in conjunction with a moderate proportion of the most easily digested forms of animal food, may not be appetizing and agreeable to the palate. On the contrary, I am prepared to maintain that it may be easily served in forms highly attractive, not only to the general but to a cultivated taste. A preference for the high flavors and stimulating scents peculiar to the flesh of vertebrate animals mostly subsides after a fair trial of milder foods when supplied in variety. And it is an experience almost universally avowed, that the desire for food is keener, that the satisfaction in gratifying appetite is greater and more enjoyable, on the part of the general light feeder than with the almost exclusively flesh-feeder. For this designation is applicable to almost all those who compose the middle-class population of this country. They consume little bread and few vegetables; all the savory dishes are of flesh, with decoctions of flesh alone for soup. The sweets are compounds of suet, lard, butter, eggs and milk, with very small quantities of flour, rice, arrowroot, etc., which comprise all the vegetable constituents besides some fruit and sugar. Three fourths at least of the nutrient matters consumed are from the animal kingdom. A reversal of the proportions named, that is, a fourth only from the latter source with three fourths of vegetable produce, would furnish greater variety for the table, tend to maintain a cleaner palate, increased zest for food, a lighter and more active brain, and a better state of health for most people not engaged on the most laborious employments of active life; while even for the last named, with due choice of material, ample sustenance in the proportions named may be supplied. For some inactive, sedentary, and aged persons the small proportion of animal food indicated might be advantageously diminished. I am frequently told by individuals of sixty years and upward that they have no recollection of any previous period since reaching mature age at which they have possessed a keener relish for food than that which they enjoy at least once or twice a day since they have adopted the dietary thus described. Such appetite at all events as has rarely offered itself during years preceding, when the choice of food was conventionally limited to the unvarying progression and array of mutton and beef, in joint, chop, and steak, arriving after a strong meat soup, with a possible interlude of fish, and followed by puddings of which the ingredients are chiefly derived from animal sources. The penetrating odors of meat cookery which announce their presence by escape from the kitchen, and will pervade the air of other rooms in any private house but a large one, and which are encountered in clubs, restaurants, and hotels without stint, alone suffice to blunt the inclination for food of one who, returning from daily occupation, fatigued and fastidious, desires food easy of digestion, attractive in appearance, and unassociated with any element of a repulsive character. The light feeder knows nothing of the annoyances described, finds on his table that which is delightful to a palate sensitive to mild impressions, and indisposed to gross and over-powerful ones. After the meal is over, his wit is fresher, his temper more cheerful, and he takes his easy-chair to enjoy fireside talk, and not to sink into a heavy slumber, which on awakening is but exchanged for a sense of discontent or stupidity.

The doctrine thus briefly and inadequately expounded in this paper may probably encounter some opposition and adverse criticism. I am quite content that this should be so. Every proposal which disturbs the current habits of the time, especially when based on long-prevalent custom, infallibly encounters that fate. But of the general truth, and hence of the ultimate reception of the principles I have endeavored to illustrate, there can not be the faintest doubt. And I know that this result, whenever it may be accomplished, will largely diminish the painful affections which unhappily so often appear during the latter moiety of adult life. And having during the last few years widely inculcated such general dietetic principles and practice, with abundant grounds for my growing conviction of their value, it appears to be a duty to call attention to them somewhat more emphatically than in preceding contributions already referred to. In so doing I have expressly limited myself to statements relating to those simple elementary facts concerning our every-day life which ought to be within the knowledge of every man, and therefore such as may most fitly be set forth in a publication outside of that field of special and technical record which is devoted to professional observation and experience.—*Nineteenth Century.*

BUILDING AND ORNAMENTAL STONES OF THE UNITED STATES.

By GEORGE P. MERRILL.

WHEN, early in his curatorship in the National Museum, Dr. George W. Hawes, one of the leading American lithologists, assumed charge of that branch of the tenth census relating to the quarrying industry of the United States, it is doubtful if any but himself fully realized the importance of the undertaking aside from its statistical bearings. Dr. Hawes was, however, not a man to be satisfied with figures alone, or one who considered the scope of a census to be merely the compilation of statistics, and in selecting his assistants he did so with especial reference to their qualifications in other lines of work as well. Thus we find upon his list the names of such geologists as Professors Shaler and Wolff, of Harvard ; Hitchcock, of Dartmouth ; Winchell, of Minneapolis ; and others of equal note and ability. These assistants, or special agents as they were called, visited each quarry in person within their respective districts, and, together with collecting the necessary information relative to the amount, kind, and value of stone quarried, number of men employed, etc., made all possible observations in regard to the geological age of the stone, its disposition in the quarry, weathering qualities as displayed in those portions of the outcrop that had been exposed for ages to the action of atmospheric agencies, and, lastly, selected samples of the rock in the form of blocks of sufficient size to dress into four-inch cubes and forwarded them by mail to the National Museum, at Washington, for further examination.* Here a corps of assistants was employed who selected samples for chemical and microscopic analysis, and left the block to be handsomely dressed into a four-inch cube and placed permanently upon exhibition, having meanwhile made careful notes upon its working qualities. Small chips of each rock were ground into films so thin as to be perfectly transparent, and submitted to microscopic examination in order not only to determine what the rock was, but also to ascertain if it contained any mineral constituents liable to unfavorable change on exposure to the weather. Whenever necessary, chemical analysis was resorted to to further aid in the solution of the problems involved.

* These blocks weighed from six to ten pounds each, but, being Government matter, were allowed to pass through the mails, though greatly exceeding in weight the limit set by law.

Unfortunately, Dr. Hawes did not live to carry out the plans he had so carefully laid down, but the vast amount of material he had been instrumental in bringing together remains to-day in the National Museum, a lasting monument to the industry of the man, and probably the most systematic and complete collection of its kind in any museum in the world. As now being arranged in the museum, the collection comprises some four thousand specimens of building and ornamental stone from upward of fifteen hundred quarries in the United States, together with very many from foreign localities.

The importance of such a collection can not be overestimated. Here, within the space of an hour, one can see and examine every variety of stone now quarried, and ascertain its scientific name and chemical or mineral composition, together with the exact locality whence it was derived. That such a reference collection will prove of great advantage to the country at large is evident from the fact that New England granites have been used in nearly every city of importance from Maine to California, sometimes to the almost entire exclusion of equally good material close at hand, but of whose existence or valuable qualities interested parties were ignorant. As an illustration of this, it may be stated that many of the public and private buildings of Cincinnati, Ohio, are built of Eastern granite brought by rail and water a distance of over fifteen hundred miles, while within one tenth that distance lie rocks in every respect equally good for the purpose, and that could be furnished at far less cost! From the published report of the census as it now appears, there were quarried during the year ending May 31, 1880, 115,380,113 cubic feet of building and ornamental stones, valued in the rough at $18,365,055; this being the product of 1,525 quarries representing an invested capital of $25,414,497, and affording employment during the busy season to upward of 40,000 men. The kinds of stone quarried are principally granites, limestones (including dolomite), sandstone, and slates. In value of total product, regardless of kinds, the leading States rank as follows: Ohio, Pennsylvania, Vermont, Massachusetts, Illinois, New York, Maine, and Connecticut, each of these producing upward of $1,000,000 worth of material. Massachusetts and Maine produce the most granite; Ohio, New York, Pennsylvania, and Connecticut the most sandstone; Vermont, Illinois, Ohio, and New York the most limestone, while Pennsylvania leads in the production of slate.

The larger portion of our granites are some shade of gray in color, though pink and red varieties are not uncommon. They vary in texture from very fine and homogeneous to coarsely porphyritic rocks in which the individual grains are an inch or more in length. The largest works at present in operation are at Vinalhaven, Maine. The quarries of the Bodwell Granite Company were first opened here in 1850, and the present annual product is some 217,000 cubic feet, valued at $112,000. The capabilities of these quarries may be best illustrated by stating that during a visit to the locality in the summer of 1883 the writer was shown the remains of a huge block of granite three hundred feet long, twenty feet wide, and from six to ten feet thick, that had been blown out from the quarry in a single piece and afterward broken up. The largest single block ever quarried and dressed was the General Wool Monument now in Troy, New York, which measured, when completed, sixty feet in height by five and a half feet square at the base, or only nine feet shorter than the Egyptian Obelisk now in Central Park, New York. The stone is light gray, often slightly pinkish in color, and corresponds closely with that from the now abandoned quarries on Dix Island, whence were taken the granite monoliths, thirty-one feet in height, for the Treasury Building at Washington. Second only to the quarries at Vinalhaven are those at Gloucester, Massachusetts—the quarries of the Cape Ann Granite Company. This rock is coarser in texture than that of Vinalhaven, and often of a slight greenish color. The new Masonic Temple at Philadelphia, and the Butler House, on Capitol Hill, Washington, are good illustrations of the adaptability of this stone for general building purposes.

Closely resembling the Cape Ann granite is that quarried at Quincy in the same State. Quarries were first regularly opened here in 1803, though it was from bowlders of this rock that was built in 1749–'54 King's Chapel, still standing on the corner of School and Tremont Streets, Boston. Quincy granite also was used in the construction of the Bunker Hill Monument, and it was for the transportation of this stone from the quarries to Charlestown that was built the first railway in America. The color of the stone is deep blue gray, and its fitness for interior decorative work is well shown in the granite stairways and polished pilasters of the new City Buildings in Philadelphia.

For columns, house-trimmings, and especially monumental work, the granite from Hallowell, Maine, is used most extensively. This rock is of fine and even grain, and very light gray, almost white in color. Its texture is such that it can be carved very readily, and it has been used in statuary work more than any other of our granites. The statues on the Pilgrim Monument, at Plymouth, Massachusetts, are of this stone. An Italian designer, who served his apprenticeship in Roman studios, is employed by this company, and many of the workmen at the quarries are said to be Italians who worked in marble in Italy, but have learned to cut granite since their arrival at Hallowell.

A granite, closely resembling that of Hallowell, is quarried very extensively near Concord, New Hampshire, and is used for similar purposes. Stones similar to these, but not at present in the market, are found near Frederickton, Virginia, and Atlanta, Georgia.

The red and pink granites now in the market are nearly all from Calais and Jonesboro, in the eastern part of Maine, though others are quarried at Mount Desert, in the same State; Lyme and Stony Creek, Connecticut; Westerly, Rhode Island; and Graniteville, Missouri. The Calais rock, which is at present the most important of these, is a light pink in color, of medium coarseness of texture, and acquires beautiful surface and polish. It is used extensively for door-posts and the bases of monuments in all our principal cities, competing favorably with the coarser red granite from Peterhead, Scotland, or that from St. George, New Brunswick.

Black granites are quarried in but two, and these widely separated, localities—St. George, Maine, and Penryn, California. Both stones are fine-grained, and nearly black on a polished surface, their dark colors being due to the abundance of black mica and hornblende that they contain. The greater part of the rock quarried and put upon the market under this name is, however, not granite at all, but diabase, a rock differing from granite in containing neither quartz, orthoclase, nor mica, but composed mainly of a triclinic feldspar and augite. The principal quarries of this rock are at Addison, Maine; Medford and Somerville, Massachusetts; York, Pennsylvania; and near Jersey City, New Jersey.

These rocks are all fine-grained and hard, and of a dark-gray color, that from Addison being nearly black when polished. The colors are rather too somber for general building purposes, but, when properly combined with brick or lighter stone, the effect is admirable. The Addison rock is being used to a considerable extent for cemetery and other monumental work, for which it seems peculiarly adapted, and together with the York diabase has been used in the stone-work of the Capitol-grounds at Washington. Diabase from the near vicinity has been used in the construction of the Stevens Institute building at Hoboken, New Jersey, and the court-house and St. Patrick's Cathedral at Jersey City. The fronts of many private and business houses in the last-named city are also of diabase, but the effect is not good, owing to the somber colors already alluded to.

From the fact that Maine and Massachusetts lead in the granite-quarrying industry, it does not necessarily follow that these States produce a greater variety or better quality of material than some others in which the annual product is far less. The supremacy is due rather to natural quarrying and transportation facilities. In Maine especially many of the quarries are situated on hill-sides close by the water's edge, where no artificial drainage is required, and but little carting of the stone is necessary prior to loading it upon vessels, by means of which transportation can be had to all the leading cities of the country without transhipment, an item of no small importance with material so bulky and heavy as stone. Added to this is the fact that the great glacial ice-sheet, that once plowed its way across the whole of New England, has entirely removed the overlying mass of decayed rock and other waste material, and left the fresh granite close to the surface and readily accessible. In regions farther to the south, beyond the limits of glacial action, the granite-beds are still covered with a mass of decomposed rock, often many feet in thickness, and which must be removed before quarrying can commence. It is probably largely due to these facts that the granites of these two States are enabled to compete so favorably in the Washington market with those from near Richmond, Virginia, a distance of only four or five hours' ride by rail.

Granite did not come into general use for building purposes in this country until a comparatively recent date, owing largely to the great difficulty in working it. According to Mr. J. E. Wolff,* one of the earliest stone buildings in Boston was the "stone house of Deacon John Phillips," erected about 1650, and which continued to stand until 1864. It was built chiefly of bowlders from the immediate vicinity. In 1737 was built of bowlders, of Braintree (Quincy) granite, the old Hancock house, since torn down. The granite bowlders scattered over the commons had been very generally used in Quincy for steps, foundations, etc., for some years previous to this, until at last the inhabitants, becoming frightened lest this supply of valuable building material should become entirely exhausted, assembled in town-meeting and voted that "no person shall dig or carry off" any stone "on the said commons or undivided lands upon any account whatever without license from the committee, . . . upon penalty of the forfeiture of ten shillings for every and each cart-load so dug and carried away." Little did they then imagine that, close at their doors, this same stone existed in such quantities that over half a century of almost constant quarrying has failed to exhaust the supply. It was not, however, until the early part of the present century that granite began to be used at all extensively in and about Boston, when the material was introduced in considerable quantities by canal from Chelmsford, thirty miles distant. It was from the Chelmsford stone that was constructed in 1810 the Boston Court-House, in 1814 the New South Church, and in 1818–'19 the first stone block in the city, a portion of which is still standing on Brattle Street. In this year also a considerable quantity of the stone was shipped to Savannah, Georgia, for the construction of a church at that place. The greater part of this granite was, however, obtained from bowlders, and it was not until the opening of quarries at Quincy, in 1825, that the business assumed any great importance. From this time the use of granite for building material increased in a marked degree, and the history of stone-quarrying in Massachusetts may properly begin with this date.

Under the head of marbles are here included all those rocks consisting essentially of carbonate of lime (limestone), or carbonate of lime and magnesia (magnesian limestones and dolomites), which are susceptible of receiving a good polish, and are suitable for orna-

* "Building-Stone and Quarry Industry of the United States," p. 282.

mental work. Vermont is at present the chief marble-producing State of the Union, excelling in this industry all the other States combined, having an invested capital of $3,886,000, and producing annually $1,340,050 worth of material. Of this the larger part is ordinary white, veined, or blue marble from Sutherland Falls, Rutland, East Dorset, and Pittsford. Dark gray, almost black fossiliferous marbles are, however, quarried at Isle La Motte, while red, mottled, and variegated varieties, used for tilings and wainscotings, are found at Mallett's Bay, in the northern part of Lake Champlain. The only statuary marble at present quarried in this country is found at West Rutland and Pittsford, in this State. The rock is of fine and even texture, and without specks or flaws, but differs from its Italian prototype in being of a dead-white color, lacking entirely the peculiar waxy luster so characteristic of the Italian marble. White and bluish marbles are also quarried at Lee, Massachusetts; Sing Sing, Tuckahoe, and Pleasantville, New York; in Montgomery County, Pennsylvania; and in Texas and Cockeysville, Maryland.

The Montgomery County quarries were first opened upward of one hundred years ago, and until as late as 1840 the stone continued to be the general favorite in Philadelphia for all manner of building, although not well suited for the finer grades of ornamental work. Girard College, the United States Custom-House, Mint, and Naval Asylum, are of this stone, while the seemingly endless rows of red-brick houses, with white-marble sills and caps, have come to be as characteristic of Philadelphia as are the brown-stone fronts of New York.

The colored marbles now in the market are brought principally from Tennessee. The ordinary red and white variegated varieties, so commonly seen in table-tops, mantels, soda-fountains, and panelings, are from Rogersville and Knoxville in this State. A fine grade of pink marble is also found at Cleaveland and Knoxville, while a fossil-bearing olive-green variety is brought from Calhoun. A peculiar brecciated stone, which I have not yet seen in the market, is also found here. It consists of yellowish, rounded, and angular fragments of varying sizes, imbedded in a fine, grayish ground-mass. So far as I have yet observed, this stone is entirely distinct from any produced elsewhere. Two fine varieties of gray fossiliferous marbles are produced at Chazy and Plattsburg, in Clinton County, New York, and are known commercially as "Lepanto" and "French gray." The first-named is gray with pink spots, while the last-named is more uniformly gray in color. With the exception of the Tennessee marbles, the Plattsburg stone is more extensively used for furniture and inside decorative work than any other now in the market. The only first-quality black marble now produced in this country is also from New York State quarries at Glens Falls, furnishing a fine grade of this material.

Other than in the States above mentioned no marbles of consequence are now produced east of the Rocky Mountains, though several States are known to contain material that might be thus utilized if put upon the market. California, however, produces two varieties worthy of especial notice. The one is a white, finely crystalline stone, traversed by a network of fine dark lines, in general appearance very much like the celebrated bardiglio marble from the Serravezza quarries, but that the ground-mass is lighter in color. The second variety is the beautiful stalagmite marble, or so-called *onyx*, from quarries at San Luis Obispo. This stone is pearly white in color, translucent, and traversed by fine, wavy, parallel lines, like the lines of growth upon the trunk of a tree. It takes a beautiful polish, and is quite extensively used for small stands and ornaments of various kinds. Excepting in the matter of color it is identical with the celebrated "Oriental alabaster" (wrongly so called), from Blad Recam, near the Ravine of Oned Abdallah, Egypt, this last being of a yellowish or amber hue. The San Luis Obispo rock is the only stalagmite marble of any commercial importance at present found in this country, though a beautiful variety, known as "Mexican onyx," is quarried at Tecali, State of Puebla, Mexico.

In the way of true conglomerate or breccia marble there is at present nothing quarried, though a beautiful variety occurs in inexhaustible quantities near Frederickton, Maryland, and in other parts of this State and Pennsylvania. The stone consists of rounded and angular fragments, of varying colors and all sizes up to several inches in diameter, of quartz and limestone imbedded in a fine gray ground-mass. This admixture of hard and soft material renders the dressing of the stone a matter of great difficulty, since the flinty pebbles break away from the softer ground-mass in the process of cutting. The large pillars of the old House of Representatives in the Capitol at Washington are of this stone.

The rock serpentine, though differing entirely from marble in chemical composition, is used for similar purposes, and may be mentioned here. The three principal sources of this rock, or of serpentine in combination with calcite, are Roxbury, Vermont; Moriah, Essex County, New York; and Dublin, Harford County, Maryland. The Vermont stone is deep green in color, and traversed by white veins of calcite. It takes a beautiful polish, and compares very favorably with the Italian *verde antique* or *verde di Prato* from quarries in Tuscany. The Moriah stone is similar in color, but granular in texture, and spotted, rather than veined. At present it is found in the market in the form of mantels, table-tops, monuments, etc. The Maryland stone is more uniformly green in color than either of those mentioned above, containing very little calcareous matter. It is said to occur in almost inexhaustible quantities and within easy reach of the Baltimore market, but for some unexplained reason little, if any, of it is now in use. A coarse serpentine used for general building purposes, but unsuited for any kind of ornamental work, is brought in considerable quantities from Chester County, Pennsylvania. The stone is dull-green in color, soft enough to work readily, and is capable of producing most excellent effects, particularly in rock-faced and rubble work. So far as the writer has observed, however, it has not yet been used to advantage, either alone or in combination with other stone, a majority of the buildings thus far constructed of it being not only failures from an architectural stand-point, but showing a remarkable lack of taste in color combination on the part of their designers. A dull-green building with light, yellowish-gray trimmings can scarcely be considered a success artistically, yet this is the style almost universally adopted. The stone has been used quite extensively in and about Philadelphia, and is the one employed in the construction of the buildings of the University of Pennsylvania and Academy of Natural Sciences in that city. It has also been used to some extent in the cities of New York and Washington, though I have not yet observed it elsewhere.

No marbles are at present quarried in this country similar to the white blue-veined Parmazo marble from the Miseglia quarries, like the red-veined from Levanto, like the yellow from Siena, the red "Griotte" from the French Pyrenees, or the black and gold (Portoro Venere) from the Spezia quarries. A stone somewhat resembling this last has been received at the museum from Helena, Montana, but the quarries are not worked, nor is the extent of the deposit known to the writer. A beautiful bright, flesh-pink marble occurs in abundance in Swain and Cherokee Counties, North Carolina, but is not now in the market, owing to lack of transportation facilities.

Of limestones and dolomites, aside from marbles, large quantities are quarried in the States of New York, Pennsylvania, Indiana, Illinois, Iowa, and Missouri. These are mostly of a dull-grayish, uninteresting color, and their uses are chiefly local. The light-colored oölitic limestone of Bedford, Indiana, is, however, an exception to this rule. Not only is the color pleasing and its lasting qualities fair, but its fine even grain and softness render it admirably adapted for carved work. Several of the Southern and Western States have an abundance of limestone and sandstones suitable for general building purposes, but so far as observed few, if any of them, are of such quality as ever to attain anything more than a local market. Kentucky has limestones in abundance and of good quality. Kansas is pre-eminently a State of limestones. These are, however, for the most part soft and porous, of a dull color, and must be found lacking in lasting qualities in other than a very dry climate. A white, chalky limestone is quarried in Trego County, in this State, and is used in the manufacture of whiting. Otherwise than from the product of this quarry, all the other whiting manufactured in the United States is said to be prepared from imported English chalk. Texas furnishes cretaceous limestones of fine and compact texture from the vicinity of Austin. Some of these take a good polish, and might be used as marbles.

No lithographic limestones that can compare with the imported stone have as yet been found in this country. Silverville, Indiana; Glascow Junction, Kentucky; and Saverton, Missouri, each produce fine, even-grained stones of a drab color which have been put upon the market at various times as lithographic stone, but so far as is known to the writer the Missouri stone is the only one now used for this purpose.

The total amount of sandstone quarried in the United States during the census year was 24,776,930 cubic feet, valued at $4,780,391; the same being the product of 502 quarries representing an invested capital of $6,229,600.

Sandstone-quarrying in the United States doubtless began with the itinerant working of the extensive Triassic deposits of "brown-stone" in the vicinity of Portland, Connecticut. Where now are excavations upward of one hundred feet in depth, were then steep cliffs overhanging the river, and from these the inhabitants of Middletown and neighboring localities early began to carry away material for general building purposes as well as for monuments and gravestones. To such an extent had this system of free quarrying been carried, that as early as 1665 a resolve was passed similar in purpose to that relative to the granite bowlders on the Quincy Commons, to the effect "that no one shall dig or raise stone at the Rocks on the east side of the river" (now Portland) "but an inhabitant of the town, and that twelve pence shall be paid to the town for every ton of stone taken." Not long after this the quarries thus opened passed from the possession of the town into that of private parties, and what is now known as Brainard's quarry is said to have been operated since 1700. There are now three quarries situated in a line along the river's bank at this place, from which have been taken altogether some 4,300,000 cubic feet of stone, or enough to build a wall nearly two and a half feet high, and one foot thick, around the entire State!

Of the same geological age and general appearance as those of Connecticut, though varying slightly in color and texture, are the brown and red sandstones quarried in Massachusetts, Pennsylvania, New Jersey, and Maryland. In all of these the cementing material that binds together the rounded and angular grains of which they are composed is largely iron oxide, which gives the color to the stone and yet leaves it soft enough to be worked at only a very moderate cost.

On account of their pleasing colors and easy working qualities these stones have been great favorites for general building purposes, as the monotonous rows of brown-stone fronts in New York city too well attest.

Of about equal importance with these brown Triassic stones are the light-colored subcarboniferous sandstones of Ohio and elsewhere.

These are all fine-grained stones with but little cementing material, the individual grains of which they are composed being held together simply by the cohesion induced by the pressure to which they were subjected at the time of their consolidation. They therefore work very readily, especially when newly quarried, and have been used more extensively for carved work than any other of our sandstones. They are best represented in the market to-day by the so-called Euclid "blue-stones" and Berea "grits" of Ohio, the former being deep blue-gray in color, while the latter is very light. They are well known to the general public in the form of window stools and caps, door posts and steps, for which purpose they have been very extensively used in all our large cities.

Somewhat resembling in general appearance the Euclid blue-stones, but of greater geological age, are the dark, blue-gray compact "gray-wackes," or flag-stones, so extensively quarried in Ulster County, New York, and other parts of this State and Pennsylvania. These stones are of fine and even texture, and split readily from the quarries in slabs, usually but a few inches thick. They are therefore eminently suited for flagging, to which usage they are extensively applied, though they also used for steps and general trimming purposes. The rock quarried at Barryvale, in Sullivan County, is of a similar nature. It was from quarries at this last-named locality that was taken the monster flag-stone, twenty-five feet two inches long, by fifteen feet wide and eight inches thick, that now forms a portion of the sidewalk in front of the Vanderbilt residence on Fifth Avenue, New York. It should be stated, however, that the size of this block was limited only by the means of transportation, and much larger could be obtained at the quarries if desired.

Another very important group of sandstone, but of still greater geological antiquity, belonging to the Medina period of the Upper Silurian formations, is quarried extensively at Albion and Medina, near Rochester, New York. These stones are usually of a reddish color and contain a larger portion of siliceous cementing material than any of those yet mentioned; they are therefore much harder and much less pervious to moisture. The stones are used for all manner of building purposes, flagging, and street-paving. A somewhat similar stone, but of brighter color and Potsdam age, is quarried in the town of Potsdam, in St. Lawrence County, in the same State. This is the stone used in the construction of the Columbia College buildings in New York city.

Sandstones of this nature, i. e., with the larger proportion of siliceous cementing material, are among the most durable of all our building-stones; but their extreme hardness and often poor colors are great drawbacks to their extensive use. In process of dressing such stone an exceedingly fine white dust arises and remains for a long time suspended in the air, to the great inconvenience of the workmen, who tell marvelous stories of its penetrating powers. They have been known to assert that, if an empty and hermetically sealed glass bottle be placed within the sheds where such stones are being cut, it will shortly be found with a fine white deposit of the dust upon the bottom and *on the inside*, and no argument can convince them that it came there otherwise than through the pores of the seemingly impervious glass!

The quarrying of slate for roofing purposes is an industry of comparatively recent origin in the United States, few of the quarries having been operated for a longer period than twenty or thirty years. The earliest opened and systematically worked are believed to have been those at West Bangor, Pennsylvania, which date back to 1835. The abundance of slate tombstones in many of our old churchyards, however, would seem to prove that for other purposes than roofing these stones have been quarried from a much earlier period. It is stated, moreover, that as early as 1721 a cargo of twenty tons of split slate was brought into Boston from Hangman's Island in Braintree Bay, which may have been used wholly or in part for roofing purposes; but the greater part of the material for this purpose was imported directly from Wales. It is interesting to note, in this connection, that, during the business depression of 1876–'80, almost the entire product of the American quarries was exported to England, where it sold for even less than the Welsh slates, though necessarily at very small profits. The return of more prosperous times, however, created a local demand, and the export trade has been largely decreased accordingly, though considerable quantities are still sent out to the West Indies, South America, England, Germany, and even New Zealand and Australia.

At present not far from $3,328,150 are invested in the slate-quarries of the United States, and the value of the annual product is some $1,529,985.

Pennsylvania is the leading State in this industry, her quarries being located in Lehigh, Northampton, and York Counties, in the eastern part of the State. These slates are all blue-black in color; as are also those from Maine, Massachusetts, and Maryland. The Vermont slates are of a greenish or purple color, while those of New York are mostly purple and red, the latter color being found in extensive deposits near Granville, in Washington County.

Besides for roofing purposes, slates are used for billiard-tables, mantels, floor-tiles, flagging, and in the manufacture of school-slates. For the last-named purpose a soft, even-grained stone is required, and almost the entire supply is at present brought from Pennsylvania and Vermont.

Of late years, the business of marbleizing slates for mantels and fireplaces has become an important industry. All kinds of stones can be imitated by this process, but that most commonly seen is the green verd-antique marble and the variegated marbles of Tennessee. Like many counterfeits, however, the work is too perfect in execution, and need deceive none but the most inexperienced.

Concerning the future of the building-stone industry little that is definite can be said. As the population increases and becomes more fixed in its abode, there naturally arises a demand for a more durable building material than wood, which is still largely used in the country towns and smaller cities. As wealth accumulates, too, better and more substantial buildings are erected, which are often profusely embellished with the finer grades of ornamental stones. The demand, then, is sure to increase. In regard to the amount of the supply there can be question; everything would seem to depend on the quality, variety, and cost of working of yet-to-be-discovered material. Are we to continue to import as now the finer grades of our ornamental stones, or will our own quarries, yet perhaps to be opened, produce enough and more than enough for our own use? I am inclined to think the latter.

In many of the Eastern and earliest to be settled States very little is yet known regarding their final resources. In Maine, for instance, fully one half of the State is as yet an unknown land. Its present quarries are nearly all immediately upon the coast. What are the resources of its immense interior can not with certainty be foretold. In the Southern and Western States and Territories, this condition of affairs is naturally greatly magnified. The Virginias, North and South Carolina, and Georgia, all contain excellent material, none of which is now in our principal markets. Michigan can furnish brown sandstones in great abundance fully equal to any now quarried in the more Eastern States, and other sandstones of a beautiful mellow tint are known to occur in Western Arizona. The Rocky Mountain region contains an abundance, both in variety and quantity, of granites, sandstones, marbles, and the more recent volcanic rocks, as basalts, rhyolites, and trachytes. Some of these are very beautiful, excelling anything in this respect from the Eastern States. Red granites far excelling the red Scottish granites of Peterhead, or the celebrated Egyptian "Syenite," occur in inexhaustible quantities. We have seen a black-and-white breccia marble from Pitkin, Colorado, which bids fair to be a formidable rival of the imported Portoro marble from the Monte d'Arma quarries, if it occurs in sufficient quantities and is accessible. A fine field for exploration is offered in the extensive stalagmitic deposits on the floors of the numerous caverns so prevalent in many parts of the country. These deposits, as is well known, are identical in composition with the celebrated "onyx" marbles of California, Mexico, and Egypt, already mentioned. The red and purple porphyries so abundant in New Hampshire, Eastern Massachusetts, and other parts of the country, offer an unfailing supply of beautiful and durable ornamental stones, but which are at present kept out of the market, owing to the great cost of working.

This leads us, in conclusion, to an important item in this connection that must not be overlooked, which is the fact that, with our present high rates of labor in this country, many of our finest grades of ornamental stones can not compete in the market with the imported article, even though greatly exceeding them in point of beauty. In the majority of marbles those lines or spots that give to any stone its peculiar attractiveness are in reality flaws, and hence their presence must add greatly to the cost of working. It is safe to say that the beautiful breccia marble from the French Pyrenees, which has been used for wall-panels in the cash-room of the Treasury Building at Washington, would not be worked to any extent from quarries in this country, so long as the imported article can be obtained at present rates. This fact is rendered probable by the cases of the Maryland breccia and the Vermont verd-antique already mentioned. Neither of these is in the market, simply because the imported marble can be furnished at lower prices. With improved machinery and methods of workmanship there seems, however, no doubt but we may in time compete with foreign cheap labor not only in our own markets, but foreign ones as well.

THE DARWIN MEMORIAL.

THE ADDRESS OF PROFESSOR HUXLEY, AND THE REPLY OF THE PRINCE OF WALES.

IT is not often that the unveiling of a statue is attended with an interest at all comparable with that which characterized this ceremony as performed last Tuesday [June 9th] in the great hall of the Natural History Museum. If the greatness of a man is to be estimated by the measure in which he has influenced the thoughts of men, it is scarcely open to question that the greatest man of our century is Charles Darwin. As Professor Huxley remarked in the course of his singularly judicious and well-balanced address, Mr. Darwin's work has not only reconstructed the science of biology, but has spread with an organizing influence through almost every department of philosophical thought. Yet it was not merely the greatness of the naturalist which invested the proceedings in the Natural History Museum with an interest so unique. It was known to the whole assembly that the man whom they delighted to honor was one whose moral nature had been cast in the same lines of simple grandeur as those which belonged to his intellectual nature. It therefore only needed a passing allusion from Professor Huxley to enable the whole assembly to reflect that it was due as much to massiveness of character as to massiveness of work that within three years of his death Mr. Darwin's name should constitute a new center of gravity in every system of thought. And it was this reflection which gave to the ceremony so unusual a measure of interest. Around the statue were congregated the most representative men of every branch of culture, from the Prince of Wales and the Archbishop of Canterbury to the opposite extremes of radicalism and free thought. Indeed, it is not too much to say that there can scarcely ever have been an occasion on which so many illustrious men of opposite ways of thinking have met to express a common agreement upon a man to whom they have felt that honor is due. The international memorial could not in any nation have found a more worthy site than the one in which it has been placed ; but, if anything could have added to the "solemn gladness" with which the personal friends of Mr. Darwin witnessed the presentation of this memorial, it must have been the evidence which the assembly yielded that, among the innumerable differences of opinion which it represented, his memory must henceforth be always and universally regarded as a changeless monument of all that is greatest in human nature, as well as of all that is greatest in human achievement.

Concerning the statue itself, we have only to speak in terms of almost unqualified praise. It is, in the truest sense of the phrase, a noble work of art. The attitude is not only easy and dignified, but also natural and characteristic ; the modeling of the head and face is unexceptionable, and the portrait is admirable. The only criticism we have to advance has reference to the hands, which not only do not bear the smallest resemblance to those of Mr. Darwin, but are of a kind which, had they been possessed by him, would have rendered impossible the accomplishment of much of his work. Although this misrepresentation is a matter to be deplored, it is not one for which the artist can be justly held responsible. Never having had the advantage of seeing Mr. Darwin, Mr. Boehm has only to be congratulated upon the wonderful success which has attended his portraiture of the face and figure ; the hands were no doubt supplied by guess-work, and therefore we have only to regret that the guess did not happen to be more fortunate.

The following is the address made by Professor Huxley, in the name of the Darwin Memorial Committee, on handing over the statue to his Royal Highness the Prince of Wales, as representative of the Trustees of the British Museum :

Your Royal Highness : It is now three years since the announcement of the death of our famous countryman, Charles Darwin, gave rise to a manifestation of public feeling, not only in these realms, but throughout the civilized world, which, if I mistake not, is without precedent in the modest annals of scientific biography.

The causes of this deep and wide outburst of emotion are not far to seek. We had lost one of those rare ministers and interpreters of Nature whose names mark epochs in the advance of natural knowledge. For, whatever be the ultimate verdict of posterity upon this or that opinion which Mr. Darwin had propounded ; whatever adumbrations or anticipations of his doctrines may be found in the writings of his predecessors; the broad fact remains that since the publication, and by reason of the publication, of the "Origin of Species," the fundamental conceptions and the aims of the students of living Nature have been completely changed. From that work has sprung a great renewal, a true "instauratio magna" of the zoölogical and botanical sciences.

But the impulse thus given to scientific thought rapidly spread beyond the ordinarily recognized limits of biology. Psychology, Ethics, Cosmology were stirred to their foundations, and the "Origin of Species" proved itself to be the fixed point which the general doctrine of evolution needed in order to move the world. "Darwinism," in one form or another, sometimes strangely distorted and mutilated, became an every-day topic of men's speech, the object of an abundance both of vituperation and of praise, more often than of serious study.

It is curious now to remember how largely, at first, the objectors predominated; but, considering the usual fate of new views, it is still more curious to consider for how short a time the phase of vehement opposition lasted. Before twenty years had passed, not only had the importance of Mr. Darwin's work been fully recognized, but the world had discerned the simple, earnest, generous character of the man that shone through every page of his writings.

I imagine that reflections such as these swept through the minds alike of loving friends and of honorable antagonists when Mr. Darwin died; and that they were at one in the desire to honor the memory of the man who, without fear and without reproach, had successfully fought the hardest intellectual battle of these days.

It was in satisfaction of these just and generous impulses that our great naturalist's remains were deposited in Westminster Abbey; and that, immediately afterward, a public meeting, presided over by my lamented predecessor, Mr. Spottiswoode, was held in the rooms of the Royal Society, for the purpose of considering what further steps should be taken toward the same end.

It was resolved to invite subscriptions, with the view of erecting a statue of Mr. Darwin in some suitable locality; and to devote any surplus to the advancement of the biological sciences.

Contributions at once flowed in from Austria, Belgium, Brazil, Denmark, France, Germany, Holland, Italy, Norway, Portugal, Russia, Spain, Sweden, Switzerland, the United States, and the British colonies, no less than from all parts of the three kingdoms; and they came from all classes of the community. To mention one interesting case, Sweden sent in 2,296 subscriptions "from all sorts of people," as the distinguished man of science who transmitted them wrote, "from the bishop to the seamstress, and in sums from five pounds to two pence."

The Executive Committee has thus been enabled to carry out the objects proposed. A "Darwin Fund" has been created, which is to be held in trust by the Royal Society, and is to be employed in the promotion of biological research.

The execution of the statue was intrusted to Mr. Boehm; and I think that those who had the good fortune to know Mr. Darwin personally will admire the power of artistic divination which has enabled the sculptor to place before us so very characteristic a likeness of one whom he had not seen.

It appeared to the committee that, whether they regarded Mr. Darwin's career or the requirements of a work of art, no site could be so appropriate as this great hall, and they applied to the Trustees of the British Museum for permission to erect it in its present position.

That permission was most cordially granted, and I am desired to tender the best thanks of the committee to the trustees for their willingness to accede to our wishes.

I also beg leave to offer the expression of our gratitude to your Royal Highness for kindly consenting to represent the trustees to-day.

It only remains for me, your Royal Highness, my lords and gentlemen, Trustees of the British Museum, in the name of the Darwin Memorial Committee, to request you to accept this statue of Charles Darwin.

We do not make this request for the mere sake of perpetuating a memory; for, so long as men occupy themselves with the pursuit of truth, the name of Darwin runs no more risk of oblivion than does that of Copernicus or that of Harvey.

Nor, most assuredly, do we ask you to preserve the statue in its cynosural position in this entrance-hall of our National Museum of Natural History as evidence that Mr. Darwin's views have received your official sanction; for Science does not recognize such sanctions, and commits suicide when it adopts a creed.

No; we beg you to cherish this memorial as a symbol by which, as generation after generation of students of Nature enter yonder door, they shall be reminded of the ideal according to which they must shape their lives, if they would turn to the best account the opportunities offered by the great institution under your charge.

The following reply was made by his Royal Highness the Prince of Wales:

Professor Huxley and Gentlemen: I consider it to be a high privilege to have been deputed by the unanimous wish of my colleagues, the Trustees of the British Museum, to accept, in their name, the gift which you have offered us on behalf of the Committee of the Darwin Memorial. The committee and subscribers may rest assured that we have most willingly assigned this honorable place to the statue of the great Englishman who has exerted so vast an influence upon the progress of those branches of natural knowledge the advancement of which is the object of the vast collections gathered here. It has given me much pleasure to learn that the memorial has received so much support in foreign countries that it may be regarded as cosmopolitan rather than as simply national; while the fact that persons of every condition of life have contributed to it affords remarkable evidence of the popular interest in the discussion of scientific problems. A memorial to which all nations and all classes of society have contributed can not be more fitly lodged than in our Museum, which, though national, is open to all the world, and the resources of which are at the disposal of every student of Nature, whatever his condition or his country, who enters our doors.—*Nature.*

MODERN BRONZES.*

By PERRY F. NURSEY, C. E.

WE had in the earlier ages of mankind a rough and a polished stone age, a bronze age, and an age of iron, each distinguished by the character of the material that was predominantly used by men for their weapons and tools, and have now added to those ages one of steel. In a similar manner we are now entering upon a revival of the bronze age, in which that substance in its varieties is to be put through stages of improvement like those that iron and steel have undergone. Many varieties of bronze have been produced within the last few years that possess features strongly distinguishing them from the ancient alloys, and some very remarkable qualities as compared with them, in view of which they are frequently used in place of even iron and steel, The bronzes of the ancients were composed of copper and tin, as is also what is now regarded as bronze pure and simple, mixed in proportions varying according to the purpose for which the compound is intended. Other substances, however, are often added, without unclassifying the product, which is still called bronze, provided copper and tin are the chief constituents. Among these substances are zinc, lead, phosphorus, manganese, silicium, iron, nickel, arsenic, antimony, and sulphur. It is the addition of certain proportions of one or other of such substances that constitutes the modern development of bronze manufacture, and which has given us some of the most useful and at the same time some of the most remarkable alloys known. These comprise no fewer than eleven distinct products, all of which find their uses in connection with the practice of engineering. They are: phosphor-bronze, silicium-bronze, manganese-bronze, delta-metal, phos-

* From a paper read before the Society of Engineers.

phor-copper, phosphor-manganese bronze, phosphor-lead bronze, phosphor-tin, aluminum-bronze, silveroid, and cobalt-bronze. There are also other bronzes which are used as substitutes for gold in cheap imitation jewelry, but they do not come within the scope of the present paper.

The action of phosphorus on copper alloys is principally due to its reducing qualities, by virtue of which the oxygen absorbed by the molten metal is removed, or the oxides formed thereby are eliminated, and the degree is imparted of homogeneity, strength, and toughness peculiar to the chemically pure metal. The phosphorus, by producing these effects, is converted into a cuprous oxide, which floats on the surface of the molten metal in the shape of a very fluid slag, while the superfluous quantity combines with the metal. It is not, therefore, desirable to add to the bronze a larger quantity of phosphorus than will suffice to reduce the oxide present.

Phosphor-bronze was first prepared by Dr. Kunzel, of Dresden, and was brought into practical use in England early in 1873. The alloys of this class are composed of copper, tin, and phosphorus, and other ingredients in variable proportions, and are made to be either as ductile as copper, as tough as iron, or as hard as steel, according as the proportions of the constituents are varied. The alloys used for rolling and drawing have very different proportions from those employed for castings, bearings, and parts of machinery. The castings of this metal are perfectly sound and homogeneous. Wherever strength, toughness, and durability are desired, phosphor-bronze is found to be better adapted than gun-metal and brass, and in many cases than iron and steel. Having the advantage of not becoming crystalline under the action of repeated shocks and bendings, it is well adapted for making wire-rope, and, not being acted upon by corrosive liquids or the atmosphere, its value as a metal remains constant. The principal varieties of phosphor-bronze, which are produced by slightly varying the proportions of the constituents, are phosphor-bronze duro A, a very dense metal, adapted for bearings carrying heavy wheels running at great velocities, and generally for all quick-speed purposes ; and phosphor-bronze duro B, which is intended for the bearings of hot-neck rolls, and for all bearings having to withstand great pressure.

Silicium-bronze was invented by M. Lazare Weiller, of Angoulême, in the search for a material for telegraph-wires, which, together with all the desirable properties of phosphor-bronze, should have a better conducting power. In it phosphorus is replaced by a silicious metalloid, by the incorporation of which a wire is produced offering the same resistance to rupture as phosphor-bronze wire, by the use of which telegraph lines may be furnished with a light, unoxidizable wire, having all needed electrical efficiency. It is also affirmed of wires of this bronze that they are of equal strength with ordinary wires, while not one tenth as heavy ; and that, if broken, they will not fall to the ground as ordinary wires do, but, by virtue of their high elasticity, will spring back and coil up close to the standards.

It has long been known that the hardness of bronze could be increased by adding iron to it, but that quality appears to be acquired at the expense of ductility and toughness, and for that reason, probably, such alloys have never come into general use. Mr. Alexander Parkes, and the late Mr. J. D. Morries Stirling, were probably the first to propose and carry into practice the use of manganese for improving the quality of bronze. Mr. Parkes combined manganese alone with copper, and used this alloy to form improved alloys of brass and yellow metal, of which to make sheathing, rods, wire, nails, and tubes. Mr. Stirling, in 1848, proposed to employ manganese in various brass alloys in which iron was present; and a metal introduced by him was used for some time in railway-carriage bearings. It, however, lacked strength, hardness, and ductility, and has long since been superseded.

A manganese-bronze having all the requisites of a useful alloy was introduced in 1876 by Mr. P. M. Parsons. It is prepared by mixing a small proportion of ferro-manganese with copper, after which various alloys are formed. The ferro-manganese is melted in a separate crucible, and is added to the copper when in a fluid state. The effect of this combination is similar to that produced by the addition of ferro-manganese to the decarburized iron in a Bessemer converter. According to Mr. Parsons, while a part of the manganese cleanses the copper of any oxides it may contain by combining with them and forming a slag, another part, with the iron, becomes permanently combined with the copper, whereby the strength, hardness, and toughness of the compound are modified, according as the proportions of the constituents are varied. Five different qualities of manganese-bronze are made. In the number one quality the zinc alloyed with the copper is considerably in excess of the tin. It may be worked hot or cold, and has great tensile strength and elasticity. Manganese-bronze number two is stronger, and can be cast in sand for special purposes where strength, hardness, and toughness are required; but it has to be melted in crucibles. One of its most important applications is to the production of articles cast in metal molds under pressure; and the articles thus made have the strength, toughness, and hardness of cast-steel, without any of its defects. It is perfectly homogeneous, and, while not possessing a fibrous texture derived from rolling or hammering, is still fibrous in character, in all directions alike, and, when broken, shows a beautiful silky fracture. It can be cast upon any object, on which it will shrink with a force equal to its elastic limit, and, when released, will show an amount of resilience about double that of steel. Its hardness is about equal to that of mild steel.

The number three quality is composed chiefly of copper and tin in about the same proportions as gun-metal, combined with a large percentage of ferro-manganese. Its chief characteristics are great transverse strength, toughness, and hardness, the facility with which it can be cast, and the soundness and uniformity of the castings produced. This quality is used for wheel-gearing, supports and connections of machines, crank-pin brasses, the shells of main and other bearings of engines, axle-boxes, and parts of locomotive-engines. It is also adapted for statuary and for large bells. Its most important application appears to be for making screw-propellers, for which, in its qualities of strength, non-corrosiveness, and perfect trueness in casting, it seems to be superior to any other substance yet found.

The qualities numbers four and five have no particular claim to strength, but are useful for bearings, slide-valves, slide-blocks, piston-rings, and other purposes in which friction has to be taken account of.

Delta-metal, the second and latest example of the successful addition of iron to bronze, was introduced, in 1883, by Mr. Alexander Dick, who named it with the Greek equivalent for the initial of his surname. His preliminary experiments were directed to removing the inequalities in the properties of the iron-bronze alloys previously attempted, and he found that all depended on getting exactly the right proportion of iron and preventing its oxidation during the process of remelting. Delta-metal in color resembles gold alloyed with silver. It can be worked hot and cold. When melted, it runs freely, and the castings produced from it are sound and of a fine, close grain. It can not be welded, but can be brazed, and, when of suitable thickness, "burned." The varieties designed for working hot are capable of being stamped or punched, similar to wrought-iron and steel, into a variety of articles which have hitherto been cast in bronze or brass. This property is of much importance, for the articles thus turned out are cheaper and stronger than brass-castings. The iron introduced into the compound by Mr. Dick's process is really chemically combined; and the alloy does not rust, and has no action on the magnetic needle. Delta-metal may be used to replace the best brass and gun-metal, and in many instances iron and steel also—for parts of rifles, guns, and torpedoes, tools for gunpowder-mills, parts of bicycles, gongs, various domestic articles, spindles for steam- and water-valves, plungers, pump-rods, and boats.

Phosphor-copper is a preparation devised by Mr. W. G. Otto, of Darmstadt, for the purpose of furnishing engineers and founders with a compound, by adding certain proportions of which to a given bulk of metal they can obtain a phosphor-bronze suitable for various purposes.

An article called phosphor-manganese-bronze is in the market, but the manufacturer has not furnished a description of it.

Phosphor-lead bronze, introduced in 1881 by Messrs. K. H. Kuhne & Co., of Löbau, near Dresden, is regarded as specially adapted for all purposes where metal is subjected to constant wear or continuous friction. The introduction of lead into its composition and its homogeneousness are said to give it special properties, by reason of which the advantages are claimed for it of self-lubrication, greater wearing capacity than any other metal or alloy, coolness under friction, great tensile strength combined with hardness, and non-liability to fracture.

Phosphor-tin is a compound designed to be added to copper for the making of phosphor-bronze.

The history of the practical manufacture of aluminum does not extend very far back into the past; in fact, its commencement dates within the limits of the present generation. The three International Exhibitions which have been held in Paris since aluminum began to be worked on a commercial scale form so many landmarks in its progress. In 1855 it was met with for the first time in the Palais d'Industrie, in the form of a large bar, and was exhibited as silver produced from clay. In the Exposition of 1867 it was to be seen in a more advanced stage, worked up into castings and various kinds of useful and ornamental articles. There also for the first time was seen the alloy aluminum-bronze. The Paris Exhibition of 1878 witnessed the maturity of the aluminum manufacture and its establishment as a current industry, having a regular demand and supply for certain purposes within the limits permitted by its somewhat high price. A little more than two years ago Mr. James Webster perfected his invention for producing aluminum, which is now being practically worked, and gives, it is claimed, alumina without a trace of iron, and free from contamination with other foreign substances. The process is being worked by the Aluminum Crown Metal Company, and the metal itself combines strength and lightness with elegance of appearance and general utility. The bronze is of two kinds—white and yellow—the former being used for cutlery and other table requisites where silver and plated goods are now employed, for metallic fittings, and for every purpose where a non-oxidizing, bright surface, with strength, is desired. The yellow metal is adapted, and is used for articles and for details of machinery where gun-metal and other alloys are now employed. It is said to stand well in engine-bearings, and to give satisfactory results when used in screw-propellers. The bronze is made in five qualities, and each quality is made hard or soft as may be required.

Silveroid, a metal introduced to public notice early in 1884, is an alloy of copper and nickel adjusted with zinc, tin, or lead, in various proportions, according to the purpose for which it is intended; but the secret of success in the manufacture is said to lie in a special method of treatment at a certain point in the process. This alloy is a metal of great whiteness, brilliancy, closeness of grain, and tensile strength.

Cobalt-bronze has been introduced since silveroid, by the same manufacturers, Messrs. Henry Wiggin & Co., who produced that metal. It is whiter and slightly more expensive than silveroid, and is interesting as containing small quantities of cobalt, with the most desirable qualities of that metal, particularly its malleability. It is manufactured in several qualities, the higher grades of which are eminently suitable for casting purposes, have a close, steel-like surface, are susceptible of a high polish, are hard and tough, and possess great tensile strength.

MEASURES OF VITAL TENACITY.

By Dr. B. W. Richardson, F. R. S.

IN the observations which I have made on animals passing into death by the lethal process, nothing has impressed me more than the curious differences of vitality or vital values of different animals. The differences are so great they seem almost inexplicable, and in many respects they are so. To some extent, however, they come under law, and we may therefore hope that by carefully continued research what is now difficult and involved may be rendered, in time, simple and perfectly clear.

The first series of observed facts relate to vital differences in animals of different species. In illustration I may take the cat and the dog. Between these animals the distinction of vitality exists irrespectively of age, and of all other conditions and circumstances of which I can gather information.

Of the cat it is commonly said that it has nine lives. By this saying nothing very definite is meant beyond the opinion that under various kinds of death the cat lives much longer than other animals that have to be killed by violent means. When any question is asked of the police or of other persons who have to take the lives of lower animals, they tell you, without exception, according to my experience, that the cat is the most difficult to destroy of all domestic animals, and that it endures accidental blows and falls with an impunity that is quite a distinguishing characteristic.

The general impression conveyed in these views is strictly correct up to a certain and well-marked degree. By the lethal death, the value of the life of the cat is found to be, at the least, three times the worth of the dog. In all the cases I have seen in which the exactest comparisons were made, the cat outlived the dog. A cat and dog of the same ages being placed in a lethal chamber, the cat may, with perfect certainty, be predicted to outlive the dog. The lethal chamber being large enough to hold both the cat and the dog, the vapor inhaled by the animals being the same, with every other condition identical, this result, as an experimental truth, may be accepted without cavil.

The differences, always well marked, are sometimes much longer than would be credible in the absence of the evidence. I have once seen a cat, falling asleep in a lethal chamber in the same period as a dog, remain breathing, literally, nine times longer, for the dog died within five minutes, and the cat not only continued to breathe, in profoundest sleep, for forty-five minutes, but would have been recoverable by simple removal from the vapor into fresh air if it had been removed while yet one act of breathing continued. This, however, was exceptional, because the cat in the same lethal atmosphere as the dog does not, as a rule, live more than thrice as long; i. e., if the dog ceases to breathe in four minutes, the cat will cease in from ten to twelve minutes after falling asleep.

The character of the vapor used does not make any difference, relatively. Carbonic oxide, carbonic acid, chloroform-vapor, carbon-bisulphide vapor, yield the same relative results. Pure carbonic oxide kills with intense rapidity, but it kills the cat less quickly than the dog. If instead of a lethal vapor prussic acid be used, in administration by the mouth, the cat dies more slowly than the dog. The same is true in respect to death by drowning.

Still more curiously, recovery from apparent death is much more frequent in the cat than in other domestic animals. Mr. Warrington once observed a cat recover from apparent absolute death by prussic acid, eight hours after it had lain as if dead. I once saw a young cat come back to life after two hours of immersion under cold water.

I do not know many facts bearing on tenacity of life in other animals, but I have observed that sheep in a lethal atmosphere die very rapidly, goats much less rapidly, and pigeons more rapidly than common fowls. There is, apparently, a specific tenacity in all species.

In animals of the same species there are distinctions determinable by peculiarities in the animal itself. In one instance where a large number of dogs were put to sleep in the lethal chamber, one was found in deepest sleep, but still breathing, side by side and partly covered by another that was not only dead but cold and rigid. A similar fact occurred last year in the human subject in a mine. A father and son killed by fire-damp lay together, the father dead, the son living, though he, the son, had come first under the influence of the lethal gas. In all the fatal accidents to the human subject from the administration of chloroform or other narcotic vapor we see the same illustration. I doubt whether in any one of these unhappy events the death has been induced by what would be, under the common run of administrations, a fatal dose. But some die from a dose that would not so much as narcotize others. An analogous series of facts is met with in relation to the effects of physical and mental shocks and to surgical operations.

The variation of measure of tenacity of life is unquestionable. What is the reason of it? What is there in one species of animal that gives a measure of tenacity over another? Why, for instance, is the cat more tenacious of life than the dog?

The only answer as yet is, that the cat is endowed with more vitality. But this is no answer as to details. Is the endowment of the greater vitality centered in the nervous system, in the muscular, in the respiratory, in the blood, in the membranes?

And wherever centered, what is the endowment?

The difference of tenacity in animals of the same species is more approachable, because we know certain factors that afford an explanation of it.

Age is a factor. In the young the tenacity is more distinctly marked than in the old. In a broad sense there is no exception to this rule.

Degenerations of tissues are factors. Fatty degenerations are reducers of tenacity. Lessened arterial tension is a reducer.

Race or breed is another factor. The strong, wiry, muscular animal of any species is more tenacious of life than the heavier and less elastic. The terrier outlives the spaniel or retriever. The man of sanguine temperament outlives the nervous and lymphatic man.

In the operation of tracheotomy for croup or diphtheria in children, other things being equal, the chances of a successful issue will be as two to one to a spare, active, wiry subject compared with the chances of the full-cheeked, full-bodied child with luscious lips and rich flowing curls of pale or golden hue. The first of these will live almost through the gate of death; the second will succumb without a struggle for life.

Will is a factor. I have twice seen tenacity of life maintained, as it were, against all possibilities by what is called the will of the sufferer. Mr. F. Hall, of Jermyn Street, had a patient in the last stage of pulmonary consumption, whom I had seen with him in what appeared to be a condition of emaciation and exhaustion that precluded the feeblest effort toward rising from bed. Yet one day, and three weeks only before actual death, this sick man by a supreme effort of volition rose, dressed himself, went out of his house, and had to be sought for by his friends and brought back, with gentle compulsion, simply to die.

A young authoress of great promise, suffering from the same disease—pulmonary consumption—in the very last days of her life rose from bed, and in the most vigorous style was engaged for several hours in composition on letters and work which had been for months laid aside. Her friends, bewildered by the phenomenon, could scarcely accredit that the effort did not presage recovery, until rapid collapse dispelled the illusion.

This tenacity of life illustrated through volition is the equivalent of that courageous endurance which some in famine and war have "miraculously" exhibited.

These examples illustrate the influence of certain factors on tenacity of life, and they may, one day, lead up to the prime cause of the difference of tenacity if they and other facts bearing on the matter be carefully observed and recorded. But, as yet, the prime cause remains a troubled and troublous question.—*The Asclepiad.*

CURIOSITIES OF TIME-RECKONING.

By M. L. BARRE.

THE natural unities for the measurement of time are three, and are afforded by the rotation of the earth upon its axis, the revolution of the moon around the earth, and the revolution of the earth around the sun ; of which the mean values respectively are 24 hours ; 29 days, 12 hours, 44 minutes, 2·9 seconds ; and 365·2422 days. These numbers are incommensurable and wholly independent of one another. But men have tried to connect them from the most remote ages, and have devised the lunar-solar year, the duration of which is related to the movements of the sun and the moon. Although this system may appear complicated, it is in reality quite simple, for the sun and moon spare man the trouble of calculating the days, while the years and months write themselves in large characters in the appearance of the sky and of vegetation.

The lunar-solar year thus having its origin in Nature, is found in the most ancient form of the Jewish calendar. The Israelite year was so regulated that the feast of the Passover was celebrated on the fourteenth day of the first month, when the barley to be offered in sacrifice was ripe at the full moon. This marked the first month of the year, named Nisan, and served as the point of departure for the twelve usual months. But, if the ripening of the barley did not occur during the fortnight following the end of the year, another month was intercalated, and the new year began with the next new moon. If we desire an exact and rigorous measure, this form of year is simply confusing. The Jews have years of twelve lunar months, of twenty-nine or thirty days, to which is added a thirteenth month, when the year is embolismic ; and they might contain 353, 354, 355, 383, 384, or 385 days. The Jewish calendar also included a period of nineteen solar years, or a lunar cycle of 235 months. The years date from the creation of the world, which is fixed by the Jews at October 7th, B. C. 3761.

The Chinese month begins with the new moon ; the first month when the sun enters Pisces, the second when it enters Aries, etc. But if the sun does not enter a new sign of the zodiac with the new month, an additional month is introduced, which is given the same name as the preceding one, with a distinctive sign. The months are of twenty-nine and thirty days, but there is no absolute rule for their succession, nor for the place of the supplementary month, nor for the intercalation of complementary years ; and, as the beginnings of the months and the years are calculated from the movements of the celestial bodies, the whole year is uncertain and changeable. In the difficulty of ascertaining from what tables the ancient Chinese calculated their astronomical elements, there would be great uncertainty in comparing a Chinese date with the corresponding date of any other chronology, were it not that the learned from the most ancient times have used a cycle of sixty days in much the same manner as we use our week of seven days, without regard to the movements of the sun and the moon. This calendar has become of prime necessity for fixing the year in which a particular day may have fallen ; and the preparation of it is considered a matter of such importance that it is confided to an imperial mathematical tribunal, and, when the work is completed, it is ceremoniously presented to the members of the imperial family and the chief personages of the government.

The Chinese years are designated by two numbers. The first, the official number, indicates the number of the years of the reign of the emperor, and is variable ; the second pertains to a cycle of sixty years, of which each year has a special name. In all Eastern Asia, the system employed for the designation of the years is based upon the combination of the name of ten, *kan*, with one of the denominations of twelve, *chi*. The cycle formed by a combination of this character may be found in Japan, Manchooria, Mongolia, and Thibet. The Aztec cycle of fifty-two years, formed of two smaller cycles of four and thirteen years, led Humboldt to suggest that Asiatic ideas might have penetrated to Mexico. Sometimes, but rarely, the Asiatics count by cycles of twelve years, each of which has the name of an animal.

The lunar-solar year of the Hindoos was based on a sidereal solar year of which the twelve months, of unequal length, had a duration exactly defined. The solar month Chaîtra consisted of 30 days, 20 hours, 21 minutes, 2 seconds, and 36 thirds, the day being divided into sixty hours. The year began with the new moon preceding the beginning of the solar year. When two lunar months began within the same solar month, the first one was intercalated. If no lunar month began in the course of a particular solar month, the year lost an ordinary month, but two intermediate months were added. Every Hindoo month has a particular name, and the new moons, which serve to fix the beginnings of the months and the years, are calculated with so great precision that it is much more easy to identify an ancient date in India than in China. But some difficulties arise out of the use of different systems in ancient times, and also from the fact that the Hindoo day is the thirtieth part of the lunar month, which consists of twenty-nine days and a half, and is consequently shorter than the natural day.

The computation of the years begins with zero, the first year counting as 0, the second as 1, and so on. Each year bears a particular name appertaining to a cycle of sixty years, which is, however, different from the Chinese cycle, and is based on the course of the planet Jupiter, which performs its revolution in 11·86 years, or, in round numbers, twelve years. The Hindoo cycle is therefore equivalent to five Jovian revolutions and $\frac{1}{10}$ of a year (11·86 years $\times$ 5 = 59·30 years); in three periods of sixty years we have to omit two years, one in the first cycle, and the other in the third; but in thirty cycles we have to omit 0·7 year × 30 = 21 years, while the preceding correction has omitted only twenty years; so a new suppression of a year has to be performed in each series of thirty cycles.

The Hindoos also employed ages in the computation of time, and these, too, divided into periods of different durations. The present age is the *kali yuga*, or the age of iron; 4,985 years of it have already passed, but its total duration is supposed to be 432,000 years. The succession of the ages, counting back, is given as follows:

Fourth age—*Kali yuga*, age of iron, or of woe (the present age), to be of 432,000 years.

Third age—*Dvapara yuga*, 864,000 years.

Second age—*Treta yuga*, or age of silver, 1,296,000 years.

First age—*Krita yuga*, age of gold, or of innocence, 1,728,000 years.

These four ages form the *maha yuga*, or great age, of 4,320,000 years. The length of a patriarchate is seventy-one maha yugas, or 306,720,000 years, to which is added a twilight period of 1,728,000 years, making in all 308,448,000 years. Fourteen of these patriarchates, augmented by a dawn of 1,728,000 years, gives 4,320,000,000 years, which form a *kalpa*, or the *æon* of the Hindoo chronology.

A kalpa is only a day in the life of Brahma, whose nights are also of the same duration. Now, Brahma lives a hundred years of three hundred and sixty days and three hundred and sixty nights. The present epoch is the *kali yuga* of the twenty-seventh grand age of the seventh patriarchate of the first æon of the second half of the life of Brahma, who is now in his 155,521,972,848,985th spring. Yet the whole life of Brahma is only a little longer than a single wink of Siva's eye!

The Greeks employed first two years of 12 months each consisting of 30 days, and a third year of 13 months, giving an average of 370 days to the year; then the cycle of 19 lunar years, with seven months intercalated in each cycle to obtain 19 solar years. The months were of 29 and 30 days, and the time was calculated by Olympiads, of four years each. Afterward, Calippus introduced the cycle of Méton, 433 years B. C., shorter than the 19 solar years, in consequence of the suppression of a day every 76 years. The era of the Olympiads goes back to B. C. 776, at which time Corœbus obtained the prize in the race, from and after which date the names of the victors were inscribed on the official registers.

The ancient Egyptians reckoned at first 12 months of 30 days, or 360 days; but they afterward added five supplementary days. The years were counted from the accession of the kings; and the canon of Ptolemy is a chronological table giving the changes of the reigns. The same form of year was formerly in use among the Persians, with the difference that they added the five supplementary days to the eighth month instead of to the twelfth. Their months had particular names, and their years were counted from the accession of Yesdegerd I, A. D. 399; an epoch which is still employed by the Persians in some parts of India. Five thousand years ago, the heliacal rising of Sirius announced to the Egyptians an event of prime importance to them—the overflow of the Nile. They honored the watchful constellation that includes this star with the name of "The Dog," and worshiped it under the title of Anubis. Their year consisting of 365 days, they remarked that the phenomenon took place later, at the rate of a day every four years, so that after 1,461 years of 365 days (or 1,460 years of 365¼ days) the heliacal risings took place in the original order, after having successively occurred at very different days and hours. This period of 1,461 Egyptian years was called the Sothic period, or the period of the dog. After B. C. 25, the Egyptian year contained 365¼ days, or nearly the real value of the year. This was called the Alexandrian year. The Copts still employ it, but begin their reckoning from Martyr's day in the reign of Diocletian, August 29th, A. D. 284, while the Alexandrian era began with the battle of Actium, September 2d, B. C. 31. Three Egyptian years included 12 months of 30 days each followed by five epagomenous days; while the fourth or following year had a sixth epagomenous day.

The Roman year consisted of 304 days under Romulus, 355 under Numa, and 366 on the intercalation of the month *Mercedonius*. The irregularities of their calendar were so great that the *pontifices* were charged with the duty of regulating the number of days in the intercalated month. Unfortunately, some of the less scrupulous of these functionaries fell into a way of "doctoring" the year so as to make it longer when their friends, or shorter when their enemies, were in office! The corruption was carried out so recklessly that the feast of the *Autumnalia* was made to come in the spring, and the festival of Ceres, the goddess of the harvest, was celebrated in the middle of the winter! Julius Cæsar put an end to this disorder by introducing the year of 365¼ days, and gave to the months such numbers of days as made the intercalation of the epagomens unnecessary. The 366th day of the fourth year was added to the month of February, which then had 29 days, and as this caused the sixth day of the kalends to be counted twice (*bis sexto calendarum*), the name of *bissextile* was given to this year. This reform took place in the year 708 of Rome (46 B. C.), which year Julius Cæsar ordered to consist of 445 days, so as to make the civil year and the tropical year agree. Hence that year was called the year of confusion. Cæsar's calendar is the basis of the calendar which, further corrected by Pope Gregory XIII, is now in use among the Western nations.

The Mexican year was a peculiar form of the year of 365¼ days. It included 18 months of 20 days each, to which were added five supplementary days; and, after 52 years, 13 new days made up out of the neglected quarters of days.

The ancient Irish year was curiously formed. The unit being the week of seven days, they computed 12 months of 30 days each, to which they added four supplementary days to give an even number of weeks, and then every six or seven years they added a week, so that the years might be of 52 or 53 weeks.

The last essay in reforming the calendar was made during the French Revolution, partly with the object of introducing the decimal system into the calculation of time, and partly to eliminate everything relating to the Roman Catholic or any other religion. The months, of thirty days each, were given names, generally typical of some peculiar feature characterizing them. They were divided into three periods of ten days, or decades, to take the place of the weeks, with six intercalated days (five in leap-years) at the end of the last month. The intercalation was not periodic, but was based on exact astronomical calculations. This calendar was used for thirteen years, beginning with the proclamation of the republic, on the 22d of September, 1792.

In the lunar year, the months are alternately of 29 and of 30 days, the moon's synodical revolution taking place in about 29½ days. The lunar cycle of the Mohammedans comprises a period of thirty lunar years, during which the seasons begin at all times of the year. If a Turkish festival now falls in the middle of the winter, it will, fifteen years hence, be celebrated in the summer.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

SKETCH OF M. CHEVREUL.

"PERHAPS never in the history of science," said the London "Lancet" a year and a half ago,* "has a distinguished career equaled in its length that of M. Chevreul ; . . . and it is probably altogether unique for a *savant* to be able, at one of the most distinguished scientific societies in the world, to refer to remarks which he made before the same society more than seventy years previously." The allusion is to a reference with which the veteran chemist had supplemented a communication he had read a few days before to the French Academy of Sciences : "Moreover, gentlemen, the observation is not a new one to me. I had the honor to mention it here, at the meeting of the Academy of Sciences, on the 10th of May, 1812." When asked in 1883 if he had seen a certain piece at one of the theatres, he answered, "No, I have not been inside the doors of a theatre since Talma's death—in 1824," or fifty-nine years previously. Talking of the weather during a mild period in the winter of 1883, he said, "The severest winter I ever experienced was that of 1793," indicating the recollection of a fact ninety years old. M. Chevreul appears to have come from a long-lived

* December 24, 1883.

ancestry. His father, Michel Chevreul, a distinguished physician of his day, according to Larousse's "Cyclopædia" (born 1754, died 1845), was ninety-one years old at the time of his death; while the "Lancet" finds somewhere nineteen additional years, and makes his age a hundred and ten years. If discrepancies like this can occur in writing exact biographies of our own times, why should we be surprised at the variances in the legends of ancient days?

Michel Eugène Chevreul was born at Angers, France, where his father was hospital physician and a professor in the Obstetrical School, on the 31st of August, 1786. He studied the course of the Central School of his native city, and then, when seventeen years old, went to Paris, where he became associated with Vauquelin in the manufacture of chemicals, and was made director of his laboratory. He was afterward, in 1810, selected by Vauquelin as preparator in the course of Applied Chemistry at the Museum of Natural History. In 1813 he was given the title of Officer of the University, and was placed in the chair of Chemistry of the Lycée Charlemagne. In 1824 he was made special Professor of Chemistry at the Gobelins factory, and director of the dye-houses connected with that establishment. In 1826 he was admitted to the Academy of Sciences, in the place of M. Proust, in whose favor he had retired from the candidacy in 1816, when he had had an opportunity of being elected. In 1830 he succeeded his former master, Vauquelin, in the chair of Applied Chemistry in the Museum of Natural History. He has been charged with the administration of the Jardin des Plantes, where he has had occasion to defend the ancient prerogatives of the body he represented against the encroachments of the political administration, and where he made a formal protest during the siege of Paris against the barbarous bombardment of the buildings of the institution.

The enumeration of the discoveries that science owes to M. Chevreul would far pass the limits which it is possible to assign to this sketch. The most important of them have been perhaps in the fields of researches on fatty bodies of animal origin, and of colors, their contrasts, their harmonies, and the graduation of their shades. The "Recherches chimiques sur les corps gras d'origine animal" ("Chemical Researches on Fatty Bodies of Animal Origin"), on which the foundation of his reputation was laid, appeared in 1823. In this work the author developed his new ideas on the relations of fatty bodies and the ethers, and propounded the first exact theory of saponification, whether produced by acids or by bases, by showing that either of those two classes of bodies tend to speed the decomposition of fat-substances in acids and in glycerine, through the absorption of a certain number of equivalents of water. The same decomposition takes place spontaneously but slowly in the open air, and is the cause of the rancidity of fats. The water absorbed in the course of the transformation contributes to the formation of the resultant fat-acid, and the glycerine is separated. When a fatty substance is submitted to the action of a strong acid, the decomposition takes place instantaneously, because the acid separates the glycerine and unites with it. If, on the other hand, the action is accomplished by means of an energetic base, the base determines the formation of a fat-acid, and combines with it, so as to leave the glycerine isolated. Glycerine had been discovered by Scheele in 1775, but, until M. Chevreul's experiments, was regarded as only accidentally present in some fats ; and to M. Chevreul is due the discovery that it is always separated in the saponification of fats, and that those bodies are now regarded as salts, formed of glycerine as a base, combined with some acid. This theory led up to the invention of star-candles, a boon to mankind, of the value of which the present generation, with its gas-lights and petroleum-lamps, can have no conception. For this discovery M. Chevreul was awarded the grand prize of twelve thousand francs founded by the Marquis d'Argenteuil, in conferring which the Société d'Encouragement pour l'Industrie Nationale declared with justice that it was only registering the opinion of all Europe concerning researches which might serve as models to all chemists. M. Chevreul, it may be added, never thought of turning his discoveries to his personal profit, but gave them freely to the world, and was satisfied with being a student of science.

M. Chevreul's researches in coloring-matters at the Gobelins factory and at the Museum gave occasion to the publication of "Leçons de chimie appliquée à la teinture" ("Lessons on the Application of Chemistry to Dyeing," 1828–1831) ; of a memoir on the law of the simultaneous contrast of colors, and on the arrangement of colored objects according to that law in its relations to painting ("Sur la loi du contraste simultane des couleurs et sur l'assortiment des objets colorées, considéré d'après cette loi dans ses rapports avec la peinture," 1829), and of a memoir on colors and their application in the industrial arts ("Des couleurs et de leur application aux arts industriels à l'aide des cercles chromatiques," 1864) ; works embodying novel ideas, the application of which in manufactories and workshops has been attended with important results. M. Chevreul was much grieved when, in his advanced age, the management of the Gobelins factory placed him on the retired list ; but, in order to appease his feelings, he was allowed to retain his appointment with the full salary attached to it. In 1879 he was retired from the directory of the Museum, but was permitted to retain his chair as professor.

Among the honors that have been accorded to him are membership of the Royal Society ; President of the Agricultural Society ; Commander, Grand Officer, and Grand Cross of the Legion of Honor ; and other memberships and decorations at home and abroad. He was a member of the International Juries at the Expositions of London and Paris. In September, 1872, the French Academy of Sciences presented him with a medal in anticipatory commemoration of the fiftieth year of his membership. The fiftieth year would not strictly have occurred till 1876; but it was generally understood that he would have been elected in 1816, had he not urged the Academy to give the vacant place to M. Proust, who was old and infirm, and could not afford to wait. M. Dumas, the Permanent Secretary of the Academy, in a "gracefully-worded speech," recounted the many valuable services rendered by M. Chevreul, "the dean of French students," as he was modestly accustomed to style himself, and at the same time bore warm testimony to the personal character of the man. M. Élie de Beaumont, who had been a pupil of M. Chevreul, added a few words of veneration and respect for his old master, after which the latter, attempting to respond, could only express his inability to do so. In 1873 the Albert gold medal was awarded him by the English Society of Arts, for his valuable researches in connection with saponification, dyeing, agriculture, and natural history. In November, 1876, he was entertained at dinner by eighty *savants* in celebration of the fiftieth anniversary of his professorship and membership of the Academy of Sciences. The American Association for the Advancement of Science, at its Boston meeting in 1880, sent him a congratulatory telegram on his reaching his ninety-fifth year, and expressed the hope that he might be spared to continue his labors until the end of his century, which only a few months are lacking to see fulfilled. In the same year, he completed the fiftieth course of his lectures at the Museum, on the application of chemistry to organized bodies. Each course consisted of forty lectures, so that the fifty courses included in all two thousand lectures.

According to "Nature," M. Chevreul's first important work was published in 1806. Among his other works than those we have already named, are one on organic analysis and its applications (1824); "Théorie des effets optiques que présentent les étoffes de soie" ("Theory of the Optical Effects presented by Silken Cloths," 1848); "De la baguette divinatoire, du pendule, et des tables tournantes" ("Of the Divining-Rod, the Pendulum, and Turning-Tables," 1854); "The History of Chemical Science," of which the first volume was published in 1866; "Memoirs of the Academy," completed in 1872, "a most interesting work, which throws light on many of the most scientific questions of the day"; and numerous papers, articles in encyclopædias, and books of less general interest than those mentioned. A curious illustration of his vigor and activity, lasting into extreme old age, is afforded by a communication which he made to the Academy of Sciences on the 4th of February, 1884, which was on the varying color-effects produced by the glare of a conflagration playing upon a gas-light that stood in front of the Museum, which he observed for an hour. Delicate work that for the eyes of a man ninety-eight years old! That vigor still continued till the beginning of the present year, when M. Chevreul presided at the meeting of the new

Association of French Students, the "Scientia"; and when his name was mentioned in connection with those of Jamin, Pasteur, De Lesseps, and Léon Say, as one of the persons whose co-operation was expected to insure the success of the organization. In his address at this meeting, he declared himself still a student.

On the 4th of January last the students of Paris made a manifestation before M. Chevreul's house, with their flags flying, in honor—anticipating the day by a few months—of the one hundredth anniversary of his birth. Twenty delegates from the body were received in person by M. Chevreul, when M. Delcambre, President of the Association of Students, spoke in eulogy of the great *savant* by whom France is honored, and who, reaching his hundredth year, still remained robust and valiant, and preserved all the force of his genius and his old energy in work. In concluding his address, M. Delcambre said: "Illustrious and beloved master, the students of all the schools have joined in this manifestation because you are to us all—I say it with full assurance—a dean, and, I hope I may be permitted to add, a comrade. As a *savant*, you have contributed to the progress of humanity; as a Frenchman, you have added to the grandeur of France. The students by my lips transmit to you their good wishes and felicitations." M. Chevreul appeared much touched by this demonstration, and thanked the students with a voice marked by emotion. M. Delcambre then presented him a register containing the signatures of all the participants.

An interesting account of M. Chevreul's habits is given by a writer who is quoted in the "Lancet": "He is generally lightly clad, and wears no hat unless under circumstances in which he is obliged to appear in one; indeed, he hardly needs a hat, as he has most luxuriant hair. He is constantly at work, allowing only ten minutes for each of his meals, of which he has but two a day. He breakfasts at seven, the repast consisting of a plate of meat and another of vegetables, which he eats together, the whole being washed down with two tumblers of water. He is said to have never drunk a glass of wine in his life. He dines at seven in the evening, and takes nothing between the two meals except a small loaf at noon, which he eats standing and by the side of his alembics. The writer who relates this states that on a visit to M. Chevreul he found him in the attitude just described, and on expressing his surprise at the frugal manner in which he lived, M. Chevreul observed, 'I am very old' (this was in 1874), 'and I have yet a great deal to do, so I do not wish to lose my time in eating.'" In his work he is said to follow a motto that he has chosen from a maxim by Malebranche, and which is regarded by "Nature" as affording a true key to his life, his works, and his discoveries: "Chercher toujours l'infaillibilité, sans avoir prétention de l'atteindre jamais" ("Always to seek infallibility, without having the pretension of ever reaching it").

EDITOR'S TABLE.

THE NEW TYNDALL SCHOLARSHIPS.

THERE are multitudes who still remember, with vivid pleasure, the brilliant course of scientific lectures delivered in 1872, in several of our chief cities, by Professor John Tyndall, of the Royal Institution of Great Britain. They made a strong impression at the time, and impelled many young persons to give greater prominence to science in their studies. But there was another and a more special influence exerted by these lectures in accordance with the deeper purpose of Professor Tyndall. The public mind was favorably affected by them in regard to the claims of pure or theoretic science. We plume ourselves on being very practical in this country, and by "practical" we generally mean the opposite of theoretical—that which issues in tangible and immediate use. Professor Tyndall showed that this is a mistaken view. He was not complaisant toward the lower motives from which science is so generally pursued; and insisted strongly upon the more elevated considerations by which the students of science should be animated. He enforced, with much impressiveness, the important lesson that to yield its noblest results science must be studied for the simple love of truth and the extension of our knowledge of Nature, leaving its utilitarian benefits to follow as they always will when new light has been thrown upon any important group of phenomena. The unselfish pursuit of science for these nobler ends was urged by Professor Tyndall upon our young men with great earnestness and something of the inspiration of religious conviction; yet none realized at the time how firm and far-reaching was his purpose, nor how lasting was to be the influence of his work in this direction in this country.

When Professor Tyndall was solicited to come to America, and told what a golden harvest he could reap by lecturing here, he invariably replied that no consideration of the kind would have any weight in inducing him to accept the invitation. "If I come to you," he would say, "it must be because my friends in the United States desire it, and think that I could be of service in the cause of American science; but I will not lecture for the sake of money, nor would I bring away a dollar of the proceeds of my labor." And when the lectures closed, true to his purpose, he left all of the money he had earned, above expenses incurred, for the promotion of scientific education among American youth. But this was not all: he devoted the money to the advancement of the distinctive ideas which he had illustrated in his lectures, by appropriating it to the assistance of such young men as desire to devote themselves to original scientific study and research. He left it in care of three trustees, the income to be expended in aid of American students of tested ability, who might wish to avail themselves of the higher opportunities of scientific culture available in the European universities.

But there were difficulties attending the carrying out of this plan which prevented the full realization of its advantages. Several students were aided, and with great satisfaction; but it was not so easy to find the young men who had the proper qualifications to be entitled to the benefits of the trust. There were, of course, plenty of them, but the finding them out was more of a task than had been anticipated. The trustees were scattered, and were busy men, having little time for correspondence, while the employment of a paid secretary was impracticable. As a consequence, the income accrued faster than it was consumed, and, as the money had been fortunately invested, it at length accumulated to so considerable an amount as to make some change desirable in the policy to be further pursued. It became apparent that the purpose Professor Tyndall had in view could be better accomplished through the agency of permanent educational institutions, having among their objects the promotion of higher scientific study. The trustees corresponded with Professor Tyndall, who concurred with this view, and it was then resolved to terminate the existing arrangement by transferring the Tyndall fund back to the possession of the donor, to be distributed to such institutions as he might select. The original amount—thirteen thousand dollars — had increased to thirty-two thousand four hundred dollars ; and Professor Tyndall decided to divide this sum in three equal amounts, to be given, one to Columbia College, of New York ; one to Harvard University, of Cambridge ; and one to the University of Pennsylvania, at Philadelphia, for the foundation of three permanent scholarships in physical science, and for the benefit of students desiring to prepare themselves for the work of original research either at home or abroad, as the authorities of the respective institutions might decide.

This princely benefaction to American science will thus be memorable in future times, not only for its magnitude, but from the impressive circumstances of its origin. The money represents the contributions of the American people, given for the enjoyment of one of the most striking and instructive courses of scientific lectures ever delivered in this country. It represents also the earnings of one of the most gifted and high-minded scientific men of this generation, who contributed half a year's labor to the preparation and delivery of the lectures. The fund is consecrated to the perpetual carrying out of the scientific conceptions and principles inculcated in these discourses, so that the intellectual influence so strikingly initiated thirteen years ago will be an enduring power in the higher scientific education of this country for all time. Three of our leading collegiate institutions will be in competition with each other to administer these scholarships in the spirit in which they have been founded, to maintain their high-class character, which will be evinced by the quality of the men they turn out, and who, by their accomplishments, will do lasting honor to the illustrious scientist whose name and fame are treasured in the hearts of many thousands of the American people.

OFFICIALISM IN EDUCATION.

The Boston "Journal of Education" complains of the persistent assaults made upon "the graded school system" of this country, and attributes very evil motives to those by whom the alleged assaults are conducted. It finds "a considerable class of the clergy of all sects laced up in the mediæval European notion that the priest has a divine right to supervise all schools, overriding even the claim of the family, and resenting the claim of the whole people to supervise education as a godless presumption." It mentions also "a growing class of scientists, scholars, and literary people" as "putting on European airs, and claiming the exclusive right, as educational experts, to control the schools." Next, there is an exclusive social class bent on "forcing its own lines of artificial distinction into the school-room." The moneyed class, again, wants to regulate education with a view to keeping the "common herd" out of the poor-house; while labor-reformers want to have the interests of the mechanic and operative classes specially considered.

Now, we must confess that we fail

to see that the account given by our contemporary—presuming it to be correct—of the views of the several classes mentioned bears out the statement that these classes are persistently assaulting the graded school system. So long as the school system belongs to the domain of politics, as it does, so long will it be open to criticism from any and every quarter. The humblest individual in the community has a right to express his opinion as to how public money should or should not be spent; but we are not cognizant of any efforts that are being made to undermine the "graded" system as such. That it is desirable to have educational institutions of every grade, from the lowest to the highest, no sensible person is likely to deny; though some might raise the question as to whether enforced taxation is the proper means of obtaining funds for certain kinds of education. If our contemporary thinks that even to raise such a question is to show hostility to the cause of education, we must beg leave to differ from him. Time was when no one could imagine that anybody not a foe to religion could propose to sever church from state; but at present the great majority, in this country at least, hold that the severance is decidedly in the interest of religion. It may be said to be all but universally agreed that people are quite able to provide themselves with religion without any help from the state; and, moreover, that the article they provide for themselves is likely to be a considerable improvement on what the state has ever doled out. Well, it may require a far greater stretch of radicalism to hold that people could also provide themselves with intellectual enlightenment without state assistance; but we are not prepared to say that he who takes up this position is necessarily either a "crank" or an enemy of society. The fact is, that the article from which we have quoted betrays just a *soupçon* of the bureaucratic spirit which naturally develops itself in connection with all state management. Those who control the schools in the name of "the whole people" do not like the clergy to have any special views of their own in regard to the moral aspects of public-school education. They do not relish the criticisms of "scientists, scholars, and literary people" who venture to find the educational machine rather too much of a machine, and its work slightly wanting in organic variety. They want to be allowed to run the machine in the way most convenient to themselves and most favorable to large visible results. We do not question for a moment that much of sincere endeavor after the best results accompanies the administration of the official system; but we do mean that, in every official system, the official or bureaucratic spirit is a constantly growing force, and must tend to a stereotyping of methods and to a more or less barren uniformity in the minds molded under its influence. The time may come when it will be seen to be as much in the interest of true intellectual liberty that education should be freed from state trammels as it is now seen to be in the interest of religious liberty that the state should abstain from interference in the spiritual concerns of the people. Meantime it is a clear sign of the development of the bureaucratic spirit in connection with education when criticism from any quarter is looked on with an evil eye, and when "scientists, scholars, and literary people," and all others who have any special views of their own on the subject, are more or less politely warned off the premises.

CURIOUS EXCUSES FOR WAR.

There is little need of evidence to show the popularity of war, yet the reprobation it meets with from the growing moral sense of the world sometimes puts its advocates upon strange defenses of it. Though always a dire calamity, war is in certain circumstances to be defended as a necessity; but those who make it a business are rarely contented to leave it on this ground. The brutal bluntness of the member of Parliament who advocated war in a distant English province, and, upon being pressed for his reasons, replied, "Why, d—n it, I have two sons in the army!" is not often emulated; even those who are interested in it as a vocation seek plausible excuses for it.

Lieutenant-Commander Goodrich, of the United States Navy, for example, writes, in the "Century Magazine": "I am not sure, however, that it is not well once in a while to assert ourselves as standing on a right because it *is* right, and as prepared to maintain it at any cost." It would seem the dictate of a wise statesmanship, on a matter of such supreme importance, to lay down the principles that should govern a nation, in resorting to war, as an established and inflexible policy. But Lieutenant Goodrich seems to think that war may be desirable, once in a while, anyhow or on its own account, or as a display of power, without reference to its usual provocations.

War is generally regarded as a last brutal resort, when the higher agencies of reason and diplomacy have failed, and the resources of civilization to keep the peace have broken down; but Von Moltke maintains that war is itself a natural and permanent element of civilization, and that the hope of ending it is equally illusive and undesirable.

But the most curious attempt to throw a glamour over the intrinsic abominations of war, and make it seem a thing worthy of admiration, is made by the "Spectator," which maintains that, in the systematic and professional killing of men on a vast scale, which constitutes war, there is a peculiar "intellectual charm." The "Spectator" intimates that Christians of the feminine type, and sentimental people who vividly realize the horrors of battle, may shrink from the system; but it says that "war, as such, has for cultivated mankind a distinct intellectual charm." The terrible fascination is admitted, but how its charm can be qualified as distinctly intellectual does not appear. The "Spectator" expatiates on the tremendous interests staked in war, which may involve the national fate, and be of immense moment to citizens; but, then, it goes on to say, "Wars which are not ours interest us nearly as much as those which are." The truth is, war appeals not so especially to the intellect as to the deeper life-instincts of humanity. Men are thrilled by the excitement of war with no regard to their culture. There is no more "intellectual charm" in war than in any great crime or catastrophe or the coming of cholera. It is probable, indeed, that the "Spectator" has here committed itself to the very opposite of what is true. It is impossible to think of the intellectual classes as such, people of cultivated sensibilities, except as repelled and shocked instead of being charmed by war; while, on the contrary, the distinctively uncultivated classes are most profoundly stirred and attracted by it. The admiration of war is indeed the deepest among savages and barbarians, with whose undeveloped natures it is in harmony. The recent war experiment of the "Century Magazine" is said to have doubled its circulation; will it be claimed that the hundred thousand new patrons that have been found in addition to its former readers, are to be ranked as especially intellectual and cultivated, or are they not probably quite of the opposite kind?

LITERARY NOTICES.

Transactions of the New York State Medical Association for the Year 1884. Edited, for the Association, by Dr. Austin Flint, Jr. New York: D. Appleton & Co. Pp. 654. Price, $5.

The first meeting of the Association was held in the city of New York on the 18th, 19th, and 20th, of November, 1884, and was attended by two hundred and forty-two fellows. The titles of fifty papers to be read were entered on the official programme of the meeting, by members representing fifteen counties of the State, besides papers the titles of which were received after the programme was published. Of these papers, seventeen were on topics of surgery, fifteen on medicine, eleven on obstetrics and gynæcology, three on ophthalmology, two on materia medica, one on physiology, and one on insanity. The present volume contains three papers, with the president's (Henry D. Didama, M. D., of Onondaga County) annual address, lists of officers and council, fellows, etc.; the "Articles of Incorporation and Constitution and By-laws"; the "Code of Medical Ethics"; the "Proceedings of the Annual Meeting"; and the "Report and Minutes of the Council."

Representative American Orators. To illustrate American Political History. Edited, with Introductions, by Alexander Johnston. New York: G. P. Putnam's Sons. 3 vols. Pp. 282, 314, 405. Price, $3.75.

The present generation of Americans is far behind the one that preceded it in a realizing knowledge of the political history of our country and of the principles on which our government is founded. The civil war and its sequences seem to have obscured the living knowledge of our earlier history, and left it nearly as colorless as some matter of a remote age; while the anomalous measures that have had to be devised to meet the unprecedented exigencies of the last twenty-five years have tended to consign the safe traditions of our old statesmen to oblivion, and contributed to the spread of novel and dangerous heresies. Hence we regard anything that will help to make living again among us the fundamental principles of American politics and the debates of the past, and the ultimate objects which our statesmen sought to reach, as of public benefit. We can conceive nothing better adapted to set these matters vividly before American youth than the orderly presentment of the best and most pertinent words of the best orators who took part in the shaping of them, such as Mr. Johnston has aimed to make in these three volumes. His compilation is divided into seven parts, illustrating seven epochs in our history: "Colonialism, to 1789"; "Constitutional Government, to 1801"; "The Rise of Democracy, to 1815"; "The Rise of Nationality, to 1840"; "The Slavery Struggle, to 1860"; "Secession and Reconstruction, to 1876"; and "Free Trade and Protection"; in all of which, except the last, a kind of chronological order is maintained. In each of these epochs the orators are presented, so far as is found practicable, on either side, whose voices were most potent in putting the issues into shape and molding opinion upon them. The earlier periods are represented, among other oraters, by Patrick Henry, Hamilton, Washington, Fisher Ames, Jefferson, Randolph, Quincy, Clay, Hayne, and Webster; the issues of the antislavery struggle by Phillips, Clay, Sumner, Douglas, Preston Brooks, Burlingame, Lincoln, Breckinridge, and Seward; and the periods of secession and reconstruction by other names equally prominent and representative; while the question of "Free Trade and Protection" is illustrated by Henry Clay's "The American System," and Frank Hurd's "Tariff for Revenue only." Each of the groups of orations is preceded by an introduction giving the historical thread by which the speeches were connected, and describing the condition of the questions to which they related.

Afghanistan and the Anglo-Russian Dispute. By Theodore F. Rodenbough. New York: G. P. Putnam's Sons. Pp. 139, with Maps and Illustrations. Price, 50 cents.

This is a convenient hand-book for persons wishing to follow the Afghanistan question, which is yet, despite the seemingly smiling aspect of the negotiations, far from settled. It gives a plain view of the situation as it was at the moment when the recent passages between England and Russia began to be lively. It first relates the successive steps by which Russia has advanced during the last century and a half from the Ural into Central Asia, and to its present position near the Afghan frontier. This history is followed by accounts of "the British forces and routes," and "the Russian forces and approaches," and by a review of the military situation.

An Inglorious Columbus; or, Evidence that Hwui Shăn and a Party of Buddhist Monks, from Afghanistan, discovered America in the Fifth Century A. D. By Edward P. Vining. New York: D. Appleton & Co. Pp. 788, with Map. Price, $5.

The term "inglorious" is not intended to be applied to our Christopher Columbus, but, in the sense in which Gray, in his "Elegy," speaks of "some mute, inglorious Milton," to the Buddhist monk who, known only to a few special scholars, has failed to receive the universality of fame which should be his due. According to the author's statement, and as is known to Asiatic scholars, there is, among the records of China, an account of a Buddhist priest who, in the year 499 A. D., reached China, and stated that he had returned from a trip to a country lying an immense distance east. In the case of other travelers, whose narratives are also preserved in ancient Chinese literature, the accounts which we possess of their journeys were either written by themselves or their followers; but, in the case of Hwui Shăn, the interest excited in his story was so great that the imperial historiographer, whose duty it was to record the principal events of the time, entered upon his official records a digest of the information obtained from the traveler as to the country which he had visited. It is this official record, or rather a copy of it contained in the writings of Ma Twanlin, which is discussed in this work. But little doubt, if any, exists as to the authenticity of the record, but there are considerable differences of opinion respecting what country it was which the monks (who were missionaries of Buddhism) visited, and described as Fusang. Some of the critics believe it to have been Japan, others America. Mr. Vining believes it was Mexico, and, in adducing the considerations to support his belief, he transcribes, or makes a summary of, all the papers that have been written on the subject, except Mr. Leland's large book, which readers are advised to buy. He believes that the route followed by the priests, which is obscurely described in their itinerary, was from Japan, or the Asiatic mainland, along the course of the Aleutian Islands—"the land of the marked bodies"—to Alaska—"the Great Han"—and thence along the Pacific coast to the "land of the Fusang-tree," which plant is not yet identified, and the "country of women," in Mexico. Among the arguments relied upon to support this view, are the correspondences of distances, which, according to Mr. Vining's computations, are close enough; the description of the country of Fusang, the customs of its people, and the characteristics of its vegetation, which is faithful as to Mexico, and includes details that would not be true of any other country; accounts, in the traditions of Mexico, of the arrival of a party of men similar to what the Buddhist party must have been; and the state of civilization in Mexico at the time of the arrival of the Spaniards, which was such as might have grown up from an Asiatic implantation. On the other hand, the history of Japan is reviewed, for the purpose of showing that that could not have been the country visited. The book also contains a translation of that part of the "Chinese Classic of Mountains and Seas" which relates to lands east of China—a work which is thought to be the oldest geography of the world, and which has never before been translated into any European language.

Assyriology: Its Use and Abuse in Old Testament Study. By Francis Brown. New York: Charles Scribner's Sons. Pp. 96. Price, $1.

The author of this book is Associate Professor of Biblical Theology in Union Theological Seminary in this city. The purpose of the book is to utter a caution against too hasty and extensive generalizations upon the discoveries that are made, one at a time, amid much groping in the dark, among the ruins of the ancient empires of the East, and which often seem to have a bearing upon the records given in the Bible. It is human nature to grasp eagerly at evidence that seems to favor what one wants proved, and to reject obstinately what seems of an opposite character; and biblical scholars are prone to the fault. Professor Brown advises such to wait in matters of Assyriology for the results of searching criticism. The discoveries in that field, though undoubtedly destined in the end to be of vast importance, are, many of them—not all—as yet too fragmentary and uncertain to build anything on that must depend upon them. The cause of truth may be injured by overhaste; it can only be benefited by deliberation and careful examination.

Local Institutions in Virginia. By Edward Ingle. Baltimore: N. Murray. Pp. 127. Price, 75 cents.

This essay, constituting numbers two and three of the third series of the "Johns Hopkins University Studies in Historical and Political Science," is not inferior in interest and importance to any of the numbers of either series that has preceded it. Virginia was a "mother of commonwealths," and the results of her development and her policy were impressed, in one shape or another, and to a greater or less extent, in Kentucky and the States that were formed out of the Northwest Territory. The purpose of Mr. Ingle's study is to ascertain from what these results were developed, and how. In pursuing it, he considers the character of the country and its settlers ("Virginia and the Virginians") "The Land-Tenure of the Colony," "The Organization of the Hundred," "The Fortunes of the English Parish in America," "The County System of Colonial Virginia," and "The Town." Under the last head, the curious fact is developed that towns which in other States appear variously as the original form of settlement, of spontaneons growth, or as the ready creatures of speculation, were not natural to Virginia; and that the formation of them was the object of several laborious efforts, prosecuted against a chronic indisposition of the people to settle in them or to favor them at all.

Geology of the Comstock Lode and the Washoe District. By George F. Becker. Pp. 422, with Plates and an Atlas. Price, $11. Comstock Mining and Miners. By Eliot Lord. Pp. 451.

The surveys upon which Mr. Becker's report is based were conducted by him as aid to Mr. Clarence King, and chiefly in the lower parts of the lode. Mr. King has already made the upper part familiar to geologists. In his work Mr. Becker had the assistance of Dr. Carl Barus, physicist, who made researches in the electrical activity of ore-bodies and in kaolinization, the results of which are incorporated here. In the report, the general account of the Comstock mines and the review of previous investigations of the lode are followed by chapters on the "Lithology of the Washoe District," with detailed descriptions of sections of the rocks prepared for microscopic examination; on the structural results of faulting, the occurrence and succession of the rocks, the heat-phenomena of the lode, and Dr. Barus's papers on "Kaolinization and on the Electrical Activity of Ore-Bodies." The relations of the minerals and the changes they have undergone are discussed very fully in the chapters on "Lithology" and "Chemistry," and the character and causes of the heat-phenomena of the lode, with the various theories that have been proposed to account for them, as fully in the chapter on that subject. These heat-phenomena are one of the most famous peculiarities of the Comstock Lode, and distinguish it from all other mines and excavations under the earth's surface. The unusually high temperature was manifested in the upper levels, and has increased with the depth. The present workings are intensely hot; and, during the winter of 1880–'81, the water in one of the levels reached a temperature of 170° Fahr., at which food may be cooked, and the human epidermis is destroyed. The rapidity of the ventilation required to reduce the temperature of the air is something unknown elsewhere, yet deaths in ventilated workings from heat alone are common, and there are drifts which without ventilation the most seasoned miner can not enter for a moment. The origin of this high temperature has been attributed to the kaolinization of the feldspar in the country rock and to residual volcanic activity. No positive evidence is adduced that it is due to kaolinization, and the results of Dr. Barus's experiments on the thermal effect of the action of aqueous vapor on feldspathic rocks, so far as they have been carried out, were wholly negative. No heating effect due to this cause could be detected with an apparatus delicate enough to register a change of temperature of one thousandth of a degree C. On the other hand, there is much geological evidence pointing to a deep-seated source of heat, probably of volcanic origin, or solfataric. The floods of waters which have been met in the mines can not be accounted for by any hypothesis connected with the rainfall of the district. Mr. Becker proposes a theory that the Comstock fissure taps water-ways leading from the crests of the great range of the Sierra Nevada. Under this theory, if the heat is conveyed to the lode by water from great depths, the variations in temperature are readily explained, by supposing variations in the distribution of the heated water.

Mr. Lord's volume—"Comstock Mining and Miners"—is chiefly historical, and has a peculiar interest in that it describes an episode in the development of one of the most important American enterprises, and relates one of the most wonderful stories in mine-working that it has ever been given to tell. The dangers faced by the miners from the extreme heat and other causes are vividly sketched. "The service demonstrates anew how elastic are the limits of human endurance when men are drawn on by some masterful passion. The bounds of possibility then confine their achievements but not their attempts. . . . Death alone has the power to say to miners, 'Thus far shall ye go and no farther!'—for no endurable suffering will bar their progress; nor will the loss of life even make them pause, unless the scourge of heat shall strike them down like a pestilence. Of late years heat has killed strong men in almost every deep mine in the lode, and in some mines the deaths so caused have been frequent." The ultimate effect of this extreme heat on the miner's constitution, even when it does not result in immediate death, is also to be considered; and, besides this, all the ordinary dangers of deep mining exist here in aggravated forms.

Contributions to the Fossil Flora of the Western Territories. Part III. The Cretaceous and Tertiary Flora. By Leo Lesquereux. Washington: Government Printing-Office. Pp. 283, with 60 Plates.

This, although published under the direction of Major Powell, is the eighth volume of the Hayden reports. It contains, first, descriptions of the cretaceous flora, including a large number of new species, some representing rare and very remarkable plants, accompanied with general remarks on the geology of the Dakota group, and on the character of the plants with regard to climate and their affinities with plants of succeeding geological periods. The second part contains a revision of the plants of the Laramie group. The third part reviews the floras of the White and Green River regions, which are separated into two groups. The relations of these plants with the flora of the Gypses of Aix, France, which is generally regarded as of the lowest Miocene or Oligocene, are indicated. The fourth part relates to Miocene plants described from specimens obtained from the Bad Lands, California, and Oregon. The plants of the cretaceous Dakota group, as known mostly from their detached leaves, are striking from the beauty, the elegance, and the variety of their forms, and from their size. The multiplicity of forms recognized for a single species is quite as marked as it might be upon any tree of our forests. In analyzing the leaves by detail, "we are by-and-by forcibly impressed by the strangeness of the characters of some of them, which seem at variance with any of those recognized anywhere in the floras of our time, and unobserved also in those of the geological intermediate periods. Not less surprised are we to see united in a single leaf, or species, characters which are now generally found separated in far-distant families of plants." The flora of the Laramie group (Eocene) is quite distinct from the cretaceous. The Green River group includes the famous Florissante Basin, of which we have already given some account. The Miocene plants, which are described by groups according to where they occur, have not been sufficiently recovered to authorize any reliable conclusion regarding their relative stage in either group.

Madam How and Lady Why. By Charles Kingsley. New York: Macmillan & Co. Pp. 321. Price, 50 cents.

This book, which now appears in a convenient volume of the series of "Globe Readings from Standard Authors," is described in the title-page as "First Lessons in Earth-Lore for Children." It presents, in the form of a pleasing allegory, the workings of the geological agencies that have contributed to the shaping of the globe, and the present appearance of its surface, and their results; the operations being supposed to be performed by a "Madam How," under the direction of a mysterious "Lady Why."

Photo-Micrography. By A. Cowley Malley, F. R. M. S. Second edition. London: H. K. Lewis, 136 Gower Street, Pp. 166.

Drawing can not be wholly relied upon for the representation of minute microscopic objects, because of the difficulty of seeing such delicate things accurately, and of commanding the pencil to give a perfectly correct reproduction of what is seen. At the best, a drawing is apt to show evidence of preconceived notions of the structure in the mind of the observer. Photography, though not infallible, always accurately returns what is sent to the plate, and is almost universally true. In the present work, the author gives the methods he has himself adopted, and the most applicable parts of the methods used by others; and, by showing the facility of their application, he hopes to make photo-micrography more popular, and place it within the reach of all. In this second edition have been incorporated the advances that have been made in microscopy, and the more recent improvements in photography. Descriptions of the wet collodion and gelatino-bromide processes, and of the best methods of mounting and preparing microscopic objects for photo-micrography, are given.

The Occult World. By A. P. Sinnett. Second American, from the fourth English edition, with the Author's Corrections and a New Preface. Boston: Houghton, Mifflin & Co. Pp. 228. $1.25.

The readers of "The Popular Science Monthly" have already been informed, to some extent, respecting the doctrines of the theosophists, of which this may be considered one of the text-books. Among their beliefs is that in the existence among some privileged or specially instructed classes of persons of mysterious knowledge and power which are hidden from the mass of mankind, to which are referred and by which may be explained many wonderful things in ancient and modern lore, the reality of which appears supported by evidence we can not despise, but belief in which, so contrary are they to our ideas of nature, taxes the most credulous. The "science" which represents this knowledge and power has made some advances since the first edition of "The Occult World" was published, and its votaries believe that they have received additional confirmation of its reality. The new developments are given in the form of additional matter and notes, the original text of the book having been changed but little.

Russia under the Tzars. By Stepniak, author of "Underground Russia." New York: Charles Scribner's Sons. Pp. 381. Price, $1.50..

This book is divided into three parts. In Part I, "The Past," is shown how the original fundamental principle of the Russian Government was the sovereignty of the people, full, free, spontaneous, and indisputable in the highest possible degree, as it still is in the *Mir*, or the rural communes; and how Czarism gained a footing, and gradually crushed that sovereignty entirely out within the empire at large, and in all the great centers. Part II, "Dark Places," is made up of the relations of incidents in the lives of political suspects and their experiences with the police. In Part III "Administrative Exiles" are described, a number of features characterizing the despotism of the military and the police, and the measures of administrative repression which the Government is compelled to adopt in its struggles against the forces of human nature to which it has set itself in opposition.

Third Annual Report of the United States Geological Survey, 1881, 1882. By J. W. Powell, Director. Washington: Government Printing-Office. Pp. 564, with Plates.

This volume contains the reports of progress for the year of the heads of the divisions of the survey, and six monographs on special features of the survey. The administrative reports are, that of Mr. Clarence King, prepared for him in his absence by Dr. Carl Barus, on the "Determinations of the Physical Constants of Rocks"; of Mr. Arnold Hague, on "Operations in the Division of the Pacific"; of Mr. C. K. Gilbert, of the "Division of the Great Basin, chiefly relating to the Survey of the Quaternary Lake Bonneville"; of Mr. T. C. Chamberlin, on the "Survey of the Glacial Moraine, from the North Border of Dakota to the Atlantic"; of Mr. S. F. Emmons, of the "Division of the Rocky Mountains"; of Mr. G.

F. Becker, on the "Comstock Lode and the Washoe District"; of Mr. Lester F. Ward, on "Vegetable Paleontology"; and of Messrs. J. Howard Gore and Gilbert Thompson, on "Triangulations and Topographical Surveys." The "accompanying papers" are those of Professor O. C. Marsh, on "Birds with Teeth"; of Roland D. Irving, on the "Copper-bearing Rocks of Lake Superior"; of Israel C. Russell, on the "Geological History of Lake Lahontan"; of Mr. Arnold Hague, on the "Geology of the Eureka District"; of Mr. T. C. Chamberlin, on the "Terminal Moraine"; and of Dr. C. A. White, on the "Non-Marine Fossil Mollusca of North America." Mr. Hague's preliminary report promises much interesting information when the papers are published in full, concerning the lithological structure of the volcanic cones of Mounts Rainier, Hood, Shasta, and Lassen's Peak, which play so important a part in the geology of the Sierra Nevada and Cascade Ranges. Mr. Chamberlin's paper reveals the interesting facts that the glacial moraine formation consists, not of a single moraine, but of a group of three or more concentric and rudely parallel ones, that sometimes coalesce and sometimes separate, so as to occupy a belt occasionally twenty or thirty miles in width; that the individual moraines, instead of being sharp ridges, consist of a broad belt of irregular, tumultuous hills and hollows, giving rise to a peculiar knob-and-basin topography; that the massiveness of the moraine finds its development in great width rather than in abrupt and conspicuous height; that throughout a considerable portion of its course, instead of pursuing a direct or moderately undulatory line, it is disposed in great loops, formed at the margins of ice-tongues, between which re-entrant portions formed extensive intermediate moraines; and that these ice-tongues occupied the great valleys of the interior, and manifestly owed their origin to topographical influences. Mr. Becker mentions the interesting fact that in the caves above the ore-bodies, on Ruby Hill, the crystals of aragonite are still in process of rapid formation; and Mr. Curtis is conducting accurate experiments to ascertain the rate of growth and the physical and chemical conditions attending their formation.

Tables to facilitate Chemical Calculations. Compiled by W. Dittmar, F. R. S. Second edition. London: Williams & Norgate. Pp. 43, small 4to. Price, 5 shillings.

This little volume contains tables of atomic weights, analytical factors, logarithms, reciprocals, physical constants of gases, etc., together with rules for gasometry, a chapter on the arithmetic of gas analysis, and other minor data, of value for daily reference in the laboratory. Its utility to the analyst is obvious, although, to a well-trained chemist, much of the matter contained in it is too familiar to need quotation in this form. To the elementary student, on the other hand, works of this character are of questionable value. The pupil who works out his analysis by the aid of factors too often fails to learn the principles upon which they depend, and does not acquire that command of stoichiometry which every good chemist should have. Of its kind, however, and in its proper place, the volume appears to be satisfactory. It is announced as being preliminary to a forthcoming work upon chemical arithmetic, which, when issued, will replace it.

Contributions to North American Ethnology. Vol. V. Washington: Government Printing-Office. Pp. about 400, with Plates.

In this volume are bound up the monographs of Mr. Charles Rau, on "Cup-shaped and other Lapidarian Sculpture in the Old World and in America"; of Dr. Robert Fletcher, on "Prehistoric Trephining and Cranial Amulets"; and of Dr. Cyrus Thomas, on the "Manuscript Troano." The last two works have already been fully noticed by us. Mr. Rau's paper relates to some curious kinds of rock-sculptures, which are described as "cups" of various sizes, rings surrounding the "cups," or independent of them, and other designs, which have been found on rocks, and on and near megalithic stones and buildings, in various parts of Europe, and similar figures which have been discovered in America. The origin and purpose of these designs have been variously accounted for. Some persons regard them as Phœnician Baal sculptures; some as originating at a remote period in the history of the Aryan race; some as having a phallic significance; some as direction-marks, etc. Mr. Rau suggests that some of the smaller cup-stones may have been used for cracking nuts, and others as paint-cups. Another class of American relics coming under this category consists of stones of larger size, on which several cup-like cavities are worked out. They usually occur as flat fragments of sandstone without definite contours. The cups are either on one of the flat surfaces or on both, and their number on a surface varies, so far as has been observed, from two to ten. They are irregularly distributed, and generally measure an inch and a half in diameter, but sometimes less. According to Colonel Charles Whittlesey, these stones occur quite frequently in Northern Ohio, more particularly in the valley of the Cuyahoga River, while he is not aware of any having been found in the mounds. He believes the holes were sockets in which spindles were made to revolve, and calls the stones "spindle-socket stones," but Mr. Rau does not agree with him. A bowlder in the rooms of the Society of Natural History, of Cincinnati, which was found near Ironton, Ohio, weighing between one thousand and twelve hundred pounds, contains one hundred and sixteen of these cups. A bowlder found at Niantic, Connecticut, has six cups, with a number of lines, which may be natural. Stones, bearing figures resembling these, appear worked into the walls of churches, and the designs may be found even in holy-water fonts. Altogether, the cup-stones present a curious field of inquiry. Mr. Rau considers the forms more or less related, and as having a similar origin and meaning; as to what these are, he is inclined to agree with M. Rivett-Carnac, in attributing to them a significance like that indicated in the Siva figures of India.

The Lenapé and their Legends: with the Complete Text and Symbols of the Walam Olum. By Daniel G. Brinton. Philadelphia: D. G. Brinton. Pp. 262.

In the present volume, which is the fifth in his "Library of Aboriginal American Literature," Dr. Brinton has grouped a series of ethnological studies of the Indians of Eastern Pennsylvania, New Jersey, and Maryland, around what is asserted to be one of the most curious records of ancient American history—the "Walam Olum," or Red Score. The interest in the subject excited by his inquiries into the authenticity of this document prompted him to a general review of our knowledge of the Lenapé, or Delawares, of their history and traditions, and of their languages and customs. This study disclosed the existence of manuscripts not mentioned in the bibliographies. Whether the Walam Olum be genuine or not—concerning which Dr. Brinton does not express a decisive opinion, though his inquiries have resulted favorably to its being regarded as an oral reproduction of a genuine native work, repeated to some one indifferently conversant with the Delaware language, who wrote it down to the best of his ability—it is believed that there is sufficient in the volume to justify its appearance, apart from that document.

The Philosophic Grammar of American Languages, as set forth by Wilhelm von Humboldt. By Daniel G. Brinton, M. D. Philadelphia: McCalla & Stavely. Pp. 51.

The philosophy of language owes much to Wilhelm von Humboldt, who was its substantial founder. The American languages occupied his attention for many years, and he wrote to Alexander von Rennenkampff, in 1812, that he had selected them as the special subject of his investigations. He was often accustomed to draw "illustrations of his principles from them, and in every way showed a high appreciation of their importance. In the present essay, Dr. Brinton has given a general exposition of Humboldt's views on these languages, and studies of them, and has added the translation of an unpublished memoir by him on the American verb, which was originally read before the Berlin Academy of Sciences, and of which only the manuscript is preserved in the Royal Library at Berlin.

The Protestant Faith; or Salvation by Belief. By Dwight Hinckley Olmstead. New York: G. P. Putnam's Sons. Pp. 77. Price, 50 cents.

The author styles this work "An Essay on the Errors of the Protestant Church," those errors consisting, in his vision, principally in the imposition of an intellectual belief in certain doctrines as a fundamental conditionof salvation.

Man's Birthright, or the Higher Law of Property. By Edward H. G. Clark. New York: G. P. Putnam's Sons. Pp. 133. Price, 75 cents.

This work seems to be the result of an attempt by the author to edit the "Ownership and Sovereignty" of Mr. David Reese Smith. The theory of that book was judged correct, but very inadequately presented; hence this attempt to redress, rearrange, and elaborate it from beginning to end. Mr. Clark accepts Henry George's theory of the right of each generation to own the soil, but differs from him as to the manner in which it is to be carried out. He announces the true law of ownership to be: "Mankind as a whole own the entire wealth of the world, natural and fabricated; but every individual in the world can command and control any piece of that wealth according to his normal purchasing power, which is the exact index of the value of his labor, his skill, his pecuniary ability. But, if he wishes to set aside for his private uses any portion of the general wealth, whether the piece of property contains his own labor or that of some one else, then he must pay on that piece of property the rest of the people's share of value bound up in it; and, if every other member of society pays his appropriate share of such values, exact justice is reached in every respect." This share is calculated to be an *ad valorem* tax on the property of every generation, exactly proportioned to the death-rate of the population.

Hegel's Æsthetics: A Critical Exposition. By John Steinford Kedney. Chicago: S. C. Griggs & Co. Pp. 302. Price, $1.25.

This is the fourth volume of Messrs. Griggs & Co.'s series of "German Philosophical Classics," the design of which is to present, under the editorial supervision of competent American scholars, the more essential parts of the important works of the masters of German thought. Hegel's "Æsthetics" is one of the most important works on the subject in existence, but it is voluminous. In the present adaptation, the first part, which gives the fundamental philosophy of the whole, is reproduced faithfully, but in a condensed form, with criticisms by the editor interspersed. A translation of the second part, which traces the logical and historical development of the art-impulse, being easily accessible (D. Appleton & Co.), the editor has substituted for it an original disquisition having more immediate regard to present æsthetic problems, but in a line with Hegel's thought. Of the third part, all the important definitions and fundamental ideas are given, but the minute illustrations and the properly technical part are omitted.

The Invalid's Tea-Tray. By Susan Anna Brown. Boston: J. R. Osgood & Co. Pp. 67. Price, 50 cents.

A dainty volume, as becomes a book of recipes of dishes designed to tempt the dainty appetite of an invalid. It contains fifty or more such recipes, of those things which are considered best adapted to the invalid's condition, most nourishing or most easily digested, according as that condition may require; for the serving of which "the first requisite is absolute neatness." Also, the author says, "vary the meals as much as possible, and let each little delicacy be a surprise. Have the hot things really hot, and the cold ones perfectly cold; and offer only a very small quantity of food at a time, or you will never be able to tempt the capricious appetite of an invalid."

Materials for German Prose Composition. By C. A. Buchheim. New York: G. P. Putnam's Sons. Pp. 252. Price, $1.25.

This book consists of selections from modern English writers, to be translated into German, to aid in which work grammatical notes are furnished, with idiomatic renderings of difficult passages, a general introduction, and a grammatical index. It has been the compiler's purpose to furnish a practical and theoretical guide to persons who, having a full knowledge of German accidence, and of the rules of the order of words, desire to gain skill in translating from English into German. The extracts have been made from the body of the author's work, with deliberate avoidance of "hackneyed" passages, and from the more modern authors. The matter is graduated into four parts, beginning with easy, detached sentences and minor extracts, and rising to more difficult passages and those involving idiomatic construction.

On Oxygen as a Remedial Agent. By Samuel S. Wallian, M. D. New York: Trow's Company. Pp. 52.

Dr. Wallian holds that oxygen stands at the head of the list of natural agencies for the removal of disease, and that "it is quite time we should practically realize, for we already theoretically admit, that this omnipresent, almost omnipotent, and yet commonplace element, can not be replaced, scarcely supplemented; that there is no known alterative, eliminator, or disinfectant comparable with it; . . . and that the original, normal, and only unobjectionable and universally efficient antiseptic is pure oxygen. . . . As a therapeutic agent, oxygen is not yet popular, nor yet the fashion; although for years enterprising quacks have been gathering a generous harvest, from honest dupes who have sickened of cruder quackery, by broadcast heralding of the magic virtues of some impossible 'compound' of it. Is it not high time that its intelligent use should be undertaken at the hands of legitimate and competent physicians, who have no secret wares to hawk about the country?"

PUBLICATIONS RECEIVED.

Sanitary Suggestions. How to disinfect our Homes. By B. W. Palmer, M. D. Detroit, Mich.: George S. Davis. 1885. Pp. 58. 25 cents.

Ethical Culture. Four Lectures. By Samuel Burns Weston. Philadelphia. 1885. Pp. 70. 20 cents.

The Abdominal Brain. By Leila G. Bedell, M. D. Chicago: Gross & Delbridge. 1885. Pp. 45.

A New Philological Theory. By Professor A. J. Mogyorosi, Allegany, N. Y. Buffalo: Lockwood & Ough, Printers. 1885. Pp. 11.

Foul Brood. Its Management and Care. By D. A. Jones. Press of "Canadian Bee Journal," Beeton, Ontario. Pp. 32. 10 cents.

Shall we hang the Insane who commit Homicides? By Clark Bell, Esq., of New York. Reprinted from the "Medico-Legal Journal." Pp. 40.

Illinois State Board of Health. Sanitary Schedule of the State Sanitary Survey.

The Biogen Series. No. 2. The Demon of Darwin. Coues. Pp. 64. No. 3. A Buddhist Catechism. Olcott. Pp. 84. 75 cents each.

The Composition of American Wheat and Corn. By Clifford Richardson. Washington: Government Printing-Office. 1884. Pp. 98.

Proceedings of the Modern Language Association of America, 1884. Baltimore. 1885. Pp. 100.

Actinism. By Professor C. F. Himes, Ph. D. Reprinted from the "Journal of the Franklin Institute," May, 1885. Pp. 22. Illustrated.

The Periodical Cicada. By Charles V. Riley, Ph. D. Washington: Government Printing-Office, 1885. Pp. 46. Illustrated.

Public Health in Minnesota. The Official Publication of the State Board of Health. Monthly. Vol. I, No. 2, April, 1885. Pp. 8.

Remarks upon Chipped Stone Implements. By F. W. Putnam. Salem, Mass. 1885. Pp. 8. Illustrated.

Bulletin of the Brookville Society of Natural History of Franklin County, Indiana. O. M. Meyncke & C. F. Goodwin, Editors. No. 1. 1885. Published by the Society. Pp. 45.

The "Sanitary Monitor." J. T. Winn, M. D., Editor. Monthly, Richmond, Va. Vol. I, No. 1, May, 1885. Pp. 14. $1 a year.

Descriptions of some Peculiar Screw-like Fossils from the Chemung Rocks. By Professor John S. Newberry. Reprint from the Annals of the New York Academy of Sciences. Pp. 4. Illustrated.

Local Institutions of Maryland. By Lewis W. Wilhelm, Ph. D. Baltimore: Johns Hopkins University. 1885. Pp. 129. $1.

Sixth Annual Report of the Archæological Institute of America. Cambridge: John Wilson & Son, 1885. Pp. 48.

Proceedings of the Biological Society of Washington. Smithsonian Institution, 1885. Vol. II. Pp. 195.

Bulletin of the United States Geological Survey, No. 2. On the Quaternary and Recent Mollusca of the Great Basin, with Descriptions of New Forms. By R. Ellsworth Call. Washington: Government Printing-Office. 1884. Pp. 56. Illustrated.

Transactions of the Society for the Promotion of Medical Science in Japan. Tokio, May, 1885.

Bulletin of the Des Moines Academy of Science. Des Moines, Ia. Published by the Academy. Vol. I, No. 1. 1885. Pp. 57.

Medical Thoughts of Shakespeare. By B. Rush Field, M. D. Easton, Pa. 1885. Pp. 86.

The Ohio State Sanitary Association. Proceedings of the Second Annual Meeting. From "The Sanitarian," May, 1885. Pp. 64.

Architectural Studies, Part I. Twelve Designs for Low-Cost Houses. New York: William T. Comstock. 1885.

International Electric Exhibition of 1884. Reports of the Examiners of Sections V, VI, and VIII. Electric Lamps. Carbons for Arc-Lamps. Philadelphia: The Franklin Institute. 1885. Pp. 12. Illustrated.

Healthy Foundations for Houses. By Glenn Brown. New York: D. Van Nostrand. 1885. Pp. 143. 50 cents.

Lectures on the Science and Art of Education. By the late Joseph Payne. Syracuse: C. W. Bardeen, 1885. Pp. 281. $1.

Practical Botany. By F. O. Bower, and Sidney H. Vines, with a Preface by W. Thiselton Dyer. London: Macmillan & Co. 1885. $1.50.

Matilda, Princess of England. A Romance of the Crusades. By Mme. Sophie Cottin. From the French by Jennie W. Rann. 2 vols. New York: W. S. Gottsberger. 1885. $1.75.

Talks Afield about Plants and the Science of Plants. By L. H. Bailey, Jr. Boston: Houghton, Mifflin & Co. 1885. Pp. 173. $1.

History of the Surplus Revenue of 1837. By Edward G. Bourne. New York: G. P. Putnam's Sons. 1885. Pp. 161. $1.25.

Forests and Forestry of Poland, Lithuania, the Ukraine, and the Baltic Provinces of Russia. Compiled by John Croumbie Brown, LL. D. Edinburgh: Oliver & Boyd. 1885. Pp. 276.

An Elementary Treatise on Hydro-Mechanics. By Edward A. Bowser, LL. D. New York: D. Van Nostrand. 1885. Pp. 298. $2.50.

List of Tests. By Hans M. Wilder. New York: P. W. Bedford. 1885. Pp. 88. $1.

Lessons in Elementary Practical Physics. By Balfour Stewart, F. R. S., and W. W. Haldane Gee. Vol. I. General Physical Processes. London: Macmillan & Co. 1885. Pp. 291. $1.50.

Properties of Matter. By P. G. Tait, R. S. E. Edinburgh: A. & C. Black. 1885. Pp. 320. $2.25.

The Q. P. Index Annual for 1884. Bangor: Q. P. Index, Publisher. 1885. Pp. 78.

The Magnetism of Iron and Steel Ships. By T. A. Lyons. Washington: Government Printing-Office. 1884. Pp. 121. Illustrated.

A Manual of the Theory and Practice of Topographical Surveying by Means of the Transit and Stadia. By J. H. Johnson, C. E. New York: John Wiley & Sons. 1885. Pp. 111. $1.25.

Commercial Organic Analysis. By Alfred H. Allen, F. C. S. Vol. I. Philadelphia: P. Blakiston, Son & Co. 1885. Pp. 476. $4.50.

The French Revolution. By Hippolyte Adolphe Taine, D. C. L. Oxon. Translated by John Durand. Vol. III. New York: Henry Holt & Co. 1885. Pp. 509. $2.50.

Christian Thought. Lectures and Papers on Philosophy, Christian Evidence, Biblical Elucidation. Second Series. Edited by Charles F. Deems, LL. D. New York: Phillips & Sons. 1885. Pp. 476.

Contributions to the Knowledge of the Older Mesozoic Flora of Virginia. By William Morris Fontaine. Washington: Government Printing-Office. 1883. Pp. 143. With Fifty-four Plates.

POPULAR MISCELLANY.

Correction.—This year's meeting of the American Association for the Advancement of Science will begin Wednesday, August 26th; not on August 20th, as erroneously stated in the July Monthly.

Fallacies about Mines.—Mr. Albert Williams, of the United States Geological Survey, has recently exposed, in a brief monograph, some of the popular fallacies which exist, often to the detriment of miners' interests, regarding precious-metal deposits. First, are local prejudices against certain formations and in favor of others. Most of these prejudices have been contradicted in one way or another, and there is no sufficient reason that any one of the kinds of country rock prevalent in mining districts is more likely to contain metal deposits than another kind. The supposition that the richness of mineral veins usually increases with depth may or may not be justified in a particular case; the only way to find out is to examine. Miners have objections against "specimen" mines, or mines that give unusual superficial promise of richness. Here, again, the only test is by trying, and it is certainly profitable to work the mines so long as they make a paying return, while it will be time enough to stop when they cease to do so. Some miners have favorite strikes, and prefer to work in no others. They are as often wrong as right. One direction of strike may promise best in one locality, and the opposite direction in another. Another miner's fallacy is the belief that the appearance of ores is a trustworthy index of their value. Such a belief, Mr. Williams observes, may seem self-evidently absurd to the experienced miner, but it nevertheless governs many prospectors, who hastily judge from the looks of the rock, when they should have waited for an assay. Notwithstanding the necessity exists for contradicting these fallacies, it would be unfair to infer that the whole subject of precious-metal mining is involved in doubt and perplexity. On the contrary, a great deal of solid fact is now established, room for which has been gained only by clearing away a mass of misconceptions. Much remains to be learned; in fact, the study of precious-metal deposits is only beginning. But it must be admitted that, on the purely practical side, great advances have been made.

Bark Dresses.—The *tapa* of the South-Sea Islanders is made from the bark of the paper mulberry-tree (*Broussonetia papyrifera*), and the bark clothing of the African tribes is prepared from trees of the same family. Dr. Schweinfurth describes one of these trees (*Urostigma Kotschyana*), which is called *rokko* in the country of the Niam-Niams, as standing before every hut, and as cultivated in Monbuttoland. The bark is most fit for use when the trunk is of about the thickness of a man's body. The whole stem is then peeled for a length of some four or five feet, and this without destroying the tree; for the juicy substance around the wood immediately granulates and shortly begins to form a new bark, which becomes fit for use again in about three years. Thus a tree, properly taken care of, may be made to furnish several suits of clothing during its lifetime. The rokko-bark much resembles that of the bass-wood in quality, except that the bark is not quite so thin. By partial maceration and much beating it is formed into a kind of thick and very pliant cloth. In a crude state it is grayish or yellowish, but steeped with a dye-wood it takes a brownish color like that of a common woolen cloth. It constitutes a valuable article of trade in the interior of Africa. The price varies considerably according to the color and quality, and the ornamented cloths are held as fancy articles, without having a fixed price. Of the colored goods, a dark-gray material is commonly worn by the Witchweri wizards; a dark-red is fashionable among well-to-do people; and a tan-colored ground with stripes and figures in black, called *mtone*, was formerly worn only in royal families, and is still much affected by the nobles in Unyoro and Ruhama, while it has been to a considerable extent supplanted in Uganda by goods from Zanzibar. It can not be bought in the market, but any one who wishes to get a pattern of it must go to one of the great chiefs and give him ample satisfaction in return-presents. The other goods may be bought at their price in cows or cowries. The skins of cattle, goats, sheep and antelopes are also worn in parts of Africa, while the skins of leopards, monkeys, and cats are worn only by privileged persons of royal or noble families.

Private Encouragement of Research.—The fact that the recent proceedings of the Royal Institution acknowledge the gift of £100 by Mr. Warren De La Rue and £50 by Sir Frederick Bramwell to the fund for the promotion of experimental research supports the view that matters of this kind might be trusted to prosper as well under the encouragement of private interest and enterprise as when quartered upon the Government for subsidy. Liberal gifts are seldom wanting to anything that proves worthy of them; and in the former case research will be supported in proportion as it is industriously prosecuted and is of value; while under the Government plan, although enough show of work may be made to draw the pensions, it is by no means sure that so much pains will be taken to make the genuineness and value of the work demonstrable.

Eskimos in Ancient New Jersey.—Mr. A. S. Packard, who has been investigating the history of the Labrador Eskimos, has come to the conclusion that those people formerly had a more or less permanent foothold on the northern shores of the Gulf of St. Lawrence. If this was so, it seems not improbable that they may have made, in very early times, expeditions farther south, to Nova Scotia and New England. This thought leads the author to Dr. Abbott's theory, that the Eskimos inhabited the coast of New Jersey during the river-terrace epoch, which he was at first disposed to reject. Examination, however, has led him to look with more favor upon it, and to think it not improbable that, long after the close of the glacial period, or after the ice had disappeared, and during the terrace epoch, when the reindeer and walrus lived as far south as New Jersey, the Eskimos, being perhaps the remnants of the palæolithic people of Europe, extended as far as a region defined by the edge of the great moraine; and, as the climate assumed its present features, moved northward. This view presented itself while he was collecting the material for his notes, and was confirmed by Mr. Tylor's remarks at the British Association.

The King Country and the Maories.—The "King Country" is a district of about ten thousand square miles in extent in the northern Island of New Zealand, to which the mass of the wild native population of the country have retired so as to be out of the way of the whites, and over which they claim and exercise exclusive jurisdiction to the extent of having, till very recently, held it *tapu* against white men. Mr. J. H. Kerry Nicholls, who lately succeeded in making a running exploration of it, describes it as one of the best-watered parts of the island, with many beauties, and offering many natural advantages for European settlement. In the west it has an extensive coast-line, and a capacious harbor. Dense forests cover a large part of its southern area, and extend northward to the mountains. Westward of this division is a considerable area of open country, while there are vast open table-lands near the snow-clad mountains in the south, and other extensive open plains west of the great Lake Taupo and north of Titiraupenga. The King Country possesses all the rock formations in which gold, coal, iron, and other minerals are found, while its extensive forests are rich in timber of the most varied and valuable kind. Geysers and thermal springs, possessing wonderful medicinal properties, are found in the vicinity of its many extinct craters; and, while it possesses one of the largest active volcanoes in the world, its landscape is also crowned by the snowy peaks of some of the highest mountains in Australasia. With these important features, it is endowed with scenery of the grandest order, and with a climate unsurpassed for its variety and healthfulness. According to Mr. Nicholls, the Maori people in New Zealand are decreasing; for, while in Captain Cook's time they numbered more than 100,000 souls, in 1881 the number had decreased to 44,099. The three principal diseases conducing to the decay of the race are phthisis, chronic asthma, and scrofula, the first two being principally brought about, Mr. Nicholls believes, by a half-savage, half-civilized mode of life, and the latter from maladies contracted since the first contact with Europeans. "It is, however, clear that there are a large number of natives yet distributed throughout the King Country, and among them are to be found, as of old, some of the finest specimens of the human race. A change of life, however, so different from that followed by their forefathers, has brought about a considerable alteration for the worse among the rising population, and, although during my journey I met and conversed with many tattooed warriors of the old school, who were invariably both physically and mentally superior to the younger natives, it was clear that this splendid type of savage will soon become a matter of the past. I found the natives living much in their primitive style, one of the most pernicious innovations, however, of modern civilization among them being an immoderate use of tobacco among both old and young." At Ruakaka, in the heart of the mountainous forest region, the Maories were found living in the same primitive way as in the time of Cook, and, "when we questioned them as to their religious principles, they told us that they believed in nothing, and got fat on pork and potatoes."

Water-Purification of Sewage. — The important part played by water in the oxidation of sewage has been tested by experiment, and may be accounted forby the quantity of free oxygen that water usually contains. The quantity that may be dissolved is increased with reduction of the temperature. At the summer temperature of 70° Fahr., water contains 1·8 cubic inch, and at the winter temperature of 45°, 2·2 cubic inches, of oxygen per gallon, which is equivalent to four or five cubic inches per foot. From calculations based upon these data, it will be seen that at a temperature of 70° there are 2·58 tons, and at the temperature of 45°, 3·16 tons, of oxygen in every 10,000,000 cubic feet of water. This shows a difference of more than half a ton per cubic foot between these two temperatures. It has been calculated that if a volume of water containing thirty-five per cent of sewage-matter be allowed to flow for one mile, exposed to the air, the whole of the sewage would become oxidized. It has also been estimated, by experiment, that a closed vessel containing water, with five per cent of sewage, gives only thirty-two per cent of aëration on the fourth day, as compared with eighty-four per cent on the day when it is introduced into the vessel. The results of these experiments tend to show that, although the self-purifying power of the water of the river is sometimes overtaxed, it still retains the power of oxidizing sewage-matter; but the question as to whether it has the power of freeing itself from living bacteria still remains to be solved.

The Identity of American Races. — J. W. Powell writes to "Science," pertinently to its review of the Marquis de Nadaillac's "Prehistoric America," that, in his opinion, "there has never been presented one item of evidence that the mound-builders were a people of culture superior to that of the tribes that inhabited the valley of the Mississippi a hundred years ago. The evidence is complete that those tribes have built mounds within the historic period; and no mounds or earthworks have been discovered superior in structure or contents to those known to have been built in historic times." Nevertheless, Mr. Powell considers the doctrine of "the identity of all peoples that ever inhabited the American Continent up to the advent of Europeans" one that is not and can not be held by any intelligent anthropologist, except in some very broad sense, as, for example, that they belonged to the human race, or that they inhabited one continent. In respect to mythologies, languages, and institutions, there are, and have been, many distinct peoples; and, in respect to arts, there is much diversity, though arts travel from people to people with the greatest ease. At the present time we can not have fewer than seventy distinct peoples among the tribes of North America, and in antiquity the number may have been greater."

Savage Sharp-Shooting.—Concerning the manners and customs of the savages of Mount Sylvia, Formosa, Mr. E. Colborne Baber related in the Royal Geographical Society: "A party of English officers from a man-of-war landed on the island, and, meeting a company of natives armed with matchlocks, challenged them to a trial of skill in shooting. Affixing a mark to a tree about a hundred yards distant, the officers made what they considered pretty fair practice, without, however, astonishing the natives, who, when it came their turn to fire, disappeared into the jungle like one man, and crawled on their bellies through the undergrowth to about three yards from the target, which, of course, they all hit exactly in the center. When the Englishmen protested that such a method of conducting the competition was hardly fair, the natives replied, 'We do not understand what you mean by fair, but, anyhow, that is the way we shoot Chinamen.'"

Emigration from the Old World.—The migrations of European population, says "The Spectator," were never so general, so extensive, and so complex as they are at present. By reason of railways and the cheapening of travel, movements that in any former age would have occupied years are now accomplished in a twelvemonth. The greatest wanderers are perhaps Italians, for the struggle for existence is keener in Italy than in any other European land; the working-classes there have to labor more hours and for less pay than anywhere else. The natural result is an enormous migration of Italian artisans and laborers into neighboring countries; and with them neither Germans, Austrians, nor Swiss can compete. "They are better skilled in their calling and more sober in their habits; and, though they begin by working for lower pay, many of them earn, because they deserve, higher wages than their native competitors. They excel in all sorts of stonework; and at Zürich and some other places architects are in the habit of stipulating that none but Italian masons shall be employed on a job. They built the St. Gothard Railway. They are found as far north as Dresden and Berlin, and the greater part of the engineering work in France is performed by Italian navvies. The Germans, Austrians, and Swiss, displaced by the Italians, push north and west. Many come to England, more go to the United States. . . . It is found in Austria that emigration is most rife in districts where two races are in conflict, and that those most prone to emigrate are of the German race. This is especially the case in Bohemia and Moravia, where the Slav and Teutonic elements are struggling for supremacy; in the north of Hungary, where the Germans have the upper hand; and in Galicia, where the population is Polish and German, and the Jewish element is being increased by immigration from Russia. It would, however, be unsafe to lay down any general law on the subject." It is not probable, for instance, that the Germans emigrate because they are worsted in the struggle for existence, but perhaps because they are more enterprising and far-seeing than their Slavic neighbors and are better able to go. In some instances, the emigration is by masses, as in the district of Wisowitz, in Moravia, which has lost nearly half its population, and in the regions of Tabor and Kuttenberg, where "a veritable emigration fever has prevailed." Austria is making a use of the wandering disposition of its discontented subjects somewhat to its own advantage, by inducing them to colonize in the annexed district of Bosnia.

The Mystery of Eels.—Naturalists are generally agreed that at least three distinct sorts of eels are indigenous to British waters: the silver-bellied or sharp-nosed eel—the one that migrates in the fall—a firm, fine-flavored fish, with an almost black back, a silvery belly, and a fine, sharp head; the grig or snig, a yellowish eel, with a projecting under jaw; and the broad-nosed eel, an uglier-looking animal with a broader head, fierce and voracious in its habits, and of base tastes. To these a Norfolk fisherman adds a fourth, the "hooking" eel or "gloat," of blackish color and medium size, which is taken by anglers and habbers and on night-lines, and does not migrate. The annual migration seaward of the sharp-nosed eels gives rise to the valuable eel-fisheries of the English rivers, in which the fish are intercepted by wicker traps or eel-sets placed across the river, and in one of which 70,000 have been caught in one night. The moving of the fish is done in the night and always in a dark night; and it is liable to be interrupted by a change of wind, a clap of thunder, or a clearing away of the clouds. What becomes of the immense numbers of eels that descend to the sea every season has never been found out. They are hardly missed from the haunts they have left; yet no one has ever seen any of them returning. In the spring, however, the young eels come up the rivers by millions, keeping close to the banks and swimming in almost solid columns. They will surmount almost any obstacle, creeping wherever there is any moisture, through grass, and over stones and timber. These "eel-fairs" last through several days; and the tiny elvers, about as large as darning-needles, used to be scooped out by the bucketful and applied to the land for manure, baked into cakes for men, or used as food for pigs, until an act was passed prohibiting their destruction. The fact that eels that have once gone down the rivers never return is asserted positively by all who have observed them. The question is then in order, How is the supply in the rivers kept up; and how is it that the eels found in the rivers are of a large size? The answer is, that young eels are produced in the rivers, and that eels are so numerous that, although immense numbers leave the rivers every year, yet equally immense numbers remain. The migrations have been generally supposed to be for breeding-purposes; but there are reasons for believing that breeding takes place in the rivers as well as in the sea, so that this alone can not explain them; and it has been suggested that they are a kind of swarming, like that of bees, impelled by excess of numbers. Naturalists affirm that the eel is an oviparous animal, and that it deposits its spawn as other fish do, and point to the presence of spawn and milt in it as revealed by the microscope; but the eel-fishers and eel-setters declare that it is viviparous; "that they have constantly opened eels in February which have been full of minute living eels (not parasites), and that in a tub of eels young ones have been found in the morning that were not there overnight. . . . To use their own words, there are thousands and thousands of eel-fry all alive in the bodies of eels cut open in February."

Dangers from Industrial Dusts.—A paper was read by Dr. Henri Napias before the Congress of Industrial Hygiene, held at Rouen in July, 1884, on the dusts developed in industries and the methods of guarding against injury from them. Dusts in the air call for especial consideration, from the fact that, besides vitiating the atmosphere in the way that gaseous impurities also do, they exert a mechanical action when brought in contact with the respiratory and digestive system. Even when they are wholly without toxic or essentially irritant effects, they are foreign bodies and obstructive, and are always in danger of exerting a traumatic action or causing abrasions. They are, therefore, all dangerous, while the dangers arising from them may be various in character. Mineral dusts, whether of stones or of metals, are the most dangerous, because, besides being hard and sharp and liable to cut the tissues, very many of them are also poisonous or caustic. Dusts of organic origin are less dangerous, but they vitiate the air, communicate unpleasant qualities to it if they are of an animal nature, and are frequently vehicles for the conveyance of infectious germs. Various inconvenient affections of the lungs are caused by breathing these dusts, among which may be counted phthisis, not as produced directly by them, but as often ultimately induced by the abrasions or deterioration of the tissues which they immediately occasion. The readiest and most available means of removing dusts is by ventilation, and, when this can be so directed as to take them away as soon as they are formed, it is almost sovereign. It will not do, however, to rely upon general ventilation, for that will at most remove the dusts but imperfectly, while its usual operation will be more likely to distribute them more widely among the operatives. The remedy should be applied to light dusts by means of chimneys or draught-flues ; and to the heavier ones by means of blasts to drive them away. In cases where the dust itself is the object of the manufacture, or is to be applied in the manufacture, the remedy is to conduct the processes in closed apparatus. When either method is practicable, the dust may be kept down or removed by water, or the articles may be worked in a moist condition. Some workmen employ masks or respirators as means of individual protection, and they may in some processes be the only efficient means available. They are liable to the objection that they are always cumbrous and inconvenient; and frequently the workmen will become careless about them, or refuse to be bothered with them, and will leave them off. They should not be depended upon when any practicable means of keeping down or removing the dust can be employed.

Gambling at Monte Carlo.—Dr. J. H. Bennett gives in the "Pall Mall Gazette" some impressive illustrations of the enormous influence for evil of the gambling establishment at Monte Carlo, Monaco. The extent of it may be best understood by a simple calculation which the author owes to a professional gambler. The chances of the table are one in thirty-six in favor of the bank, and its annual gains, after all its expenses are paid, are $3,500,000. Hence $126,000,000—and thirty-six times its expenses in addition—have to be staked in it, won and lost, every year. "It is this fact of the gambler dealing with large masses of money that partly accounts for the strange fascination exercised by gambling. A careful player, who begins with, say, a thousand pounds capital, may have fingered, according to the doctrine of chances, thirty-six thousand pounds before he loses his capital. If he play long enough, the bank royalty of one in thirty-six is sure to swallow up his capital; and then he has had all the emotion of having been alternately successful or the reverse, rich or poor. He regrets when he has at last lost his initial capital that he did not stop when successful, which he never does, vows that he will be more prudent next time, and, in order to have the chance, sells, borrows, raises money anyhow." These facts destroy the argument brought forward by the patrons of the public tables, that playing at them is more straightforward and fairer than private club gambling, and that, as long as the latter is allowed, the former should not be interfered with. "At a public gaming table the bank royalty must inevitably ruin all who play constantly long enough to have risked their capital thirty-six times, even if the playing is carried on honestly, if such a term can be used. . . . Regular gamblers find this out in the long run, and learn to avoid the public establishment," resorting to the gaming clubs or forming them; and this is the explanation of the brood of gambling clubs, casinos, etc., which rise up, as at Nice, in proximity with the public gambling establishment. "They proceed from it, are created by it, would not exist without it. . . . When I first inhabited the Riviera" (in 1859), continues Dr. Bennett, "the Monaco gambling-house was a mere gambling club or casino, which excited but little notice. Now it has become the great attraction, the great fact. Half the people one meets are going or have been to Monte Carlo."

"Anti-fouling" Paint for Ships.—Because iron and steel are peculiarly liable to corrosion when immersed in salt-water, vessels made of them require special protection. This can be given by covering the metal with some alkaline or basic substance, or the oxide of some metal electro-positive to it. Caustic lime and soda are very efficient for this purpose, and act equally well when made into a paint with oil. But their efficiency is destroyed when they cease to be caustic, or when they are saturated with carbonic acid, which they absorb freely from the air. Magnesia is equally efficient, and does not absorb carbonic acid. It therefore makes as good a material for a paint as could be desired, and, moreover, forms an excellent basis on which to lay an anti-fouling paint, which it protects from the galvanic action of the iron by isolating it, while it does not affect its anti-fouling qualities. Without the protection thus afforded, the iron not only effects the decomposition of the anti-fouling paint, but it also by contact takes away the anti-fouling qualities of that part of the paint which it does not decompose. All of the best anti-fouling paints depend for their efficacy on some compound of mercury or copper, while the action of iron is very strong in contact with both these metals; hence perfect isolation of the paint from the iron is necessary to make them of any value. Besides paints of magnesia and alumina, spirit and benzoline varnishes, powdered coke, anthracite or coal, lime, cement, and various kinds of silicates, mixed or suspended in oils, have been found good in greater or less degrees for these purposes. Zinc oxide also has some slight merits, while red-lead paint, which has been used, is "out of the question. It is bound to give out after a certain time; and, besides, the metal beneath is corroded."

The Teak-Tree and its Timber.—The teak-tree is found growing in various places in the East Indies, through a region reaching from the eighth degree of south latitude in Java to about the Tropic of Cancer, and of undefined extent in longitude, but not farther west than 72° east. Its vertical *habitat* is about 3,000 feet above the level of the sea, but seldom below 2,000 feet. Its northern limit is in Bundelcund, where it is found in specimens not tall, at elevations rising as high as 4,000 feet. It grows in groups, a circumstance which is very convenient in trade. The wood is held in the highest esteem by ship-builders, and is preferred to any other for the backing of iron-clad vessels. It shrinks hardly any, is considered the strongest and most durable timber of India, or perhaps of the world, and resists the attacks of white ants. The qualities of the timber vary greatly according to the character of the soil on which it grows, sometimes so much as to induce the belief in different species; but close examination has shown that, though varieties may exist, there is but one species. In Java, the Government have control of 1,650,000 acres of teak, besides new plantations. The planting and raising the trees, and mode of felling, classing, and measuring the timber are carefully regulated. Forest reserves of considerable extent exist in various parts of India, from some of which specimens have been shown more than 100 feet long, and 93 and 100 inches in circumference at the base. One of the chief sources of supply is British Burmah, where the total area of the reserve forests is 3,274 square miles, and 836 square miles were added during 1881–'82. Nineteen thousand teak-trees were girdled, and 130,000 tons or 6,500,000 cubic feet of the timber were exported during this year from Rangoon and Maulmain. The principal forests are near the Irrawaddy River, where water conveyance is easy and ship-building is prosperous. A very fine plantation has been established at Nilambur, on the river Beypore, in Malabar, where 100 acres are planted each year, and there are now about 1,800,000 trees. An increasing source of supply is also being developed in Siam. According to Colonel Beddome, the growth of teak is very rapid, compared to that of the oak. The growth in the sapling state may be calculated at about one or two cubic feet a year; but after thirty years it is immensely accelerated, and an increase of five cubic feet has sometimes been remarked in a year. Several other trees, but little known as yet, are mentioned as nearly equal in value to the teak. The takieng, besides being a rival to it in size and quality, possesses the advantage of being easily bent by artificial means. Sir Robert Schomburgk saw a log of it measuring 135 feet, perfectly sound, in the building-sheds of the King of Siam. The red peema of Burmah and Tenasserim is considered equally useful with teak, as is also the touk-kyan, with its dark-brown wood. Angely is well suited for the floors and bottom-planking of ships, but has to be used with copper, as it corrodes iron. Jackwood, a tree of the same family (*Artocarpus*), furnishes an excellent fancy and furniture wood, and is admirably adapted for boat-building. An Australian timber called tuart is believed by Mr. Simpson to be superior to all others for the backing of armor-plated vessels, as it can not be split by any possible means.—*From a paper read by Mr. P. L. Simmons before the Society of Arts.*

The Duk-duk.—According to Mr. Wilfred Powell's "Among the Cannibals of New Britain," affairs in the Duke of York Islands are regulated by an officer called the duk-duk, who appears to combine in himself the functions of judge, police officer, and executioner. He is distinguished by his peculiar dress, and by his helmet, which, reaching down to his shoulders, quite conceals his face. It is made of basket-work, so that the wearer can breathe freely, and is painted in front as a terrible face. When any person is accused by his neighbor or otherwise blamed, he must pay the duk-duk a sum of money as damage, and this officer goes in person to the house of the accused to see that all is made right. If the accused will not settle, his house is burned or he is speared. Women and children dare not look at the duk-duk, for fear they will die on the spot, and therefore run away and hide, whenever they know, from the peculiar cry he utters to give notice of his approach, that he is coming. Men may be initiated into the mystery of this office when they reach a certain age, on payment of a prescribed sum, and, if they do not do this, they must keep out of the way of the duk-duk. The initiated must never speak of the secrets of the mystery out of the spot that is consecrated to it, and the uninitiated must not go to that spot.

Temperature of the Glacial Period.—Some geologists hold that the glacial phenomena were the result of warmer, not of colder, conditions of climate than now exist. Their views are briefly summarized by M. Millot, of the scientific faculty of Nancy, France. For the production of glaciers in temperate latitudes an active evaporation at the equator, to furnish moisture to be condensed into snow on the mountains, is above all things necessary. Thus, the quantity of ice produced will be within certain limits proportioned to the heat received at the equator. No heat, no evaporation; no snow, no glaciers; on the other hand, there will be no glaciers if it is too hot for the snow to be deposited on the mountain-tops. This was probably the case before the glaciers appeared. Then, as the heat of the sun gradually diminished, as it is supposed to be doing regularly, the glaciers begun on the mountains, small, but growing, for the evaporation at the equator was still infinitely greater than it is now. So it may have continued for ages, the snow condensing on the mountain-tops, and the sun lifting up immense quantities of water to be condensed. This was a period of maximum favorable conditions for glaciation. Then, the sun still cooling, the amount of evaporation fell off, till it ceased to afford the excessive supply, and the glaciers became stationary, then retrograde till they were reduced to the relatively insignificant proportions in which they now appear. This theory explains the deposition of glacial moraines in the midst of tree-ferns and a Mediterranean vegetation; for, while the glaciers were extensive in consequence of the immense precipitation everywhere but immediately upon them, a warmer climâte prevailed than is now enjoyed in the same regions. This theory explains also how Arctic animals, finding suitable conditions of existence in the glaciated districts, came to be mixed up, as is shown by their remains, with the herbivorous animals of milder climates, which were separated from them only by a line. This theory, unlike all other theories of the glacial period, does not require the supposition of any interruption of the regular, normal order of climatic development and events.

Arts and Customs in New Guinea.—Mr. Coutts Trotter, in an address before the Royal Geographical Society, stated that while the people of New Guinea are still in the "Stone age," their artistic faculty is strongly marked, especially among the western tribes. This is shown conspicuously in the carved ornamentation of their canoes, houses, implements, and weapons. Their tastes are further seen in the habit of adorning themselves with flowers and leaves — of crotons, dracænas, coleus, begonias, scarlet hibiscus, and the anise-scented clausena. They are also alive to the advantages of trade, the tribes on the western coast having for centuries been exchanging the varied products of the country with the Malays, Bughis, Chinese, and others, for cotton cloths, iron and copper wares, knives, beads, mirrors, indigo, and arrack. In conducting their inland trade among themselves, they assume that inter-tribal war is the normal condition of man, and adopt ingenious devices to mitigate inconveniences. But even the plan of setting apart for each hill-tribe its allotted station on the coast is not always sovereign for the avoidance of collisions. The people of the southeast peninsula make long voyages to the west of the Gulf of Papua for sago, in strange craft composed of several canoes lashed together, with a house at each end. Each village or district often has its trade-specialty, as, for example, for pottery, or for canoes, or shell or other ornaments. Salt is in great demand, especially in the interior, whither sea-water is sometimes carried in hollowed bamboos; or salt is obtained by burning the roots of trees which have grown in the salt water. The people in most parts are skilled agriculturists, and grow, generally with the help of artificial irrigation, all the usual plants of tropical Pacific culture, most of which—with probably the traditions of scientific agriculture—seem to be of Asiatic origin. Any one may clear and cultivate a piece of land within the territory of his tribe, but they have a strong sense of proprietorship, even of the fruit-trees in the forest, and of the fish in their own streams, or their own tract of coast. The social and political organization of the people is quite rudimentary. The chiefs have but little power. Important matters are settled by the assembly, and, otherwise, every man, beyond conforming to certain established customs, is a law to himself.

How to live One Hundred Years.—How to live a century and grow old gracefully are discussed in a pamphlet under that title recently published by Dr. J. M. Peebles, who appears to have faith in the practicability of both his propositions. Success depends upon many elements, among the most tangible of which are air, sleep, food and drinks, and clothing. We must breathe pure air, and breathe deeply; not be afraid of night-air, and get as much of our air out-of-doors as we can. As to sleep, "I say," says Dr. Peebles, "to my friends and patients, 'get up; get up at five o'clock in the morning'; and I set them the example. If they want more sleep I say, 'take it; take all you want; take eight hours; take nine hours; take ten hours, if you choose; but take them in the early hours of night rather than by daylight. Don't insult Nature.' If you get angry, take a bath and go to bed and sleep; if the world abuses you, take extra sleep; if you are dyspeptic and discontented, take a long, sound sleep, and, waking, you will find that all the world is smiling." For diet, the vegetarian and farinaceous system is recommended. For drink, water, which should also be applied freely and frequently outside, while intoxicating liquors, tea, coffee, etc., are best left alone. The clothing should always be arranged with a view to protection against variations of heat and cold, and with no other, and should not be allowed to impede any of the functions or movements of the body. Dr. Peebles thinks that there may be good in medicines, notwithstanding all that is urged against their use by many writers on hygiene, and says: "If there were no pre-natal weaknesses, no transmitted blood-poisons or hereditary tendencies; if there were no sudden climatic changes; if there were no violations of the physical, mental, and moral laws of God, medicines would be quite unnecessary. But, as rational, practical men, we must take human beings precisely as we find them; and we find many of them wretchedly begotten, badly cared for in infancy, unwisely trained in childhood, wickedly tempted in youth, and in manhood frequently exposed to winds, pelting storms, and the low malarial lands of the Western prairies. Thus conditioned, human ills, aches and pains and diseases are absolutely unavoidable, and accordingly remedies — medicinal remedies — carefully selected and wisely administered, are positive necessities." Finally: "Exercise charity toward all, control your passions, govern your appetites. Develop and manifest a sweet and peaceful spirit. Carefully observe the rules of health; . . . and, with a fair constitution to start with on the journey of life, you may easily live a full century."

Do Insulated Conductors attract Lightning?—A house in Neufchâtel, Switzerland, was struck by lightning and burned last summer; and it was suggested that the electric stroke had been invited by a lot of old iron that was stored in the attic. M. Calladon, speaking in the French Academy of Sciences of this suggestion, remarked that the mere presence of metal, without communication with the earth, could not have any material influence in attracting the lightning from the clouds; if it had, then the houses with tin roofs, many of them without lightning-rods, now so common, would be in great danger, whereas they are not struck oftener than houses with tile roofs. The presence of iron, however, might increase the danger of fire after the house had been struck; for, if we place a combustible substance between two conducting surfaces, it is generally sure to take fire when an electric current is passed through it from one of the conducting surfaces to the other. So, if lightning should strike a house, it would find its way to any masses of metal within the building and ignite whatever combustible matters it passed. In view of this fact, and of the present very extensive use of metal in house-construction, the provision of suitable conductors to divert electrical currents from the combustible parts of the building has become more important than ever.

Was it Volcanic or Cosmic Dust?—Mr. W. Mattieu Williams is of the opinion that the long continuance of the glowing twilights tells against the validity of the volcanic-dust theory; for that dust must have settled by this time, or, if so much of it has continued to float in the atmosphere, it should have shown its presence more palpably than it has done. The two alternative hypotheses to this one, worthy of serious consideration, are: 1. That the earth, and possibly the whole or a large portion of the solar system, has, in the course of its journey through space, passed through a region unusually rich in meteoric dust; or, 2. That an unusually large amount of aqueous vapor has been raised to the upper regions of our atmosphere by increased solar activity. Apparently in favor of the meteoric theory is the statement of F. Mangini, that on three days in February and March, 1885, when the glows, accompanied by rain, were especially remarkable, he collected at Reggio, in Calabria, some new-fallen red dust, which, when examined under the microscope, seemed to consist of mica, quartz, and irregular polyhedric crystals. Analysis brought out magnetic iron oxide, sulphuric and phosphoric acids, silica, calcium, magnesium, aluminum, nickel, and arsenious, ferric, and manganous oxides. The dust did not come from Etna, because the wind was blowing in the opposite direction, and Etna dusts are black; nor from the Sahara, because Sahara dusts contain no iron.

Oranges in Palestine.—The climate and soil of Palestine are well adapted to the cultivation of the orange, which, according to Consul Merrill, there suffers from no diseases or parasites of any kind. The trees appear to flourish best near the sea, and the orange-groves are for the most part near Jaffa and Gaza. In Jaffa there are five hundred gardens, of which one hundred and fifty are ranked as first class, all the gardens together containing about 800,000 trees. The trees are set about fifteen feet apart, while the ground between them is planted with small fruits or vegetables. The sweet lemon is used as the stock, and the variety of orange desired is grafted upon it. The trees are watered every week in the summer, at a cost per season of about one fifth the value of the crop in gardens of the first class. The Jaffa oranges proper, the only kind exported, are oval, or lemon-shaped.

NOTES.

M. Domeyko has summarized the results of forty-six years of observations on earthquakes in Chili. They are more frequent in the northern part of the country, where there are no volcanoes, and the Andes are fifteen thousand feet high, than in the southern part, where there are volcanoes, and the mountains are only a third as high. The effects of the shocks on buildings depend more on the nature of the soil than on the violence of the spasms. The sea-phenomena are of two kinds: local, or oscillating, when the waters retire to beyond the lowest-water mark, to return in waves a hundred feet high beating upon the coast and destroying everything they reach; or, when the shocks occur at a distance, the water runs along the coast in a grand wave without previously retiring. In the more severe earthquakes, when there are several shocks in the same day, it is generally the second or third one that produces the greatest destruction. The destructive effects of an earthquake are never as considerable in the interior of a mine as at the surface.

M. Quentin Paul Desains, of the Physical Section of the French Academy of Sciences, died after a very short illness, about the 1st of May. He was born in 1817, and had been a professor in the Colleges of Caen, Stanislas, and Bourbon, and a member of the Academy since 1873. He was the author of several valuable papers on the laws of radiant heat, the polarization of the calorific rays, the latent heat of aqueous vapor, etc.

M. Jamin attributes the cold nights usual in April and May to the fact, which he deduces from the experiments of Mr. Glaisher and others, that the minimum of vapor in the atmosphere prevails then, the maximum being in August.

M. Edouard Heckel, of Marseilles, has called attention to a new prospective source of gutta-percha in the *Butyrospermum Parkii*, or *Barsia Parkii*, of the interior of Africa, from the seeds of which the natives already extract a kind of butter. The plant possesses many advantages. It is very widely diffused; it will grow apparently in the most desert, gravelly soil; it matures in four years; and it is available to a certain extent, to native taste, as a food-plant.

M. Dieulefait has been inquiring why there is so much sulphur in stone-coal, and why there is so little of free alkaline carbonates in the ashes. For that purpose he has analyzed the surviving species of the families of the coal-plants, particularly the *Equisetaceæ*, and has found in them a greater than the usual proportion of sulphuric acid. Hence he deduces, as the answers to his questions, that the coal-plants were more highly charged with sulphur than most existing plants; and that, for that reason, their alkaline constituents assumed the forms of sulphates instead of carbonates.

The chimney of a manufactory in Breslau, about fifty feet high, is made of pressed paper, a substance which, it is remarked, has almost perfect powers of resistance to fire.

M. Admiral Mouchez has taken, at the Paris Observatory, distinguishable photographs of stars of the fourteenth magnitude. On a plate about ten inches square he has photographed a field of about five degrees square on which are shown 2,790 stars of between the fifth and fourteenth magnitudes, equally clear in the edges and the center of the picture. Stars of the fifteenth magnitude can be discerned in the negatives, but they were not clear enough to be transferred to the paper. It is estimated that, if the stars are distributed over the whole sky as thickly as over these five degrees, then the total number of them is 20,500,000.

A commission of inquiry respecting the earthquake in Ischia of July, 1883, appointed by the Italian Government, has reported that the number of victims of the catastrophe, not counting mere contusions, was 3,075, of whom 2,313 were killed or died in the hospitals, and 762 were wounded. Of the 672 dwellings in Casamicciola, 537 were wholly destroyed, and only one wholly escaped injury; of the 4,300 inhabitants of the town, 1,784 were killed. At Ischia town the shocks were strong, but no serious harm was done. Accommodation was provided after the disaster for 9,500 unhoused inhabitants of the island, in 700 temporary barracks of corrugated iron.

OBITUARY NOTES.

Professor Fleeming Jenkin, of the University of Edinburgh, died June 12th, in the fifty-third year of his age. He was distinguished in locomotive and constructive engineering art, and in connection with the laying of cables, including the first transatlantic one, and general telegraphy. He was made Professor of Engineering in University College, London, in 1865, and in the University of Edinburgh three years later. He has written several papers in engineering and electrical science, and was the author of the article on "Bridges" in the "Encyclopædia Britannica."

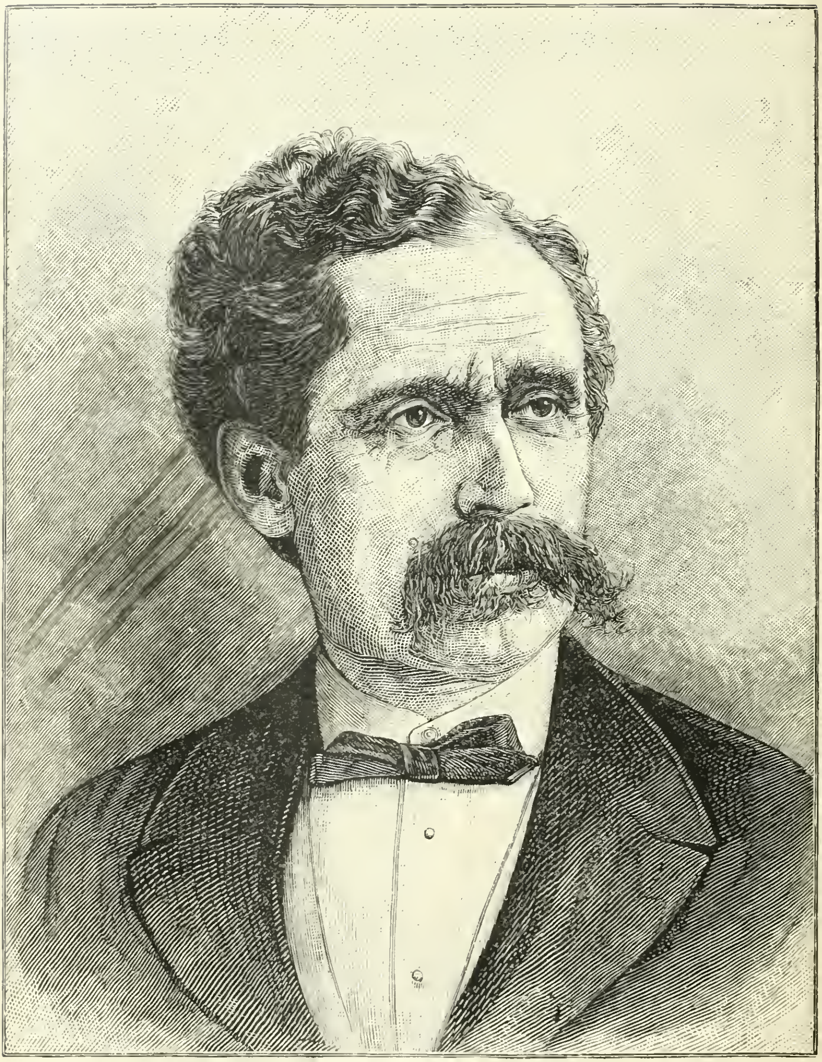
Lieutenant Tilly, the leader of one of the German West African exploring expeditions, has recently died in the Cameroons.

Mr. Alexander Croall, Curator of the Smith Institute, Stirling, Scotland, is dead, in the seventy-seventh year of his age. He was the author and illustrator of "Nature-printed British Sea-weeds."

Mr. Alexander Murray, formerly of the Canadian Geological Survey, died in the early part of this year. He was born in Scotland in 1811, and, after serving in the British Navy for several years, went to Canada about 1837. He was invited by Mr. W. E. Logan to join the geological survey of the province, which was about to be begun, and, having no previous knowledge of the science, qualified himself for the work by special studies. On the survey he was able and efficient, and superintended a large part of the work for twenty years. He had charge, from 1863 to 1883, of the geological surveys of Newfoundland, the collated reports of which, published in 1881, are our chief sources of information on that subject.

The Rev. T. W. Webb, of Hereford, England, author of "Celestial Objects for Common Telescopes," and of numerous articles on observational astronomy, died May 19th.

The anatomist, Professor Henle, of Göttingen, died on the 13th of May last.



GUSTAV NACHTIGAL.

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THE RELATIONS OF RAILWAY MANAGERS AND EMPLOYÉS.

By Dr. W. T. BARNARD.

I.

THE problem how to secure the most effective and harmonious relationship with their employés is one of rapidly growing importance in the minds of those managers whose duties bring them into close contact with the rank and file of railway service, and is also beginning to force itself upon the attention of investors in this country, as it has already largely done in Europe. Though quite generally the real underlying cause of strikes and labor agitations, among railway people especially, is unequal enforcement of discipline, irregularity in or unequal distribution of work, debts incurred through the misfortunes—rather than, as a rule, through the fault—of the operatives, inducing restlessness, etc., their discontent usually forces itself upon the attention of the railway director in the first instance as a *wages* question. As the successful and economical operation of a railway requires a certain number of *reliable* servants thoroughly trained for and skilled in their respective positions, considering the rapid extension of our railways, many years must elapse before the surplusage so cheapens this class of skilled labor as, on the one hand, to induce managers to relieve overburdened servants in busy seasons by dividing their duties among a larger number than will barely suffice for current needs, or, on the other, affords them security from strikes and unjust demands through the presence of unemployed skilled artisans eager to supplant the discontented. Meanwhile the necessity of meeting competition and reduced earnings by improved machinery and increased technical efficiency will constantly enhance the importance and value of a permanent and zealous corps of employés with whom fair wages, while important, are overshadowed by other considerations personal to their service. In its simplest aspects the subject of the wisest form of adjustment between labor and capital is enough; but, when considered in relation to our American railways, so many and complicated questions of management and economies arise, and the possible consequences of innovations are so great and serious, that few officials possessing sufficient influence with their directors and stockholders to make their advocacy effective have time or courage to take the initiative in an intelligent reform, which, under the most favorable circumstances, could only be established by overcoming the timidity of capital and the obstinate opposition of the ignorant and prejudiced. At first blush the proposition that intelligent beings would not welcome with hearty support and co-operation any measure whose patent object was the improvement of their welfare seems untenable, but the student of history will recall few instances where the violent opposition of the masses has not followed all general efforts to ameliorate their condition, since and before the day when the founder of the Christian religion suffered crucifixion for his temerity in a kindred cause. It is generally recognized at home and abroad that only through the betterment of their present physical condition and surroundings can a body of permanent, satisfied railway servants be secured; yet the path to success in such an enterprise is strewed with many difficulties, the primary one in this country arising from the absentee ownership of our great railroads, and the difficulty which a body of stockholders, or their representative directors, have in recognizing the needs and feelings of the rank and file operating their properties—living, as they do, far from their lines, or, if near, immersed in pursuits that do not bring them together. The ownership half of the railroad world—in the United States, at least—certainly knows little, and recks less, of how the employé half lives. True, no difficulty would probably be experienced in getting investors in railroad securities to admit, in glittering generalities, the desirability—even necessity—of bettering the condition of those upon whose energy, honesty, and fidelity they rely for dividends; but when confronted with any systematic measure for the accomplishment of this result, which apparently involves a considerable expenditure, they "back water" with alacrity. Philanthropy and benevolence find no resting-place in the bosoms of the average railroad shareholders; at least few think of beginning their charities among the homes of their people; therefore, to enlist their pecuniary support of any costly plan for helping railroad operatives, it must be shown *to pay the shareholder.* Treating the subject from a purely business stand-point, let us see *if it pays* our great corporations to rest their connection with their employés upon the mere payment of current wages.

At the close of the year 1884, 125,000 miles of railroad * were in

* These figures are quoted as the nearest estimates obtainable from the best authorities.

operation in the United States and 9,949 in Canada; the estimated gross earnings of which were, in round numbers: United States, $770,684,908; Canada, $33,421,767; and the net profits: United States, $268,064,496; Canada, $7,826,872. The year's freight traffic over those lines was: United States, 390,074,749 tons; Canada, 13,716,462; while the passengers carried a mile were estimated at: United States, 8,778,581,061. In Canada it is not given; but the total number of passengers carried was 9,984,354, against 334,570,766 in the United States. The business transacted over the lines was handled by an estimated force of 1,600,000 employés,* whose combined earnings, while unobtainable with accuracy, must have been enormous. Considering the magnitude of the interests involved—not only the value of the property operated, but the vast number of human beings who freely intrust their lives to the railroads—and the growing demand for increased speed in transportation, it needs little illustration to show that their responsibilities as common carriers are such as make it of paramount importance to their managements to secure and retain the services of the most experienced and reliable citizens obtainable; thereby obviating, as far as possible, the often fearful consequences of inexperience and negligence, and promoting public confidence by the knowledge that the lives and property of their patrons will not be subjected to unnecessary hazard. There are few employments in the country more onerous and exacting, and not any where negligence, inexperience, or absent-mindedness has more fatal consequences than those embraced in the operating departments of railways; hence the necessity of protecting themselves against the depressing influences to which most men, struggling against present or impending pecuniary difficulties, are susceptible, must be readily apparent.

In periods of activity such classes of labor are frequently overtasked, while in times of depressed trade their earnings are generally decreased by actual reduction of wages, or variable employment, to a bare subsistence. Then, when disability or old age overtakes them, few possess reserve earnings from which to draw for the necessaries of life.

In the report of the English Select Committee on Civil-Service Superannuation, it was stated that the dread of poverty had a very injurious effect on the minds and health of business-men, artisans, etc. The celebrated Dr. Farr, of England, when consulted upon the advantages of remuneration, partly by salaries and partly by provision for old age, thus sums up the evidence and arguments in favor of such an arrangement:

"In the first place, superannuation is a guarantee of fidelity; in the second place, it encourages efficient officers; in the third place, it retains good men in the service; in the fourth place, it induces men

* Estimate of United States Railroad Commissioner as to employés in the United States.

to retire when they become old or inefficient from any cause ; and, in the fifth place, it prevents old servants from falling into disgraceful dependence, or distressing destitution, which would be a public scandal, and would deter desirable persons from entering the service."

It is not always true, in the history of railroads or other corporations, that the one paying the highest wages is best served. The company that is most forward in caring for the general welfare of its employés, particularly in the matter of providing support for those disabled, aged, and of long service ; that holds all its officials to a rigid responsibility for arbitrary or tyrannical exercise of power ; that convinces its lowest servants that they will be protected against injustice, even at the hands of their highest official superiors—will soon obtain such prominence among the masses as will bring to its service the best material the market affords, though it give no more than—nor often quite so much as—others, who regard their employés only as so much material to be utilized or expended in the interests they serve.

The writer has for a considerable time studied the relationship existing between the managers and employés of many of our large corporations, and his observations seem to justify the conclusion that, whereas, in no other business employing large bodies of labor is there a wider field for cultivating cordiality and reciprocity of interests between owners and employés than in railroading, also in no other business (except, perhaps, mining) have such opportunities been more neglected. The admirable results he has observed following even a partial recognition of the equities between the executives and the rank and file of one or two railroads affords a glimpse of the great possibilities—easily made certainties by proper cultivation—of community of interests and aspirations between the two, that in unsettled times must prove invaluable.

It is unnecessary here to analyze the causes which produce the discontent and lack of unity between managers and employés, painful to observe, but too generally prevalent in this country, where the fascinations and the *esprit de corps* of railroading are so great as to give powerful support to any systematic and liberal efforts to reach a better understanding. One prominent origin of the lack of attachment to corporate interests here alluded to may be cited by way of parenthesis, namely, the system prevalent on most railways under which subordinate officials may discharge those under them without explanation or question. Where rigid accountability has been substituted for such irresponsibility the happiest results have uniformly followed, for thereby the lowest as well as the highest individual in the service became assured that, while he might be suspended for a short time by the exercise of arbitrary authority, a full hearing and exact justice would ultimately be had from an unprejudiced tribunal ; while such supervision over those vested with limited authority naturally made them careful and discreet in exercising it. By uniform and consistent dealing with misdemeanors, not only is discipline preserved, but the culprits and all others concerned are made to understand that justice *only* will be administered, while harsh criticism and complaints of injustice receive no sympathy ; the standard of service is elevated and its efficiency increased ; and all fear of personally incurring the displeasure of superior officials, and the consequent currying of favor—generally to the company's disadvantage—are obviated.

Railroad companies not only need men sound in body, but in this country they frequently need the moral and political support of their employés. This, a mere wage *quid pro quo* will never develop. Why not, in addition, identify the interests of their employés with their own, either by that most potent of all bonds, pecuniary advantage, or otherwise engender personal devotion to those officials who are responsible for the conduct of the service?

As a rule the operatives of railroads reside in those counties and districts in which they work, and are more or less influential political factors. With us majorities rule, and as employés necessarily outnumber their employers, who are constantly compelled to seek concessions from political bodies, therefore, for their own welfare and safety, the latter should pursue such a policy as will enable them to count upon the support and friendship of their masters.

Mr. Charles Francis Adams, Jr., some years ago published in "The Nation" a communication from a correspondent who concluded some suggestions on promoting identity of interests between railroad managers and operatives with the following language : "The railroad man who makes suggestions of this character from the Western end of the line renders himself liable to have his ideas ranked as 'Utopian,' 'visionary,' etc. I have, however, been through the mill, and believe that a little attention to these matters would give our owners a more zealous and earnest service ; would foster and preserve a higher *esprit de corps ;* would develop a strong attachment to the line and its owners ; would remove the possibility of strikes and riots ; and would lead to the securing of a better grade of men, which means increased efficiency and increased net earnings ; and all this can be secured at small cost and with little trouble to the local management."

That such views are not "Utopian" is proved by the fact that many of the principal English and Continental railway companies have on various occasions, and with considerable expenditure of time and money, inaugurated for their employés (and devoted large sums to sustaining) benevolent societies for promoting one or more of the objects the writer quoted outlined. Such action by financiers and railroad directors, whose keen business perceptions, stimulated by close competition, are not apt to be misdirected or clouded by philanthropical or sentimental ideas, shows how important they regard the cultivation of bonds of sympathy and fellowship with their armies of operatives—

susceptible as they are of an organization and discipline as perfect and efficient as distinguished the greatest armies of history.

If further proof of the utility of such action is desired, it can be had by observing the result attained by one of our Eastern trunk lines —the management of which has made itself prominent in organizing for its employés protection against financial distress resulting from sickness, accidents, old age, and other vicissitudes of life and death —which will be noticed further on—as also in the fact that such measures have actually and uniformly been found to compensate for material differences in wages ; to put the service offering them at a premium, and ultimately to secure it the best and steadiest men at relatively insignificant outlay.

But it has often been asserted that corporations, no more than individuals, should enter into the philanthropy business, and that railroad companies are not more than other employers interested in the personal welfare of their people. Such assertions convict their authors of ignorance of social science and lack of forethought unpardonable in this advanced age in those intrusted with the overshadowing interests of our great American railways. In defense of such assertions it is alleged that individuals and classes of men are in the market representing labor, and other individuals or combinations of men representing capital are likewise in the market ; that the one is perfectly justifiable in purchasing the other at its market value, and, when capital ceases to be able to pay the market value of labor, the other will naturally seek other purchasers, and that there the claims of one upon the other cease ; that as labor is never held bound to maintain its connection with capital to the laborer's disadvantage, so, when labor ceases to make profit for capital, the latter must be allowed to exercise the same right to sever their associations.

While as a broad proposition this must be admitted to be true, railroads are, more than most other employers, interested in the prosperity of their employés, and, like all other corporations whose work is dangerous, are partly answerable for the misfortunes of their employés, and peculiarly interested in providing means for lessening liabilities to accident, and in relieving the suffering and hardships caused by injuries received in their service. In partial recognition of this principle, many individuals and corporations employing small bodies of labor continue the pay of their men when sick, but where large masses are to be dealt with such a course would entail an expenditure beyond all reason. As an illustration of this, on one of our Eastern trunk lines, the employés of which number something over twenty thousand (and several of its rivals have more than double this force), the sick and disabled from all causes have, within the writer's knowledge, numbered continuously more than six hundred per annum for at least four consecutive years. Increased remuneration for labor will not alone solve the problem under discussion, for railroad men are proverbially improvident as a class, and under certain conditions increased payment means only greater extravagance. Therefore, a wise policy, if not higher considerations than those of self-interest, should prompt the managements of large corporations to provide, even at considerable expense or financial risk, not only for the protection of their employés from, or indemnity for the effects of, injuries, but also for their physical, mental, and moral improvement, so as to render them contented, zealous, and forbearing.

An admirable illustration of this fact is found in an inspection of the cotton-spinning factories of Windisch, near Zürich, the most extensive of this character on the Continent. Educated in England in all the technicalities and ramifications of his business, its present head, Mr. Hans Wonderly, has evidently imbibed and has put into practice many of the most advanced ideas respecting community of interests between employer and employé there prevalent. On the way to the mills one passes the hospital built by the firm, a pretty building healthily situated on a hill-side, near a sharp bend in the river Reuss, surrounded by flower-gardens and containing accommodations for thirty beds. At present it serves as a dispensary in which the district doctor dispenses medicines and advice at the expense of the firm. This firm provides neat cottages for over one hundred families of its workmen, conveniently located at short distances from their factories. Though it employs over a thousand operatives, and though it rents these cottages for only four pounds per annum, more than one half of its employés own their own houses, the surroundings of which are marvelous in beauty and neatness. The work-people remain in the firm's employ from generation to generation, and great kindness is shown their disabled and superannuated. Though at times embarrassment is experienced in providing employment for all who look with natural dependence upon it, this firm uniformly maintains its fatherly protection over all permanent employés. All its overlookers are trained on the spot, and the principle of giving its high positions to its own deserving people, which is strictly enforced, encourages aspiring young men to look for promotion at home rather than elsewhere. Thus a feeling of clannishness has been established which has kept its work-people united and satisfied, when at neighboring places all sorts of disputes and agitations have been in progress, and a strike has never occurred at any of its factories. This exemption from all labor troubles is attributed by the firm not alone to good management and satisfactory wages, but mainly to the great consideration and forbearance shown by the work-people themselves in times of financial depression. Time-breaking through drunkenness is unheard of in these factories. Well-organized schools for the young people are operated under the auspices of the firm, and there are also excellent night-schools wherein subjects interesting or advantageous to the operatives are taught free by instruction and lectures. The operatives are supplied with food, clothing, and other necessaries, and with luxuries, through excellently organized co-operative stores, and a savings-bank and building association are also in operation under guarantee of the firm. The work-people are reported to be remarkably cleanly and well dressed, and to show in a high degree the effects of comfort and civilization, which, considering that, as compared with the English and American standards, their incomes are very small, is gratifying evidence of the beneficial effects of such a system (*vide* vol. i, "Second Report of the Royal Commissioners on Technical Education").

Another exemplification of the practical wisdom of what would by some be classed as Utopian ideas can to-day be found nearer home in the town of Pullman, near Chicago, where proper provision for the comfort and welfare of the *attachés* of the great works there located has secured for this manufacturing company the most skillful workmen in their respective departments probably to be found in the country; that without any marked increase of current wages has made a most satisfactory return for invested capital, and built up a town surrounded with influences that refine and elevate the minds and character, and permanently benefit alike the company and its workmen. Abundant evidence is furnished by manufacturing and other corporations abroad that paternal care and solicitude for their operatives are not thrown away, but tend in no small degree to establish good feeling and community of interest, and that, instead of conflicting with the cold calculations of business economy, such care is in reality the prompting of self-interest best understood. While railroads nor other corporations employing large masses of labor can withhold their employés altogether from improvidence and recklessness, from the consequences of which the employer must generally suffer, they can, by means kindred to those above suggested, compel their people to provide for their future welfare, and in other ways elevate their standard of efficiency; and neither the lukewarmness nor opposition of the servant releases the employer from an obvious duty to himself, his ward, and the public. Railroad corps especially are, like armies, amenable to rigid discipline judiciously applied, and where the necessity for self-protection is so obvious the justice of the employer inaugurating and *enforcing* measures promotive of their mutual interests will always be early recognized, and opposition will be sporadic and short-lived. Arguments and statements illustrative of the great necessity for the employer securing a closer affiliation, if not copartnership, between his interests and those of his employés through other and additional means than are now operating among our American railways, manufactories, etc., might be multiplied *ad nauseam;* but, on the assumption that the foregoing, if not within itself convincing, will at least suggest what will be conclusive upon this point, let us consider the manner in which substantial gain may be effected at least cost and with less risk to capital, premising the discussion with a few remarks as to some of the troubles that are constantly arising under current methods :

By the laws of many of our States, railroads are held legally liable for physical damage to their employés, though resulting from causes beyond the reasonable control of executive management ; and the disbursements of those railroads whose lines traverse States in which public sentiment or the laws are at all hostile, on account of donations, judgments, costs, etc., for injuries to employés, form heavy and ever-increasing items in their operating expenses. In England a workman (in railroad or other hazardous service), when injured, or his legal personal representative in case the injury results in death, has the same right of compensation and remedies against the employer as if he had not been a workman, nor engaged in the service of the employer, though there the law is carefully discriminating, and is effective only when the injury is caused :

1. By reason of any defect in the condition of the ways, works, machinery, or plant connected with or used in the business of the employer ; or

2. By reason of the negligence of any person in the service of the employer who has any superintendence intrusted to him while in the exercise of such superintendence ; or

3. By reason of the negligence of any person in the service of the employer to whose orders or directions the workman at the time of the injury was bound to conform, and did conform, where such injury resulted from his having so conformed ; or

4. By reason of the act or omission of any person in the service of the employer done or made in obedience to the rules or by-laws of the employer, or in obedience to particular instructions given by any person delegated with the authority of the employer in that behalf ; or

5. By reason of the negligence of any person in the service of the employer who has the charge or control of any signal, points, locomotive-engine, or train upon a railway.

The workman has not the right of compensation nor any remedy against the employer :

1. Unless the defect causing the accident arose from, or had not been discovered or remedied owing to, the negligence of the employer, or of some person in the service of the employer, and intrusted by him with the duty of seeing that the ways, works, machinery, or plant were in proper condition.

2. Unless the injury resulted from some impropriety or defect in the rules, by-laws, or instructions of the employer.

3. In no case where the workman knew of the defect or negligence which caused his injury, and failed within a reasonable time to give or cause to be given information thereof to the employer or some person superior to himself, in the service of the employer, unless he was

aware that the employer or such superior already knew of the said defect or negligence.

The amount of compensation recoverable under this act may not exceed such sum as may be found to be equivalent to the estimated earnings, during the three years preceding the injury, of a person in the same grade employed during those years in the like employment and in the district in which the workman is employed at the time of the injury; but under our various State laws, when interpreted by juries, the measure of damages is usually severely onerous, if the employer be a railroad corporation, and, even when such cases are appealed to higher judicial tribunals, the tax costs are very heavy. In Germany, railroads—whether owned or controlled by the Government, or owned and managed by corporations—are not only legally compelled to assess their employés for the benefit of authorized relief funds, but are required to contribute thereto from their corporate funds—generally in amounts equaling the premiums collected from their members; and conformity to this regulation is invariably required in all the working departments of the roads.

In Great Britain, it has become quite general for employers to seek release from personal liability, or from costs for damages or partial indemnity, by either subscribing to the several employés' liability insurance companies or by wide-spread attempts to evade their responsibilities under the law by inducing the workmen to contract themselves out of the act. Several other methods of securing release from liability have been devised, the most prominent of which, perhaps, is the length to which defendants go in the appeal courts.

The employés of most American railroads are incessantly confronted with petitions for charitable contributions in aid of their fellow-workmen and companions overtaken by misfortunes, which almost always involve others dependent upon them for the necessities and comforts of existence. Such appeals to people too generally living in the presence and under the dread of the embarrassments and evils incident to interrupted wages can seldom be ignored, though often their alms frequently materially encroach upon the previously mortgaged incomes of men engaged in pursuits than which few are more exacting, and that taxed their abilities and time to such an extent as precluded the possibility of supplementing through extra labor wages reduced by competition to barely living rates. The higher officials of the company are constantly importuned in the same direction, and the contributions they feel constrained to make sometimes reach considerable sums. The recipients of such charity naturally experience a sense of humiliation; their self-respect is lowered, and upon recovery from sickness or injuries they too frequently resume their occupations handicapped by the discontent and restlessness of debtors, to whom such condition is too novel and harassing to be borne with equanimity. From this results constant anxiety to better their condition, and it prepares them for any and all alliances or changes that promise increased wages, and makes them easy dupes of the designing and turbulent.

One result of the indifference of railroad managements toward their subordinates has been to array against them agencies most potent in fermenting discontent—secret societies, brotherhoods, and similar organizations ; for it is a notorious fact that these mainly owe their success and strength to the assistance and relief they hold out to their members and their families in sickness, disablement, and death. Thrown upon his own resources, the man who has constantly before him the perils of his vocation and the misfortunes that would result from inability to earn wages, naturally enrolls himself in any organization that promises the needed protection. Constantly confronted with the history and with comparisons of the grievances of his fellow-members, and without motive or cause for attachment to his employers ; perhaps, unconsciously, feelings of discontent and ill-will arise, and naturally he meets any reduction of wages or suspension from labor with outraged feeling, and often with violent actions born of long though secret hostility, where there should have been but fraternity and good-fellowship of affiliated interests. That this is no sentimental picture, many of the actors of the great labor-strike of 1877 testify. On more than one line was the statement afterward repeatedly made by railroad men, that had it not been for the protection from want afforded by the Locomotive Brotherhood and other kindred organizations, whose influence in antagonism to capital was so potently felt in that struggle, and which protection they had repeatedly besought their officers to inaugurate for them, they would never have joined or been influenced by those organizations.

To recapitulate the many serious disadvantages and losses, direct and indirect, suffered by our railroads through strained relations with their employés, though recognized and felt with anxious solicitude by their executive and administrative officers, would little interest the general public ; nor, indeed, as a rule are railroad investors apt to give serious attention to what they consider matters of administrative detail beneath their notice, until, at last, they force themselves into prominence by threatening their profits or speculations. But the unparalleled rapidity with which railway, mining, and manufacturing industries dependent thereupon have sprung into existence in America in the last three decades, calling for an ever-increasing supply of labor skilled in the manipulation of coals and metals, and their products, has had the effect of directing the attention not only of those immediately or by contiguity interested, but also of the general public, to all that pertains to the welfare of workers in that field. While labor agitations and strikes do not now, perhaps, exercise graver influences for good or ill over those pecuniarily interested than they have always done, the publicity given to such movements by a press eager for news and exciting incidents, and the avidity with which political manipulators seize upon opportunities afforded by the agitation of bodies of men, wisely or unwisely, eager to secure material advantages through any immediately effective agency, unitedly operate in bringing into prominence those accidents and losses of life and property inseparably connected with mining and railroading. In the United States the operatives of railroads have, as already stated, been too generally left to their own resources, though now public opinion is gradually forcing upon employer and employé a recognition of the duty of securing both the laborer and his dependents from the consequences incident to his occupations. Where humanitarian considerations are not governing, those of self-interest are more potential, and the increasing frequency of successful suits for damages on the one hand, and on the other the constantly accumulating difficulties of earning a livelihood without steady, uninterrupted occupation incident to increasing population, are unitedly forcing this question to the front.

Recurring to the inquiry, by what means within reach substantial improvement can be effected in the condition of railroad servants at least cost, and with a minimum risk to capital and a maximum of devotion to the service, we have seen, by means of an illustration, by what simple and inexpensive means partnerships, almost ideal, have been effected by private enterprise in Europe, and such illustrations might be multiplied indefinitely.

Further study of the methods of foreign railroads in dealing with this subject will show that their efforts (which must be successful, for labor disturbances are very exceptional abroad) have almost uniformly taken the form of benevolent societies, organized, or contributed to and fostered, by the railway managements.

The practical utility of such organizations has there been exemplified for many years. In their various forms (when established under the auspices of responsible authority) they meet many of the necessities of the railroad employé: they provide means for avoiding insurance organizations unworthy of confidence; lessen the risk of insolvency and loss of premiums paid; offer convenience, certainty, and regularity in making payments, and give a fixed and definite rate of assessment and compensation, in place of the uncertainties of coöperative associations, lodges, or brotherhoods, in which many members, though taxable on the death of a fellow-member, evade or refuse to respond to assessment.

Among such associations may be instanced the London and Northwestern Railway Insurance Society and Superannuation Savings-Bank; the Friendly or Providence Society and Mutual Guarantee Fund; the Great Northern Railway Benevolent Institution; the Great Western Railway Superannuation Society — all of England; the benevolent institutions of the Chemins de Fer du Midi of France; and a host of other Continental societies, all having for their objects the succor of railroad employés and their families in sickness or grave infirmities, or wounds entailing incapacity for work, old age, death, and the promotion of culture and habits of thrift and industry. Many of these societies reach further than mere relief, and provide for the moral and intellectual training and entertainment of their members and their children ; aid them in acquiring and embellishing properties, and exercising a controlling influence in the councils of the nation in all matters of legislation affecting the working-men ; they have elevated their members' conditions from servitude and poverty to independence and prosperity, and in other ways have exercised a paternal care and supervision over their interests. Early recognizing in such societies an agency potent to improve alike the secular estate and the moral, physical, and intellectual condition of their employés, and also understanding that easy circumstances and contentment develop increased usefulness in all walks of life—in none more so than in railroad service—the English railways, by liberal and judicious encouragement of such enterprises, have practically relieved themselves from many onerous burdens under which nearly all our companies are still suffering.

[*To be continued.*]

THE PRESENT ASPECT OF MEDICAL EDUCATION.

By WILLIAM GILMAN THOMPSON, M. D.

THERE is no branch of education which attracts so little public interest and support as proper medical instruction, yet no one would gainsay the necessity that, if there are to be physicians at all, the community should be guaranteed that they have been most thoroughly trained.

It is not so very long since an air of mystery, which no laymen would attempt to penetrate, enveloped the art of medicine. It required generations to separate medical practice from alchemy, astrology, and the search for the elixir of life. The traditions and influence of Hippocrates and of Sydenham lasted well into the past century, and down to 1750 almost all of the scanty medical literature was in Latin, and the gradually accumulating facts of observation were still too little systemized to be weaned from an admixture of the most unreasonable speculation and pseudo-philosophic discussion. As late as 1784 the condition of medical education in the United States was most rudimentary, and for some time thereafter dissections of the human body could only be made by stealth.* The functions of physician, nurse, apothecary,† and often, too, of pastor, farmer, dentist, and

* See McMaster's "History of the People of the United States," vol. i, pp. 27–31.

† "Life of Dr. John Warren," p. 314.

veterinary surgeon, were frequently combined in one person in the early part of the present century.

What a contrast appears to-day! Popular medicine and hygiene are becoming everywhere the fashion. Public sentiment and action are aroused in regard to all manner of sanitary and curative measures. When men of distinction are ill, the conditions of their pulse, temperature, and respirations are telegraphed all over the civilized world, to be read at the breakfast-table in the morning newspaper. Their medicines and their doses are minutely described; diagrams of the course of a bullet, or startling pictures of microscopic sections of tumors, or views of cholera-germs, appear in our daily papers; and in the most popular family magazines we read articles upon the "anatomy of the brain," or "how to trap a soil-pipe." We have a mother's magazine devoted to improvements in baby-feeding and the scientific development of the infant mind. The book-stores abound in popular works upon every medical topic, from the subject of singers' sore throats to the treatment of sea-sickness, consumption, or the opium-habit. A great deal of all this, especially the newspaper medicine, is fostered by a maudlin craving for every detail of that which is exciting or horrible. It is to cater to the same kind of feeling that newspapers describe how many lumps of sugar a condemned murderer took in his coffee on the morning of his hanging. The germ-theory, too, has given a great impetus to popular medicine.

The germ appeals to the average mind: it is something tangible; it may be hunted down, captured, colored, and looked at through a microscope, and then, in all its varieties, it can be held directly responsible for so much damage. There is scarcely a farmer in the country who has not read of the germ-theory. A cow-boy in Arizona was shot dead in the saddle recently by a comrade for the insult implied by calling him a "d——d microbe"!

Still, a great deal of this popular medical talk and instruction is the outcome of an earnest desire to learn to alleviate the growing evils of heredity and environment, especially in overcrowded cities. The importance of a universal knowledge of, and attention to, the laws of physiology and hygiene is becoming more and more appreciated,* and the elements of these subjects are taught in the public and private schools. The mental training to be acquired through the observation of biological and physiological facts is recognized as being of the greatest importance, and laboratory courses of instruction in these studies are already introduced in many of our colleges and universities side by side with the classics. There is a wide-spread popular interest in the thorough training of nurses for the sick, and in such practical and beneficial work as the establishment of diet-kitchens for the sick poor, and sanitary reforms of all kinds. We have "Sanitary Protective Leagues" and "Sanitary Aid Societies," composed princi-

* See Spencer on "Education," chap. i, p. 76, "What Knowledge is most worth."

pally of laymen, and instruction in "First Aid to the Injured" is given to policemen, firemen, and enthusiastic young ladies! Very many laymen also interest themselves most liberally in the establishment and management of hospitals and dispensaries.

All these activities, directed toward improving the public health and alleviating sickness and suffering, are most gratifying and commendable, and call for increasing thoroughness in methods of educating physicians, for, without the co-operation of the public with scientific men who devote their lives to the study of these subjects, much benevolent energy as well as time and expense are wasted or misapplied. Is it not clearly of vital moment that the public for its own protection should see to it, by legislation or other means, that the medical schools of this country are of the highest order? A dozen well-trained and properly qualified physicians will be of vastly more benefit anywhere than a hundred "M. D.'s" who have slipped through some of our so-called medical "colleges" in the easy manner that is still quite possible. It is disgraceful, and yet it happens constantly, that men are graduated by prominent medical schools or colleges in this country without ever having listened to an abnormal heart-sound, seen a case of measles, or been present at a confinement. "But," it is asked, "why should the general public take any interest in medical education? Why not let doctors manage their own 'shops,' as they always have done, unaided by public support?"

The answer is that, so long as a medical college is dependent entirely upon the fees of its students for support, the highest educational good can not be attained. The question concerns endowment. A review of a few facts and statistics will demonstrate this need.

The medical profession in the United States, like many branches of industry, is at present suffering severely from over-repletion. There are more doctors, in proportion to the population, than in any other country in the world. The laws of supply and demand tend to lead many men toward those schools where they can soonest secure their diplomas with least expenditure of time and money (and too often of energy). The schools become overcrowded, and new ones spring up with alarming rapidity. A century ago, with a population of 3,000,000, there were two medical schools. To-day, with a population of 50,000,000, we have eighty-seven medical schools,* distributed through twenty-eight States and the District of Columbia. Of these schools, thirty-nine have been opened within fifteen years, and twenty-one (or about twenty-six per cent) within five years past. With them are associated over 1,300 instructors (many of whom offer their services gratuitously) and over 10,000 students, while about 3,600 new doctors are annually "turned loose upon the community," as the daily press courteously expresses it. Forty-six per cent of the schools offer only a two-years

* The writer would be understood as referring only to "regular" schools in this article; there are very many others.

course of instruction, three of them offer a four-years course, and the remainder offer, although only few *require*, a three-years course. The inaugurators of the reform of prolonging the course of study were the Chicago Medical College and the schools at Harvard and the University of Pennsylvania. At but few schools is the instruction graded for different years, and students are usually compelled to pay for hearing twice over the same course of lectures in two years. This, with a little dissection, a thesis, and examinations upon the lectures, is frequently all that is required of them before receiving a diploma. Almost all practical work is optional, and, instead of each student being obliged to secure a hospital experience, he is lucky if he obtains an appointment as *interne* after an additional competitive examination for which he has crammed himself full during months of toil over text-books and lecture-notes.

The better class of students feel the inefficiency of this system and so far as possible supplement it by attending small "quiz classes" for recitations and practical work, which are, however, entirely independent of the colleges, and are in no sense obligatory. The success of these small voluntary classes (often conducted by men who are without any official connection with the colleges) in drawing students, who thus incur considerable additional expense, is in itself a severe commentary upon the poverty of the colleges which restricts them from making their own advantages all that they should be.

Such is the system in vogue to-day at a large number of our medical colleges. There are, fortunately, a few where a much higher standard is not only encouraged but required. No wonder that our students, immediately after graduating, go by the hundred to Paris, Berlin, Vienna, etc., where the Government encourages professional schools, laboratories, and scientific bureaus by substantial support and thorough system. They go abroad, partly because it is the fashion, and gives them a sort of advertisement as having done the proper thing, and partly to learn a new and useful language, and study foreign methods of life. But the fundamental reason of their going is that, instead of sitting in a huge lecture-hall with two or three hundred other men, to take notes *verbatim* of a lecture which often might be read in a text-book at home, they can join small classes in which they practically demonstrate every fact for themselves, under the guidance of an instructor.

Lectures have their value, certainly, but it is a relative value which is greatly enhanced by practical teaching. A gigantic picture of a sore throat, hung on the wall of a lecture-hall, is after all far less instructive for a student than looking into the real throat, telling what he sees there, and then looking again, while what he at first omitted is pointed out to him.

There are many demonstrations which can be better made, and many theories which can be more conveniently discussed, in a lecture ;

still, it is well to bring a student face to face with at least one patient before intrusting him with a diploma and license to practice at large.

But practical work, at its commencement at least, means increased expense. There must be separate and well-appointed laboratories for chemical, physiological, anatomical, and pathological research, rooms for photography, germ-culture, delicate electrical apparatus, for hygienic and therapeutic demonstrations, for libraries, and for the reception and treatment of many classes of patients at clinics. Moreover, assistant instructors and demonstrators are needed, in order that each student may receive a fair share of personal attention. (At present the classes are so large that candidates for graduation are often unknown by sight even to a majority of their instructors.)

Suppose for a moment that the professors of a medical college put their hands in their own pockets and provide these improvements, as they have already done in some instances to a limited extent. Many students will leave for cheaper and easier colleges, and the fees are likely to fall off so much that professorships having no endowments to rely upon must be abandoned. Thus the lack of endowment is a virtual check upon all growth. Division of labor with a new assistant instructor means division of personal income with him. The expense of maintaining a new laboratory means a further reduction of the professor's income. As Dr. O. W. Holmes wittily says, "A school which depends for its existence on the number of its students, can not be expected to commit suicide in order to satisfy an ideal demand for perfection." * General Eaton (to whose admirable report on medical education † the writer is indebted for many of the statistics of this article) strongly advises that every medical school or college be required by law to procure forthwith an endowment of not less than $300,000.

Strangely enough, in some instances the professors themselves object to the endowment of their chairs, because they fear a sacrifice of their independent methods, or because it seems impossible to secure endowments which would yield as fair incomes as they at present derive from the students' fees. But there is no reason why the students should not continue to pay as they do now, and a certain amount of endowment, required by law, would prevent half a dozen men from forming a new medical college without proper laboratories, apparatus, or facilities of any kind. The experience of the past ten years proves this danger to be a real and increasing one.

The professorships and laboratories once endowed, the professors can be trusted to elevate the standard of medical education very rapidly throughout the country. But there should also be separate State or National Boards of Examiners who alone should have the power of granting licenses to practice medicine, based upon proofs of prac-

* "Boston Medical and Surgical Journal," January 19, 1882.

† "Report of the Commissioner of Education," 1882–'83, clxiii–clxxxiv, 660–672.

tical laboratory and hospital work, and upon the diplomas of only first-class colleges, which latter should be raised to a uniform high standard of merit. Applicants for licenses should be examined, not as to what theories they hold, to what "pathy" they conform, or what text-books and lectures they have crammed, but as to what evidence they can give of personal examination of the human body and personal observation of its ailments and witness of the influence of remedies.* Laymen can render great assistance in these matters (and the gain is ultimately their own) by furthering appropriate legislation, frowning upon quackery and cheap diplomas, as well as by co-operating with the medical colleges in offering freely the use for clinical instruction of all the hospitals and dispensaries which the public support and control. Most valuable opportunities for clinical observation are at present needlessly wasted through lack of this system. To-day the value of income-bearing funds of the eighty-seven medical colleges does not exceed $350,000, which yield an annual income of only about $20,000. It is instructive to contrast with this statement the fact that the one hundred and forty-five theological schools and colleges of the United States have a productive property of $9,500,000, and an annual income therefrom of nearly $600,000!

Of our eighty-seven medical schools, forty-two are associated with general colleges or "universities," but the connection is usually merely nominal, and no means of support are derived from the parent college. The precarious footing upon which many of these institutions stand is to be inferred from the fact that no fewer than fifty-one other medical colleges founded in the United States within a century have collapsed and vanished.†

It is a grave misfortune to have so many medical colleges as now exist, for it is a farce to attempt to educate medical students away from the hospitals and dispensaries which only the largest cities furnish in abundance. The tendency to-day in all branches of education—from the Fröbel Kindergarten system to the study of engineering—is more and more toward placing practical work and personal observation before tradition and theoretical instruction. Surely medical education must not be left behind in facilities.

There are many encouraging signs of speedy improvement in this matter. There is a growing dissatisfaction with the old system. The percentage of medical students who are graduates in letters or science is constantly increasing. At present they number nine per cent, and they have frequently had the advantage of a year or two of biological, physiological, and chemical practice before entering the professional school. The number of such students at the Medical College of the University of Pennsylvania has doubled in the past six years. The

* The State Board of Health of Illinois is a praiseworthy pioneer in this field.

† "Conspectus of the Medical Colleges of America," 1884, 1885. Illinois State Board of Health.

number of medical schools which require some sort of preliminary examination for admission is also increasing. A great deal is expected of the Johns Hopkins Hospital and Medical College (which are handsomely endowed) when they shall be in operation. Several chairs have been endowed in the Medical College of the University of Pennsylvania. Mr. Vanderbilt's recent magnificent gift was for a lot and building and not for endowment, but the donor set the excellent example of aiding an already tried institution instead of launching a new one among the many which are at present struggling to float. The work accomplished in the past ten years by physicians themselves through their various societies and organizations in exposing quackery, injurious patent medicines, malpractice, and bargaining in diplomas for which no study has ever been expended, has revealed and corrected an enormous amount of abuse and crime, notwithstanding the very tardy legal and popular support which has attended these efforts. Our great need is a little more system and concentration of energy, or a diversion of some of the wide-spread public interest in general medical topics toward securing and demanding the most thorough medical education for every one who seeks to become a physician. This will be of incalculable service to the entire country; and endowments, whether by State legislation or private bequests and subscriptions, combined with State or national supervision of licenses to practice, will so far advance the thoroughness of work at home by making it independent of large or small classes of students, that we may hope before long to invite foreign students to learn from us how to take the lead in medical education.

INSECT FERTILIZATION OF FLOWERS.*

By Dr. W. J. BEHRENS.

OF insects the Coleoptera, the Lepidoptera, the Diptera, and the Hymenoptera are the orders most concerned in the fertilization of flowers. More rarely, fertilization is effected by one or other species of Hemiptera, Neuroptera, and Orthoptera, but these are not of sufficient importance to demand further attention here. We shall therefore confine our remarks to the orders constituting the former group, and consider the various physical peculiarities by which insects belonging to them are enabled to effect the end in question. Such peculiarities chiefly take the form of *special structures* (invariably confined to the head), *by means of which the insects are enabled to reach and abstract the honey* contained in the flower. We shall also have to consider the *organs concerned in the transport of the pollen.*

* From "Text-Book of General Botany," by Dr. W. J. Behrens, of Göttingen. Translation from the second German edition. Revised by Patrick Geddes, F. R. S. E. Edinburgh: Young J. Pentland, 1885.

The order Lepidoptera comprises many species of great importance in effecting the process of fertilization. Their large wings are well adapted for rapid flight from flower to flower, and their long proboscis enables them to reach the honey even when the nectary lies at the bottom of a very long and narrow corolla-tube.

The position assumed by the butterflies when engaged in abstracting the honey deserves notice. The wings, which during flight flutter to and fro with a rapid motion, are folded together perpendicularly over the body, in which position they are maintained so long as the insect remains poised on the flower (Fig. 1). The butterfly is thus enabled more readily to escape detection by its many enemies (e. g., birds) than if, when resting, its brilliant wings were outspread. The under surface of the wings is usually of a much less striking color than the upper, and consequently does not prove so attractive. It even happens in many instances that butterflies only visit such flowers as are of the same color as their own wings, this precaution, of course, rendering detection extremely difficult. Many blue butterflies show a marked preference for blue meadow-flowers, while in the Alps the scarlet lilies and many of the orange-colored *Compositæ* are visited almost exclusively by butterflies of like hue. The moths, while extracting honey, do not assume a position similar to that of the butterflies, but hover over the flowers, their wings rapidly vibrating meanwhile.

Fig. 1.—A Butterfly (*Hipparchia Janira*) at rest on a cluster of flowers; natural size.

The butterflies are excellent honey-hunters, because, as already said, their proboscis is very highly developed. It arises from the head midway between the eyes (A, Fig. 2), and frequently exceeds the entire body of the insect in length. When not in use, it is kept coiled up like a watch-spring (I, II), but can be uncoiled at will, and thrust deep down into the nectary of a flower. The proboscis is hollow, and the honey is sucked up by the extreme tip.

In the butterfly the proboscis is the only part of the mouth that is fully developed. In many insects the mouth is very complicated in structure ; but in the butterfly a number of the parts are almost entirely suppressed. The *labial palpi* (I, II, III), however, are usually pretty well marked. They are long and narrow, and are densely covered with hairs. To these hairs the pollen adheres, while the butterfly is engaged in sucking the honey, and by them it is carried to the stigma of the next flower the insect enters.

The proboscis is usually from three to seven centimetres long, but in many tropical moths it attains a length of over twenty centimetres. It is by the great length of their proboscis that many butterflies are enabled to suck the honey from flowers having very long and narrow corolla-tubes, where it would be quite inaccessible to other insects. We need scarcely say that this feature is a great advantage to the butterfly order, for it means that they have the monopoly of the honey of flowers with a long, tubular corolla. The honeysuckle (*Lonicera Periclymenum*, see Fig. 3) is a good native example of a flower with a tubular corolla, in which the nectary, *a*, is so situated as to be beyond the reach of the various bees and butterflies with short proboscides, likely to be attracted by it in the daytime. In this case the honey is entirely reserved for one of the evening moths (*Sphinx ligustri*) which possess a proboscis of almost exactly the same length as the corolla of the flower—i. e., about forty millimetres. Attracted by their fragrance, the insect will hover over a cluster of flowers for a time. Finally selecting one, it uncoils its long proboscis, thrusts it deep into the innermost recesses of the corolla, and, at its leisure, sucks the sweets denied to less fortunate members of its kind.

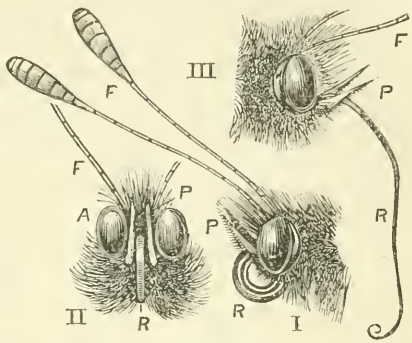

FIG. 2.—HEAD OF PIERIS RAPÆ (cabbage-butterfly), four times enlarged. I, side view, showing the proboscis coiled up. II, front view of the same. III. side view, showing proboscis uncoiled. *R*, proboscis; *P*, labial palpi; *A*, eyes; *F*, antennæ.

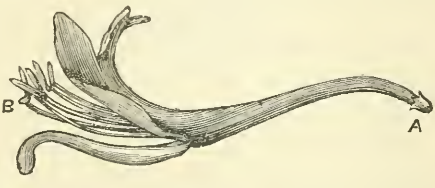

FIG. 3.—FLOWER OF HONEYSUCKLE (*Lonicera periclymenum*), frequented by privet hawk-moth (*Sphinx ligustri*), natural size. *A*, nectary; *B*, entrance to the throat of the corolla.

As fertilizers the beetles are not so important as the butterflies and moths. Only a small proportion pay regular visits to flowers, the greater number deriving their food from quite other sources. Many species which do frequent flowers only effect injury, devouring, as they do, some of their most important organs—e. g., the stamens or the ovary. Others, however, and especially those whose small size admits of their creeping into the interior of the flower, frequently promote cross-fertilization, the viscid pollen adhering to the general surface of their body, from which it is brushed off by the stigma of the next flower they enter. Such flower-beetles as *Anthrenus*, *Meligethes*, *Malachias*, and certain smaller sorts, are extremely useful in this way.

In other species *certain parts of the body* are specially adapted for obtaining food from flowers. Thus, in the crown-beetle (*Cerocoma*

Schæfferi, Fig. 4, I, II), the middle of the antennæ are characterized by very strong and well-defined expansions, and are partly covered with hair. The palpi are very long, and the tongue is provided with two tufts of hair. These form together a large yellow crest on the anterior portion of the head (Fig. 4, II). In midsummer this beetle is occasionally to be met with on the flower of the milfoil and corn marigold. If one of these beetles be caught and examined with a lens, the crest is usually found to be covered with a multitude of little yellow pollen-grains.

Among the long-horned beetles the *Lepturidæ* are specially well adapted for procuring food from flowers. The anterior part of the

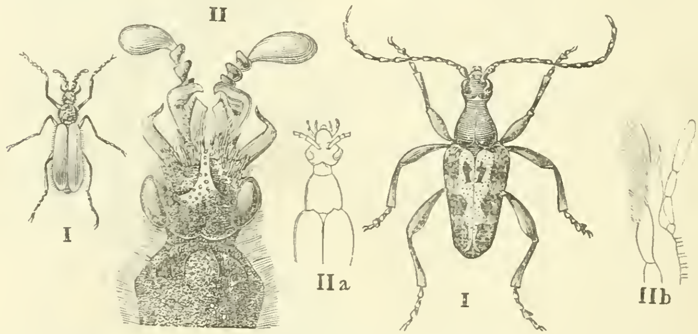

Fig. 4. Fig. 5

Fig. 4.—Crown Beetle (*Cerocoma Schæfferi*). I, beetle, natural size. II, head, ten times enlarged. Fig. 5.—Longicorn Beetles: I. *Pachyta octomaculata*, three times enlarged. II. *Leptura livida*: *a*, head, natural size; *b*, labium.

body (head and thorax) is narrow and elongated, so as to enable the insect to push its way pretty deeply into the interior of the flower. The mouth-parts are well developed, and stand straight forward from the head. The labium is usually hairy, and is thus extremely useful in extracting honey (Fig. 5, I, II).*

Compared with the beetles, Diptera or flies take a very prominent position as promoters of cross-fertilization. One great advantage which they have over the former class is their power of free and rapid motion. While the beetles are almost without exception compelled to adopt a slow mode of locomotion, the movements of the flies are among the most rapid known in the insect world. The number of native species of Diptera is very large; of those which frequent flowers we shall here consider but a few (Figs. 6–10). One of the largest and most rapid flying of the Diptera is the humble-bee fly (*Bombylius major*, Fig. 6). In this species the proboscis, which is situated on the anterior portion of the head, is of considerable length, so that the insect can reach the honey even when it is secreted some way down the

* The rest of the *Lepturidæ* live for the most part in or on wood. In contrast to the species just described, the thorax is broad, the mouth situated toward the under side of the head, and the maxillæ either very slightly hairy or totally destitute of hairs.

corolla-tube. The manner in which *Bombylius* hovers over a flower while extracting the honey closely resembles that already described as characteristic of the moths among the Lepidoptera.

The *Empidæ* (Fig. 7) are easily distinguished by the peculiar formation of the head and proboscis. The latter is not directed forward, but almost perpendicularly downward, and the head itself is round; the whole thus bearing some resemblance to the long-beaked head of a crane. Many of the *Syrphidæ* are also honey-suckers. In structure they resemble the common house-fly more than the Diptera we have

Fig. 6. Fig. 7. Fig. 8.

Fig. 6.—Humble-bee Fly (*Bombylius major*), natural size. Fig. 7.—*Empis livida* (after Meigen), four times enlarged. Fig. 8.—*Syrphus*, natural size.

just considered. The posterior part of the body is mostly distinguished by a number of bright and dark colored bands and specks. As typical examples we may mention the large *Syrphus* (Fig. 8), the allied *Eristalis tenax* and *arbustorum* (Fig. 10), and the cone-fly (*Rhingia rostrata*, Fig. 9). The latter may easily be recognized by its peculiar proboscis, which is kept coiled up under a small conical projection on the anterior part of its head. The sucking apparatus of the Diptera consists of a suctorial proboscis, resembling in a general way that of the common house-fly. It is tubular, short and thickened at its extremity, so as to form a disk, upon which are furrows and hairs. It is by means of this disk that the honey is taken up. The proboscis of the Diptera being almost always short and blunt, they can only extract honey from such flowers as have an open corolla. Insects of this order, then, need only be sought for on flat flowers, and there indeed they may be seen on any sunny day, rapidly creeping about, and greedily imbibing the nectar. The *Umbelliferæ* are special favorites with them, the nectar being found on the disk in the center of the flower, which can very easily be reached. The Diptera are never found on flowers with long corolla-tubes. Only such forms as the humble-bee flies, *Syrphidæ*, *Empidæ*, and a few others, have a proboscis large enough to enable them to obtain honey from flowers of slightly tubular form. The proboscis of *Bombylius* (Fig. 11, I) is about one centimetre long. It is strong and stiff, cleft at the extremity, B, and thickly beset with

Fig. 9. Fig. 10.

Fig. 9.—Cone-fly (*Rhingia rostrata*), natural size. Fig. 10.—*Eristalis arbustorum*, natural size.

hairs. Certain other structures entering into the formation of the mouth (e. g., the lip, A, the mandible, D, and the maxillæ, C C) almost equal it in length. The cone-fly (*Rhingia rostrata*), in common with many other broad-headed flies, possesses the power of coiling up its proboscis, the length of which is about twelve millimetres (Fig. 11, II–IV). That anterior portion of the cone-fly's head (II) is prolonged forward so as to form a sort of beak (S). When not in use, the proboscis is kept coiled up beneath this prolongation. When required, the extremity of the proboscis (B III) is first inclined downward, and the organ is next suddenly shot out to its full length. When fully extended the proboscis projects far beyond the beak-like anterior portion of the head (IV). The extraction of the honey is effected by means of the cleft tip (B). The cleft extremity is used in sucking.

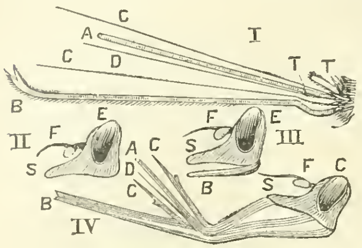

Fig. 11.—Structure of the Mouth of the Diptera. I, humble-bee fly; II–IV, cone-fly. II, side view of head, with the proboscis coiled; III, do., the proboscis beginning to uncoil; IV, do., completely uncoiled. *E*, eye; *F*. antennæ; *S*, beak; *T T*, palpi; *B*, extremity of proboscis; *A*, lip; *D*, mandible; *C C*, maxillæ.

We have already seen that many flowers are exclusively visited by Lepidoptera, their honey not being within the reach of insects belonging to any other order. Such, for instance, are honeysuckle and privet. Very few flowers, however, are frequented solely by Diptera; for the length of the proboscis, even in those Diptera in which it is best developed, is attained, if not surpassed, by many of the Hymenoptera (humble-bees, honey-bees, etc.). The latter class, therefore, share with the Diptera the privilege of frequenting certain species of flowers. We shall now pass on to consider them for a little.

Of all insects the Hymenoptera (*bees* and *wasps*) are, on account both of their physical structure and their peculiar instincts, the best adapted for the task of extracting and collecting honey from flowers. The species comprised in this order, and more especially the bees, are all characterized by a superior share of intelligence, not only as honey-hunters, but in many other respects. Their mode of living together in large, well-ordered communities, presided over by a queen, has long been a subject of marvel and of study. Out of the wax, which exudes at the joints of the abdominal segments of their bodies, they construct a "comb," consisting of a number of united cells. The cells when finished are filled with honey or "bee-bread," a substance composed of a mixture of honey and pollen. This bee-bread forms the food upon which the young larvæ are reared.

The bees are the greatest promoters of cross-fertilization, not only among the Hymenoptera, but among all insects whatsoever.

Over two hundred species of our native bees (*Apidæ*) are known as frequenting flowers, the most familiar being the common honey-bee

(Fig. 12). The task of collecting and storing honey is performed exclusively by the neuters (workers). The humble-bees do not fall far short of the honey-bees in the assiduity with which they frequent flowers, and they surpass the latter in size and in length of proboscis. Our most common species are the earth humble-bee (*Bombus terrestris*, Fig. 15), the garden humble-bee (*Bombus hortorum*), the moss-bee (*Bombus muscorum*), and the stone-bee (*Bombus lapidarius*). Very

Fig. 12.

Fig. 13. Fig. 14. Fig. 15.

Hymenoptera.—Fig. 12.—Honey-bee (*Apis mellifica*), queen, natural size. Fig. 13.—Hairy-bee (*Anthophora retusa*). Fig. 14.—Earth-bee (*Andrena Schrankella*). Fig. 15.—Humble-bee (*Bombus terrestris*).

similar to the humble-bees in appearance and structure are the hairy-bees, one of which is shown in Fig. 13. They are readily distinguished, however, as we shall presently see, by the formation of the hind-legs. In Fig. 14 we have a sand-bee (*Andrena Schrankella*, a species representing one of the largest genera), which may be seen in early spring on catkins and other spring flowers.

We have already said that, over and above their high intelligence, bees are remarkable for having certain parts of their body specially modified in connection with the acquiring of honey and pollen. We must therefore further consider the structures concerned in effecting this end, viz., the *suctorial apparatus* and the *apparatus for collecting pollen.*

The suctorial apparatus is in most bees developed in very great perfection. In many (Figs. 13–15) the proboscis is of considerable

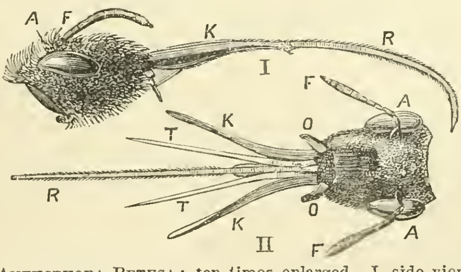

Fig. 16.—Head of Anthophora Retusa; ten times enlarged. I, side view; II, top view. *R*, tongue; *K*, maxillæ; *T*, labial palpi; *O*, mandibles; *T*, antennæ; *A*, eyes.

length, in some cases being as long as the body. It consists (Fig. 16) of the long vermiform tongue (R) (as in the butterflies), the upper surface of which is mostly well provided with oblique rows of long bristles. The maxillæ (K) and part of the labial palpi (T) are modified into flat, leaf-like, linear processes, which are arranged around the tongue (R), and thus complete the suctorial proboscis. While, therefore, the suctorial apparatus of the butterfly consists simply of a coiling or suctorial tongue, it must be noted that in the bee other parts are concerned in the formation of the tubular sucking apparatus. In many bees, besides, the tip of the tongue is peculiarly modified, so as to enable the insect to taste the honey before beginning to collect it, an arrangement by which honey of unpleasant taste can be rejected.

Apparatus for collecting Pollen.—Of all insects the bees alone have certain parts of their body specialized for the collection of pollen. The structures developed for this end are in their way perfect. They may be found either on the ventral surface of the posterior portion of the body or on the legs. Accordingly, bees may thus be divided into two groups: 1. Bees having structures for the collection of pollen on the ventral surface of the body; and, 2. Bees having such structures on their legs. To the first group belong the mason-bees (*Osmia*) and the leaf-cutter bees (*Megachile*). In these species the ventral surface of the abdomen is furnished with long, stiff, retroverted hairs, by means of which the pollen is brushed from the anthers as the insect passes in or out of the flower. The grains get entangled among the hairs, from among which the bee afterward dislodges them by means of its legs.

This contrivance is admirably adapted for obtaining pollen from flowers having a flat corolla, but not for such as have the anthers concealed in a deep tube. Our most highly developed bees (humble-bees, honey-bees, etc.) have therefore apparatus suitable for collecting pollen from flowers of all shapes.

The most highly developed bees collect the pollen on the hind-legs, but all do not possess the structures adapted to this purpose in like perfection. Fig. 17 represents one of the hind-legs of the hairy-bee (*Anthophora retusa*, compare Fig. 13); we here see the trochanter (R), the femur (S), the tibia (T), the tarsus (P), the four other joints of the foot (F), and, finally, the two claws (K). The tarsus (P) and the tibia (T) bear the structures by which the pollen is collected; both are seen to be laden with many grains of pollen (left white in the illustration). The tibia and tarsus are broad and flat, and are thickly covered with hairs. The pollen is brushed from the anthers by means of the hairs on the tarsus (P), and is afterward transferred to those of the tibia (T), where they are suffered to remain until the hive is reached. In the humble-bee (Fig. 18, *Bombus terrestris*) the same arrangements are carried out in yet greater perfection. The tibia (T) is smooth on the outer surface, while the inner surface is covered with long, stiff hairs, which form with the surface of the tibia a little depression, into which the pollen is brushed by the short hairs of the tarsus. In the honey-bee the arrangements are similar to those just described, but the hairs of the tarsus are much better adapted to their purpose (Fig. 19). They are disposed in eight or nine rows, while in the humble-bee they are distributed irregularly. By this regularity of arrangement the honey-bees are enabled to brush the pollen from the anthers far more effect-

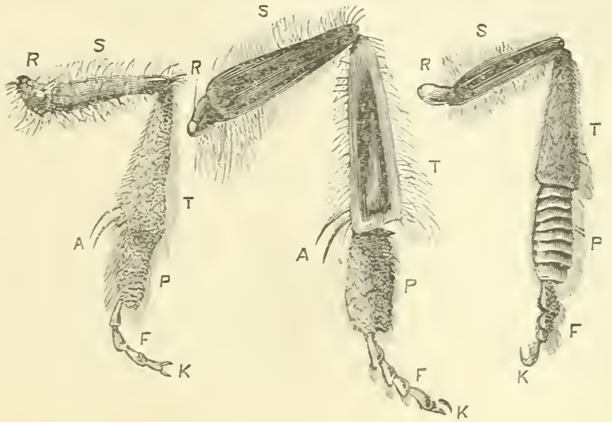

Fig. 17. Fig. 18. Fig. 19.

Hind-Legs of Bees, showing structures for collecting pollen. Fig. 17.—Hairy-bee, four times enlarged. Fig. 18.—Humble-bee, four times enlarged. Fig. 19.—Honey-bee, five times enlarged. *R*, trochanter; *S*, femur; *T*, tibia; *A*, prickles on tibia; *P*, tarsus (pollen-brush); *F*, other segments of the foot; *K*, claws.

ually. The pollen, once removed from the antlers, is next transferred to the hairs, or to the surface of the tibia, to which, being viscid, it readily adheres. After the process of collecting has been carried on for some time, the pollen forms thick yellow masses, which completely envelop the legs. Laden with the fruits of its toil, the insect wings its way homeward, and deposits them in the bee-hive.

While our native flowers are many of them entirely dependent on insects for the transference of pollen, the process of cross-fertilization is, in many tropical species, always effected by birds, which visit the flowers on account of their nectar.

In America the humming-birds (*Trochilidæ*, Figs. 20–22) and in Africa the honey-eaters (*Cinnyridæ*) are the great promoters of cross-fertilization.

The honey-birds are found in the tropical regions of Africa, Asia, and Australia, while the humming-birds belong to tropical and South America. The former suck the honey with their long, tubular tongue, which is brush-like at the tip. Their relations to flowers have not yet been sufficiently investigated, but a good deal is known respecting those of humming-birds.

The humming-birds are small (the largest species attaining to about the size of a swallow, the smallest not much larger than a humble-bee) and of delicate structure. They are famed for their magnificent plumage, which almost always displays metallic tints. Their flight does not resemble that of any of our native birds, being maintained by rapid vibrations of the wings, which enable them to remain apparently motionless in one spot for a considerable time. Their passage from place to place is effected by a series of rapid darts, almost too swift for the eye to follow. Their flight might perhaps be best compared to that of a moth. Like these insects, the humming-birds hover for long over a flower, sipping the honey with their long, thin bill, and in other particulars also—in color and form, for example—humming-birds and moths offer some remarkable parallels. Representatives of each may be found, to distinguish between which needs a close scrutiny, and which, when on the wing, might perplex the best observer. To all outward appearance the humming-birds are birds when at rest, insects when in motion.

The tongue of the humming-bird is admirably adapted for extracting the honey from flowers, being really a suctorial tongue in the truest sense of the expression. Long and tubular, often bifid and hairy at the tip, this organ serves to catch the insects that may be concealed in the flower (Fig. 22, I). The beak is long, thin, and pointed ; the upper

FIG. 20. FIG. 21.

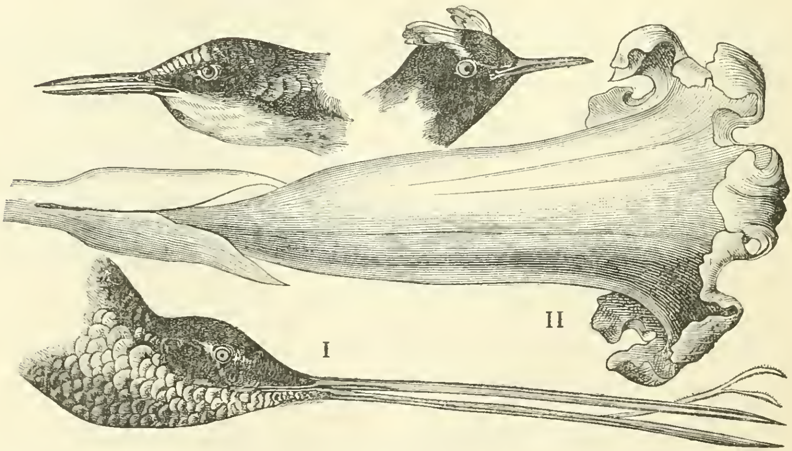

FIG. 22.

HUMMING-BIRDS. FIG. 20.—*Heliothrix aurita*, three fourths natural size. FIG. 21.—*Heliactinus cornutus*, three fourths natural size. FIG. 22.—I, SWORD-BEAK (*Docimastes ensifer*). II, A flower visited by it for its honey (*Datura*); three fourths natural size. (After Brehm.)

jaw closes over the edges of the lower jaw, thus forming a kind of tube incasing the tongue. In almost all species the beak is straight or very slightly curved (Figs. 20–22) ; in the sickle-beak alone (the *Eutoxeres aquila* of the equator, for example) it is sickle-shaped. The length of the beak varies in accordance with the length of the corolla-tube of the flowers habitually visited by the different species. In the *Heliactinus cornutus* of Brazil (Fig. 21) it is 1·5 centimetre long, in the *Heliothrix aurita* of Minas-Geraës in Brazil (Fig. 20) about two centimetres. The longest beak among the humming-birds is that of the

Docimastes ensifer of Venezuela (Fig. 22, I), that of the female being eight, of the male ten centimetres long. Fig. 22, II, shows a flower of the datura species freqented by the last-named ; we here see how the length of the beak and that of the corolla correspond.

We thus see that in the tropics there are not only wind and insect fertilized flowers, as with us, but also certain which are bird-fertilized, i. e., plants in which the transference of the pollen is effected by humming-birds.

ORIGIN OF MAN AND THE OTHER VERTEBRATES.

By Professor EDWARD D. COPE.

THE early part of this century saw the establishment of most of the fundamental principles of the science of physics, especially as applied to astronomy. A few decades later saw the science of chemistry emerge from the empirical and enter the philosophical stage. It has been reserved for the second half of the century to witness the discovery of the facts and principles of the history of life on the earth. The public mind is gradually awakening to the fact that the grandest truths of creation are being placed within their reach by the researches of contemporary science, and that the knowledge of the manner of the origin of the human race is no longer withheld from us.

The study of the fossil remains of animals has revealed an immense number of forms of life which in former ages have peopled the world. The study of geology has shown that the history of our planet is marked by successive deposits in water, which have become beds of rocks. The relation of these beds to each other gives us the relations of the animals and plants whose fossil remains they contain. Thus we have obtained a consecutive history of life from its early appearance to the present day. Before the doctrine of evolution was understood, the successive populations that filled the successive periods were supposed to have been the products of special creations. Now it is believed, with the best of reason, that all forms of life have been produced by changes of structure which arose in the course of descent, the one species coming from the other ; and that interruptions in the series of species from older to later periods are simply due to the absence of the means of preserving their remains at certain times during the course of the history of the world. These interruptions indicate periods of dry land, since fossils are not preserved unless they are excluded from the air by a covering of water or of mud.

It is one of the peculiar advantages of the North American Continent to the scientist that the geological structure of its great interior is comparatively simple, so that its history can be easily read. It follows that the history of the succession of life is recorded with the same regularity, and may be read by those who will bestow the necessary labor upon it. Those who have, during the last ten years, devoted themselves to this study have been rewarded by the discovery of the course of development of many lines of animals, so that it is now possible to show the kind of changes in structure which have resulted in the species of animals with which we are familiar as living on the surface of the earth at the present time. Not that this continent has given us the parentage of all forms of animal life, or all forms of animals with skeletons, or vertebrata, but it has given us many of them. To take the vertebrata, we have obtained the long-since extinct ancestor of the very lowest vertebrates. Then we have discovered the ancestor of the true fishes. We have the ancestor of all the reptiles, of the birds, and of the mammals. If we considered the mammals, or milk-givers, separately, we have traced up a great many lines to their points of departure from very primitive things. Thus we have obtained the genealogical trees of the deer, the camels, the musk, the horse, the tapir, and the rhinoceros, of the cats and dogs, of the lemurs and monkeys, and have important evidence as to the origin of man. We have the primitive mammals from which all these kinds that I have mentioned drew their descent, and from which, no doubt, many other lines were derived which we have not yet discovered in North America. Such are the lines of the elephants, the hyenas, the bears, the hogs, and the oxen. The ancestors of the strange, pouch-bearing marsupialia, have been found in part. These creatures, now confined (except the opossums) to Australia and the adjacent islands, were, at an early period, widely distributed over the earth. Some of these are found in the fossiliferous deposits of our plains and Rocky Mountains.

So soon as the possibility of learning the manner of creation of animals is admitted, curiosity and speculation are awakened. Many alternatives naturally occur to the mind. Were any of the living kinds of animals descended from any other living species, or have the ancestral animals all disappeared from the earth? Have the giants of ancient periods become reduced in size and strength, or have the giants of to-day grown from weak and insignificant beginnings? Have things grown more and more perfect with the lapse of the ages, or have they degenerated from more perfect ancestors? Have these changes advanced alike in all continents, or have they proceeded differently in different parts of the earth? Such are the questions that confronted the student of North American vertebrate paleontology fifteen years ago, and some of them could only be answered by North American material, not only because its record is the most complete, but because, as the second continent studied, it furnished the first opportunity in the history of the science for a comparison with the record already placed before us by the paleontologists of Europe.

Answering the last question first, it has been conclusively proved that there has been a general correspondence in the progress of vertebrate life in the two continents of the northern hemisphere. The differences, though numerous, are of minor importance. Some families of vertebrata have existed on the one continent, which were absent from the other, but the number of such is not large. Even the same genus occasionally existed on both continents.

The other questions must be answered by reference to the genealogies themselves, or phylogenies, as they are called.

In tracing back all the lines to which we have yet had access, the same kind of changes is found to have taken place in all of them. Let us take, for instance, the animals with hoofs. These embrace the cloven-footed and odd-toed orders, with their many species and families, which are represented by the ox, deer, camel, hog, and hippopotamus, for the cloven-footed ; and the horse, tapir, and rhinoceros, for the odd-toed. Most of these creatures walk on their toes. Many of the first-named group have but two toes, more or less united together, while the horses, of the second group, have but one toe. The bones of the two rows which form both the palm and the sole alternate with each other ; and the ankle-joint is a well-constructed tongue-and-groove arrangement. The teeth in many of them are highly complicated by the infolding of the enamel of the crowns of the molars, and this special development of the molars has been accompanied by a corresponding reduction in their number, and in the number of the incisors. In tracing the lines of these animals backward in time we have made the following discoveries : First, the infoldings of the enamel of the molars become shallower, and are finally represented by the valleys between four hills or tubercles, which stand to each other so as to be inclosed by a square figure. The number of the molar teeth increases. If incisor teeth were absent, they appear. The toes increase in number, becoming five on all the feet. The step becomes plantigrade or flat-footed, the heel reaching the ground. The tongue and groove disappear from the ankle-joint, which becomes flat. The bones of the two rows of the carpus and tarsus no longer alternate with each other, but rest, each one of the first on each one of the second row only. In 1874 I foretold that the ancestor of all the mammals above mentioned would prove to be a "pentadactyle, plantigrade bunodont"; that is, a five-toed sole-walker, with tubercular molar teeth. In 1881, seven years later, I obtained evidence that such a type of mammals abounded in North America during the early Eocene Tertiary period, and the prophecy was fulfilled. The best-known genus of this division has been called Phenacodus, and the figures of it will be found in the "American Naturalist" for 1884. In a still earlier formation of the Eocene, nearly all the hoofed mammalia were found to be of this type, showing conclusively that this group, which is known as the Condylarthra, was the ancestor of all hoofed mammals (Fig. 1).

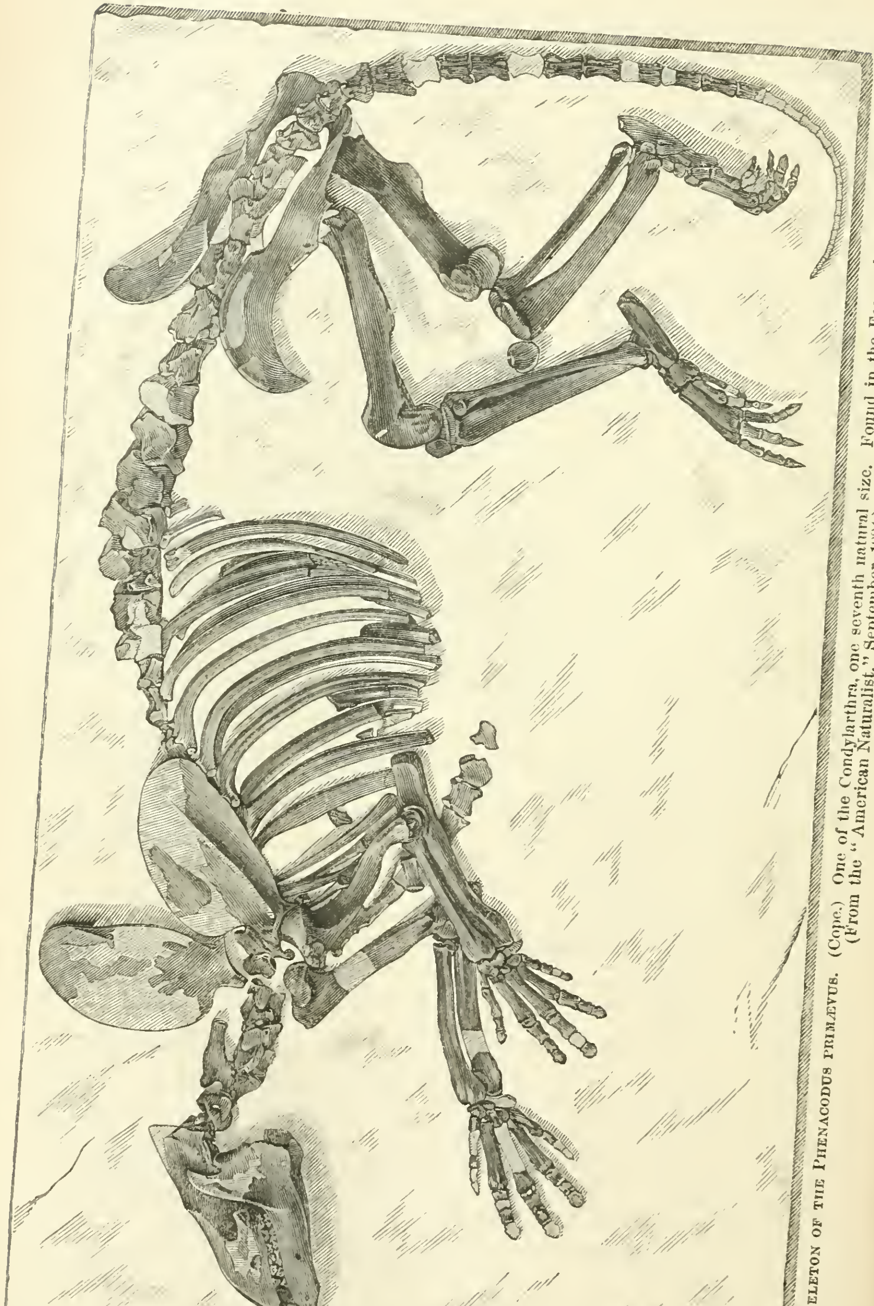

FIG. 1.—SKELETON OF THE PHENACODUS PRIMÆVUS. (Cope.) One of the Condylarthra, one seventh natural size. Found in the Eocene bed of Wyoming Territory. (From the "American Naturalist," September, 1884.)

But the Condylarthra were also ancestors of a still more important line of mammals. A remarkable type of quadrupeds known as lemurs at present inhabits Madagascar and some parts of Africa and Malaysia. These creatures, known by the Germans as *Halbaffen*, or half-apes, present a curious combination of the characters of monkeys and carnivora of the raccoon pattern. They could easily have stood in the position of parents to the monkeys in general; and suspicions to this effect have been abundantly confirmed by the discovery of numerous representatives of the sub-order *Lemuroidea* in the Eocene beds of both Europe and North America. And these again have been traced as certainly to the Condylarthra as ancestors, so that this group is again proved to be the ancestor of man as well as of the hoofed animals. And here was fulfilled another prophecy made by the writer, along with the one already mentioned, viz., that the ancestor of man also, would be found to be a "pentadactyle plantigrade bunodont."

An especial point of interest in the phylogeny of man has been brought to light in our North American beds. There are some things in the structure of man and his nearest relatives, the chimpanzee, orang, etc., that lead us to suspect that they have not descended directly from true monkeys, but that they have rather come from some extinct type of lemurs. Lemurs, which fulfill this anticipation, have been found in our Eocene beds, and belong to a peculiar genus which bears the name of Anaptomorphus. These creatures have a dentition more like that of the anthropoid apes than any living lemur

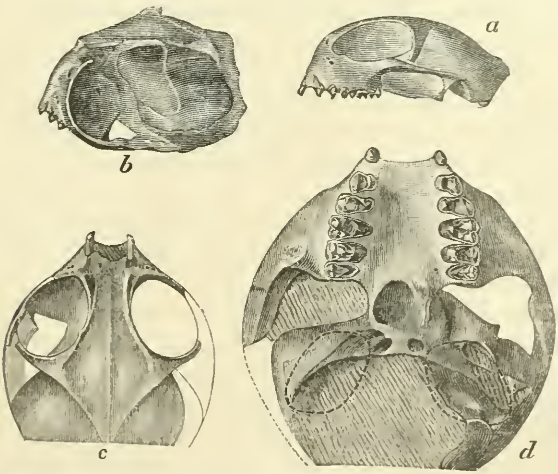

Fig. 2.—Skull of the Primitive Lemur (*Anaptomorphus homunculus*) (Cope). Natural size, except Fig. *d*, which is four thirds natural size. (From the Eocene of Wyoming.)

exhibits. They had the most acute senses of sight and hearing, if we may judge from the bony parts which surrounded those organs. They also had larger brains than those of any other mammal of their period, though they did not differ much in this respect from the existing lemurs. Both of the two species known are small, not probably exceeding a gray squirrel in size. Only the skulls and jaws are known (Fig. 2).

But the Condylarthra prove to be the ancestors of a still greater population of descendants. We have traced all forms of grinding teeth up to a pattern which consists of four tubercles or cones arranged within a square. But it has been possible to show that one of the four tubercles appeared after the other three, as an addition to them, so that the earliest form of molar or grinding tooth was tritubercular, and that the quadritubercular was an outgrowth from it. Now, one of the three families of the Condylarthra has tritubercular molars, and there is little doubt that it was the ancestor of the two other families. The principal genus of this family is called Periptychus. From this family came an order of hoofed mammals, which never rose to the possession of four tubercular grinders, although the crowns became crested by the modification of the three which they possess. This order, the Amblypoda, had a short life in geological time, and did not grow in the dimensions of the brain, but developed huge skeletons with skulls that sprouted into horns and strange processes.

The Condylarthra with three tubercles are probably also the ancestors of the carnivorous orders. The lions, tigers, wolves, and bears of to-day can be shown to be descendants of animals absolutely intermediate between themselves and the animals just mentioned. These half-carnivores, or Creodonta, have, like the ancient hoofed mammals, more numerous teeth than their modern representatives, and differ from the true carnivora in just the ways, in limbs and feet, that we have seen that the ancient hoofed mammals differ from their modern descendants. Creodonta were not such dangerous animals as the carnivora, with some possible exceptions, because, although they were as large, they generally had shorter legs, less acute claws, and smaller and more simple brains.

This genealogy, it will be seen, does not show us the ancestors of the Condylarthra. This remains for future discovery. It is, however, probable that they will be found in the earlier geological periods, among some of the marsupial mammals only known thus far from the jaws and teeth. It must also be noted that a number of these ancestral groups are represented in the existing fauna by a few genera. Of the Condylarthra, a near relative exists in the Hyrax, or cony, which now inhabits Africa and Western Asia. Of the Creodonta, several genera exist in Madagascar, West Africa, and the northern hemisphere. The mastodons are late representatives of an ancient type, and their phylogeny has not yet been fully made out. But they certainly also came from the Condylarthra.

There is a remarkable likeness between the history of the development of the reptiles and that of the higher mammals, in one respect, and that is, that they have apparently all been derived from a single order, which occupied the earth at one (an early geological) period. As reptiles are inferior to mammals in the scale, so they are of earlier origin. The primitive reptilian order first appeared in force on the earth during the Permian epoch—that populous time which immediately followed the age of the true coal. If it existed during the coal-measures proper, it has not yet been found in them in North America. This order has been named the Theromorpha. Its representatives have been found in Russia, Germany, South Africa, Illinois, Texas, and France. I give the names in the historic order of discovery. It embraced both carnivorous and herbivorous forms, and species of sizes from that of the Malayan tapir downward. Those with piercing teeth occur everywhere, and those with grinding teeth in North America only. South Africa furnishes us with genera with leaf-shaped teeth, and others with no teeth at all. This order represents the first air-breathing land-population of vertebrates, and they evidently fulfilled most of the functions of the mammalia of to-day, though none of them were fliers, so far as known. Many of them had strange physiognomies, with blunt noses and large nostrils, and long teeth mingled with other smaller ones. Besides having given origin to most of the reptilia, this order presents many points of resemblance to the mammalia. Some of the bones resemble very closely those of the duck-bill or Platypus of Australia, and some of the bones of the skull are more mammalian than the corresponding parts of any other reptiles. It is probable that the lowest order of mammalia, which is to-day represented by the duck-bill (the Monotremata), were derived from the Theromorpha. (See "Proceedings" of the American Association for the Advancement of Science for 1884.)

The different lines of reptiles have been traced less completely than those of the mammalia, partly because their history is more ancient, and the formations where their remains are preserved have suffered greater disasters. The changes that have appeared with advancing time have been in the bones of the shoulder-girdle and pelvis, in the limbs, vertebræ, and skull. Certain changes in these parts resulted in the appearance, in the period immediately following the Permian (the Triassic), of the orders of the sea-saurians, the flying saurians, and the land-saurians or Dinosauria. In the next period, the Jurassic, we have the first certain knowledge of the tortoises and lizards; while, in the following ages of the Cretaceous, we get the pythonomorphs and the snakes. All of the existing orders were in the world by the beginning of Tertiary time, but the great monsters that characterized the middle period of the earth's history were only represented by the crocodile branch of the Dinosauria.

The changes of structure which these several lines underwent in the course of the ages were quite different from those which the history of the mammalia exhibits. Instead of becoming more perfect organs of locomotion, the limbs, if we except those of the flying reptiles, lost some of their special characters, becoming more remote from the mammalian type. The pelvis became weaker and more open. The shoulder-girdle lost parts in some orders, and gained some expansion in others. The vertebræ became more perfectly articulated by the bodies, and in the case of the snakes by the arches also. Finally, the ribs lost one of their points of articulation with the vertebræ, and the jaws became looser and more open, and especially adapted to swallowing large bodies whole. The history consists of a successive departure from the mammalian type, and a running into a specialization, which, in some cases, means degeneration.

A curious specialization which supervened on the reptilan type is that of the birds. Various saurians exhibit unmistakable approximations to the birds. The land-saurians include types that walked on the hind legs and had many bird-like characters of the hinder feet and of the pelvis. The flying saurians present affinities in the same direction. The class of birds presents many perfections both general and special. Their brains are larger than those of reptiles, and they acquired warm blood. In their own specialty of flight they display wonderful power, while the highest orders add that vocal skill which makes them so pleasing to man. Here is a good example of advance in evolution. Cases of degenerate evolution are to be found in birds, but they are few.

The next lowest class, that of the Batrachians, prevailed during the coal-measure period. They expanded enormously during the Permian, and were worthy contemporaries in size and numbers of the theromorph reptiles. Their numbers diminished subsequently, as the record now stands, though some of the species maintained their bulk during the Triassic period. In modern times they are comparatively insignificant; frogs, toads, salamanders, sirens, and cœcilias not playing an important part in the existing fauna. In tracing the successive changes of structure of these creatures, one is forced to believe that degeneracy has played an important part. The bones of the skull have so diminished in number as to leave it in some cases in a condition comparable to that of the primitive fishes. In not a few modern types the metamorphosis is never completed, the animals remaining permanently breathers in the water. Whatever we may call such changes, they are plainly a specialization which has carried them further and further away from their starting-point; and, as in the case of the reptiles, this starting-point has been near to orders higher than itself. The Permian Batrachia are nearer in structure to the Permian reptiles (*Theromorpha*) than any subsequent form of Batrachia has been (Fig. 3).

Professor Agassiz pointed out that the early fishes presented relations to other vertebrata, as I have since shown to be true of the Batrachia and Reptilia. Some of the primitive fishes he called "sauroid" or "reptilian" fishes. Batrachian fishes would have been a more accurate designation, for it is highly probable that it was from one of the early orders of fishes that the Batrachia took their rise. Omitting from consideration the lowest vertebrata, the sand-lances and lampreys, which are not fishes, we have remaining a body of animals which pre-

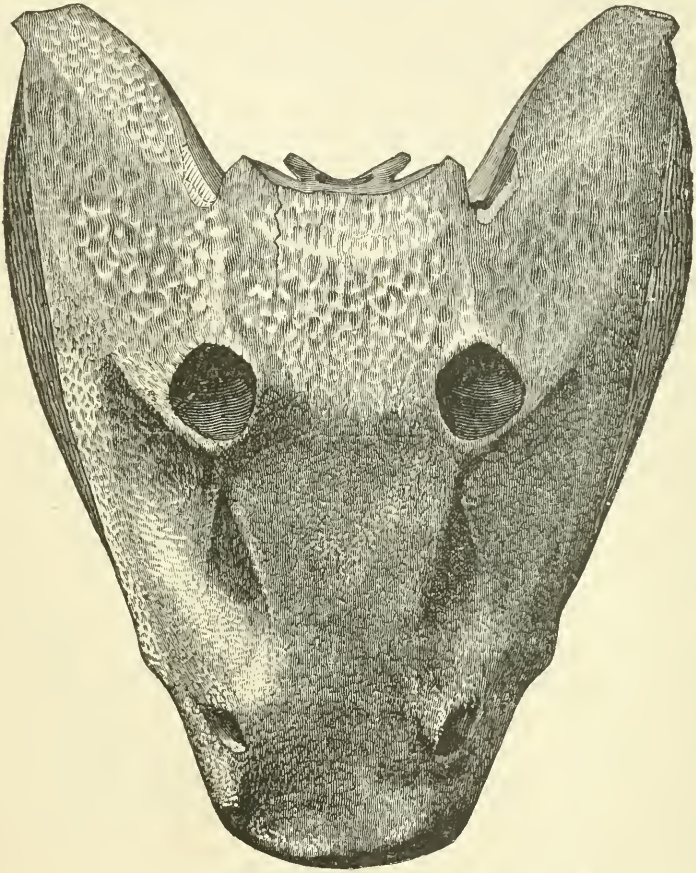

FIG. 3.—SKULL OF ERYOPS MEGACEPHALUS. (Cope.) A Batrachian of the Permian period. One fifth natural size, upper side. (From Texas.)

sent great varieties of structure. Of the four great sub-classes into which they naturally fall, but one can be called true fishes. The others embrace the sharks, the chimæras, and the lepidosirens. It is interesting to note that these four divisions are more closely approximated during the Permian period than at any later time. An order technically referred to the sharks, and known as the Ichthyotomi, combines many of the characters found separately in three of the sub-classes. The creatures which especially deserve the name of batrachian fishes, the ceratodonts, etc., also abounded during the Permian period. From this time the true fishes began to run their course. They have peopled all waters, and have branched into a greater diversity of form than any of the other divisions of vertebrata. And paleontology and zoölogy show that they have pursued a course which is in its essential principle the same as that displayed by the Batrachia, and in a less degree by the Reptilia. They have diverged further and further away from the batrachians, which they once resembled, and in so doing have left behind them the general ascending line that led some of the land animals to become Mammalia. They have become specialized into types which have special modes of life adapted to special localities. Some of the lines of descent are clearly degenerate, as indicated by a loss of parts. Some of these degenerate lines inhabit the deep sea; others have become movably sessile, attaching themselves to fixed bodies. Others have found protection in an external armor of bony plates rather than in activity and sensibility. But many fishes are in their especial way wonderful exemplars of animal energy, though none of them rise high in the scale of intelligence.

In review of the results obtained from the recent study of vertebrate paleontology, certain principles may be clearly discerned. These are as follows: 1. The earlier types were more generalized, the later ones more specialized. 2. The specialization is sometimes upward or progressive, and sometimes downward or retrogressive. 3. The retrogressive development has been more general in early geological periods, the progressive more general in the later geological periods. For a more detailed exposition of these principles, see "American Naturalist" for February, March, and April, 1885.

It is not my intention in this article to do more than to display the facts of the case. The exposition of the hypotheses of evolution which explain these facts must be reserved for another article. Suffice it to say here, that the study of the changes of structure displayed by the lines of evolution, has brought to light some very definite exhibitions of the application of energy. The illustration of the *modus operandi* of this creative energy is a very important chapter of evolution, and one that interests mankind practically, even more than as food for his intellectual activity.

AN EXPERIMENT IN PRIMARY EDUCATION.

By Dr. MARY PUTNAM-JACOBI.

II.

ONLY one attempt was made during this year to teach the child the meaning of words. It was done through a simple generalization which had become indispensable in the study of geometry, when she passed from plane to solid figures. By means of wooden models she learned, in addition to the cube—the sphere, ovoid, oblate, cylinder, prism, tetrahedron, octahedron, and dodecahedron. She then was led to make parallel lines of plane and solid figures with a corresponding number of sides or angles, then to abstract the Greek numerals *tri*, *tetra*, *penta*, *hexa*, etc., found to belong to both columns, and set this in the center, with the syllable *gon* on one side, and *hedron* on the other. An hour was required to complete the setting out of these figures, and arranging these titles with movable letters, which for the first time the child learned to use for spelling. The exercise was, of course, repeated again and again, until every step was perfectly familiar. From the beginning the child had no difficulty in connecting the plane and solid figures, nor in learning the numerals appropriate to each. The new effort at abstraction and classification was at first somewhat hard, but soon became easy. The facility with which the impression of forms may be made upon a child's mind, when this is as yet uncrowded by notions on the other qualities of objects, was shown by a little incident at this period. A few weeks after having made her first acquaintance with the oblate, she saw at dinner for the first time some small stewed onions. "Oh!" she exclaimed, "they have brought us some oblates for dinner." Another day, when she accidentally pulled the cord of a window-shade in a certain position she observed that she had thus made "two scalene triangles." Looking at the ceiling above a lamp, she called to me to notice how the light made three "beautiful concentric circles."

One other study during the year was made upon the intrinsic meaning of words. In the course of some observations on plants the child had learned to recognize the ovary and ovule, and to herself dissect them out of a flower. When this had been done, the analogy between the vegetable ovule and chicken-egg or ovum was easily pointed out, and the relation of the latter to the geometric ovoid. The four objects were then placed in a row on the table, the names of each spelled with movable letters, and then the common root *ov* described and taken out. The important and fundamental idea was thus grasped that there was an intrinsic meaning to at least some words, and also that objects associated by a common name, whose specific variations were of subordinate importance, must be classed together as deeply related, notwithstanding superficial difference of aspect. But this idea, once distinctly enunciated and understood, was then set aside for a season. That the idea was understood, I tested in the following way: At table the child remarked that a particular potato was "shaped like an egg." "What shall we then call it?" I asked. "An ovoid," was the reply. "Very good. Do you know what I thought you might call it?" "An ovum," she answered, with an air of mischievous triumph. "And why did you not?" "Because it is not an egg, but only shaped like an egg." I tempted the child with the suggestion that she should tease the waiter by asking him to bring us some ovules instead of eggs; but the instinctive modesty of childhood recoiled from the pedantic proposition.

The necessity for precision in the use of terms, thus initiation into scientific terminology, was enforced incidentally on another occasion. A playfellow much older than the child picked up a piece of mica and called it isinglass. This conventional inaccuracy I strongly rebuked, and, procuring a piece of real isinglass, led the child to note its difference, and to condemn in private and without malice the slovenly language of her presumably untaught comrade. Now, the child had a doll called Rosa, and was in the habit of illustrating any absurdity by pretending that Rosa was guilty of it. Some time after the conversation on the isinglass she was watching a stream of water falling in the sunlight from a hose. She exclaimed: "See the beautiful silver water coming from the old gray hose. Rosa would have called that mica!"

When the box of wooden geometric models was thoroughly mastered, after about six months' study, I procured for the child a set of models of crystals, such as are used for studying mineralogy. About half of these proved too complex for study, but the child easily learned to recognize and distinguish twenty-six, partly simple, partly compound forms. As each face of the crystal showed some plane figure which she had already learned, and as she was also familiar with the Greek numerals from three to twelve, it was generally easy for the child to devise the name of the crystal, even when apparently so repelling as a scalenhedron, rhombic dodecahedron, right rhombic pyramid, etc. It was interesting to notice her capacity to discern the general outline of a crystal and thus its generic features, and afterward to distinguish the secondary divisions of its sides, or the specific characters; thus in a four-faced cube, a three- or six-faced tetrahedron, a three-faced octahedron, etc. The forms in the four systems of crystallization were learned by repeated handling of the models, until the child's perceptions had become saturated with them, and she could, for instance, discover for herself four-faced cubes in the curved molding on staircases. Then, at the beginning of the second year, the crystals began to be copied in clay, and opportunity then afforded for studying their axes, or the basis of their classification, by means of long pins thrust through the soft model in appropriate direction.

Arithmetic, the second science in Dr. Hill's category, was begun several months after the first studies of form and outline. Instead of the beans so frequently recommended, the child used sticks of different sizes and colors. For two or three months she studied such numbers as seem almost to form natural complex entities, and hence have often been sacred numbers, thus: four, nine, ten, twelve, twenty-four, thirty-six. The child was exercised in dividing these up into symmetrical groups, whose resemblances she was trained to tell at a glance by the eye, before enumeration. Thus she learned to form groups of threes, fours, and sixes, and to unite them in as many fantastic combinations as could be invented. The object was to effect the transition from the perception of form to the conception of number by a series of visual impressions as vivid as possible. The breaking up of a whole into parts really precedes in facility the additioning of parts into a whole, for the reason that the power of destruction in a child obviously precedes the power of construction. Froebel's fifth gift of cubical blocks has its first application on this fact, since the entire mass forming a cube may be broken up into twenty-seven smaller cubes. When we reached the number twenty-seven, I told the child it was the smallest cube that existed. But she having a year previously, when only four years old, learned to handle these same cubes, corrected my error, and demonstrated triumphantly that eight blocks would make a still smaller cube. The incident shows the tenacity of ideas once implanted in the right way and at the right time.

It is much more difficult to teach a child to subtract than to add, a fact upon which Warren Colburn sagaciously comments. In the discussion of practical problems, a hitch often occurs in the child's mind which may be quite unsuspected by the teacher. Thus, if Henry and Arthur go to buy a ball which costs sixteen cents, and one boy had six cents and the other seven, I found the child unable to solve the problem as to how many more cents were needed, because, as she said, she could not take thirteen from sixteen, since the very trouble was that the boys did not have sixteen cents. It was necessary to use sticks, and with the distinct formal agreement that those of one color should be known to represent an imaginary number, those of another color the number of actual things manipulated. But what a stride for a young child's mind to make, into a sphere neither real nor imaginary, but where the existent and the non-existent are indissolubly associated in an ordinary practical affair of every-day life!

From the beginning the decimal system imposed itself spontaneously upon the child's mind, on account of the facility of visibly recognizing groups of five and ten sticks, and of verbally recognizing their successive additions. In this way the multiplication-table—the famous despair of little Marjorie Fleming—was mastered with great ease by this far less gifted child. Every one remembers the fierce vehemence of Pet Marjorie's protest, "But 7 times 9 is devilish, and what Nature itself can't endure!" It is so, if presented as an isolated fact. The child I taught, however, discovered of herself that the successive addition of tens was as easy as that of ones. After that, when she came to add (or multiply by) nines, she would say, first add ten, then say, and nine was one less. If it were eight, it was two less, etc. After a fortnight of these exercises, she was asked one day out of study-hours what was the sum of 14 and 19, and answered immediately 33. Upon being asked to explain the process, she said, "10 and 19 makes 29, then I must add 4 more, and 1 and 29 are 30, and 3 more are 33." When three decimals were reached, a somewhat laborious exercise was performed. Thus, to operate with 138, the number 100 was constructed out of ten packages of purple sticks, each package containing ten sticks. These packages were placed in a row; underneath was a second row, containing, to represent the number 30, three packages of yellow sticks, each containing ten; finally, a third row of eight units was made with green sticks in a single series. In this exercise the sticks were all of the same size; in another, later, a hundred was represented by a single long stick, usually purple, a ten by a yellow stick next in size, a unit by a stick still smaller and green. Thus the original and clumsier representation was condensed by the substitution of an expressive sign for the literal numbers, and as soon as the sticks became used as signs, and not as the objects really to be counted, the mutual relation of their respective sizes also ceased to be literally exact, and became merely schematic. Thus was gradually managed a transition to the use of pure written signs or symbols. The transition initiated and enlarged the condensation of Roman into Arabic numerals. Knowledge of the process of subtraction, especially in three and more decimals, was essentially facilitated by this device with sticks, and the terrible difficulty of borrowing ten quite overcome. Thus, if the number 288 were to be taken from 362, the larger number would be represented by three long purple sticks, six shorter yellow sticks, and two green sticks, the shortest of all. These colors were always selected because harmonizing so well with each other. Then, similarly, the 288 was represented by two purple, eight yellow, and eight green sticks. It was easily recognized by the child, that one of the yellow sticks could be removed from the ten sections of the 362, and ten green sticks substituted, bringing the entire number of units up to twelve, from which the eight of the lower figures could be taken. It was also obvious that, when one yellow stick had been taken away, only seven remained. There was no need, therefore, to employ the usual confusing statement that a ten must be borrowed from the upper figures, and later restored to a different place in the lower.

The study of abstract numbers, with Colburn's arithmetic, was begun when the child was five and a half years. At the end of a year she had thoroughly mastered the first four rules, including both "short" and "long" division, and was considerably advanced in the study of fractions, proper and improper.

The last study entered upon during this year was that of natural objects, and, for obvious reasons, plants were chosen for this purpose. I suppose that most persons seriously interested in education are acquainted with Miss Youmans's admirable little "First Lessons in Botany," and the plea she makes for this science as a typical means of training the observing powers of children. According to her plan, the first object studied is the leaf—and the pupil is taught at once, not only to draw the leaf, but to fill out a schedule of description of it. Much may be said in favor of this method, which proceeds from the simple to the complex form, but it is by no means the only possible one ; the writing part of the scheme is, moreover, impossible for a child who has not yet learned how to write. There is another method which consists in seizing at once upon the most striking aspect of the subject, and which shall make the most vivid impression upon the imagination. For this purpose the leaf is the least useful, the flower the most so. The earliest botanical classifications are based upon the corolla, and, in accordance with a principle already enunciated, a child may often best approach a science through the series of ideas that attended its genesis. The conditions are different for an adult, who requires to get the latest results ; the child's mind is always remote from these, but often singularly near to the conceptions entertained by the first observers. Again, it is unnatural to enter upon the beautiful world of plants by the study of forms and outlines—which is much better pursued when abstracted from all other circumstances, as in models of pure mathematical figures. But with plants comes a new idea—that of life, of change, of evolution. It is fitting that this tremendous idea make a profound impression on the child's mind ; and this impression may be best secured by watching the continuous growth of a plant from the seed. The study of life is a study of events, of dynamics, of catastrophes. The earliest observation perceives the extraordinary influence of the surrounding medium upon the destinies of the living organism. It is not difficult to surround these destinies with such a halo of imagination as shall impress on the mind a sense of the mystery, sanctity—I may add, the necessary calamities of life—before it has become absorbed in the consideration of living personalities.

I trust it will not seem a piece of bathos when I add that I initiated the pursuit of these objects by making the child watch the growth of seven beans on a saucer of cotton-wool. A specimen bean was first dissected, and its principal parts named—the cotyledons, the embryo with its radicle and plumula, the episperm. The daily reference to these terms speedily rendered the child quite familiar with them. To seven other beans were given appropriate names, as of a band of brothers, and they were then planted on cotton-wool by the child. A daily journal of events was opened, in which I wrote each day or two, at the child's dictation. As she had learned the Arabic numerals, she inserted these herself in the protocol whenever necessary. The entire history of each bean was thus written out, and the successive steps of its development, from the thrilling moment when the radicle first peeped out, to the time when, after transplantation to a flower-pot, the plumula had developed to a long, trailing vine. The rate of growth of this vine was measured day by day exactly, with a rule, the number of leaves counted, etc. But the mathematical considerations were here subordinated to a larger idea, that of the succession of events. Some of the beans molded early in their career, and the relations of this catastrophe to the accidental differences of position, moisture, etc., were carefully studied. On one occasion the child dictated to me the following entry for the journal: "The episperm, on the under surface of Tertius, is all black, and has split, leaving a space the shape of an equilateral triangle, with the apex pointing to the convex edge of the cotyledons." In the summer, when flowers could be obtained from the woods in abundance, the child made collections of ovaries and ovules, and was never tired of finding the latter asleep in their beds, in so many differently shaped houses. At this time the static considerations were allowed to predominate, and the child rather forgot the function of the embryo seeds—so much so that, upon seeing some small pieces of ice lying in half a musk-melon, she said that these were like the ovules in an ovary. At the beginning of the second year, the study of plant-growth was resumed with seven hyacinths, that received appropriate names, as seven sisters. The first lessons in written expression coincided with the beginning of this new study; for now the child was allowed to write the plant-journal herself. The exercise was complex. The child first examined the hyacinths, and noted whether anything had transpired since the last observation. She then framed a spoken sentence, in which such an event was accurately described. She then dictated the writing of this sentence as a whole, which she was afterward to copy. During this dictation, some knowledge of spelling was incidentally acquired; for the child was led to spell by sound, and without reference to silent letters. The words she had not yet seen. Finally, when fairly at work at the writing, the meaning of the sentence was temporarily ignored, and attention closely concentrated upon the forms of the letters, and no mercy shown to inaccurate imitation of them. Thus, one day she entered the observation that Blanche, in a blue glass, had grown much more vigorously than Aura, in a dark one; and a blue glass was given to the less favored sister, in the hope that she would improve. She noted that the tips of the white roots were gray and conoid in shape (making the observation herself independently), and was allowed to demonstrate the function of these tips by cutting one off and seeing the growth of that root arrested. On another day she first discovered, then described, then wrote down, that the first broad leaves of Blanche had split open, showing two others at right angles to them. This was her first perception of this remarkable law of phyllotaxy, and she herself illustrated it by making two loops with the thumb and finger of each hand, and making them intersect each other. The previous acquisition of mathematical conceptions was constantly shown to facilitate and render precise her observations of complex objects.

It was rather as a concession to a prevailing prejudice that at this time the child was taught to read. This study, usually made of the most importance, was held for this child to be quite subordinate and easy, and little stress laid upon it. The child was allowed to follow her own inclination, to divine the subject of the chapter from the picture at the head of it, and, to a considerable extent, the words in each sentence from the context; when the wrong word was thus suggested, she was obliged to spell out the real word by sounds, always seeking first the central or predominant sound, and building up the word around it, instead of enumerating the letters in order. Thus in the word *scratch* she took out the letters *a t*, as the central nucleus, preceding the first by the sound of *r*, then of *c*, then of *s*; then, when the sound *scrat* was complete, adding that of *ch*. She was made to read as much and as rapidly as possible, relying upon constant repetition and association of ideas to secure familiarity. Thus unconsciously the conception was continued, that written as well as spoken language was an outgrowth of thought before the attempt was made to study it as an object of thought. This method is like that of learning to walk before studying the laws of Weber on locomotion.

This method may seem slovenly, but, after all, it is both the natural and scientific method of studying an unknown tongue, which must be deciphered by the context. How else did Champollion read the Rosetta stone, or Eliot find a written language for his Indian Bible? Throughout this period the task of reading was treated as something so easy as to be insignificant, and was so regarded by the child herself.* The main intellectual work of the day's lessons (whose duration was never more than an hour and a half) was concentrated upon the arithmetic, map-drawing, analysis of flowers, and the geometrical studies, that she now pursued by the help of Hill's "First Lessons," and Spencer's "Inventional Geometry." She studied angles, vertical and adjacent, the relations of angles and circles, and the measurement of the former by the latter. Exercises in these were practiced daily with compass and ruler; and, when lines drawn with the pencil failed to give a large enough visual impression, they were designed with colored sticks. This enlargement of the material illustration never failed to clear up any obscurities. At the time these notes cease, the child was six and a half years old.

I have tried to make clear in these few notes the outlines of a (single) experiment, which seems to me to show that the mental education of even a very young child may be imbued with scientific methods and even ideas which should furnish suitable preparation for advanced scientific studies. It can not be a matter of indifference that such habits of mind are acquired from the beginning, or only after much previous faulty training. What comes first will always remain the most important, will always dominate the rest. Experience in the medical education of women has repeatedly brought home to me the difficulty of teaching such an art as medicine to persons who come to it through the prevailing systems of school discipline, especially those which are applied to girls. Experience with one little girl at least convinces me that the aptitude for vivid and accurate perception, and for

* What is easy, when taken instinctively, may be incredibly difficult when itself becomes the object of thought and study.

scientific method in ideas, often exists where unsuspected, and only demanding proper cultivation.

As an illustration of the method described in the text, when carried into more complete studies, I insert an exercise written by the child when six and a quarter years old. It is a description of a wild Iris, which she analyzed herself on successive days, writing down the results from *memory* on the next day. She was never told anything, but obliged to discover for herself each fact, to compose the sentence describing it, and to spell by ear the words of the sentence without copy. She was allowed to insert in her description whatever fancies occurred to her. The headings and order of evolution of the subject were alone dictated. With nearly all the technical terms she was, however, already familiar; two only were told—"perianth," as opposed to corolla, and "blade." Before analyzing the Iris she was obliged to take a long walk to the woods for it, and first to draw a map showing the way, and by means of the compass. Two intersecting lines from sight-objects were dictated by me, and the fact learned by this and another previous experiment which had failed, that to locate an object in space at least two lines are required. The final description, whose writing occupied two or three weeks, was as follows:

The Rainbow Family.—(This name was given as a literal translation of *Iridaceæ*, and as a return in a spiral to the first natural object studied eighteen months before, the rainbow. The way was also prepared for the future historical study of the myth of Iris.)

Iris Tricolor.—(The numeral was already familiar.)

Perianth = 6 Petals. (The algebraic signs and numbers were used to indicate that in a scientific document, not a flowing style, but the fewest words and most concise expressions were required.)

These stand on top of a long tube in which the style is locked in. There are two kinds of petals: 1. Three which are the biggest, and have three colors. There are two parts to each—the upper broad part called the blade, and the lower long narrow part. (The term "blade" was here taught for the first time.) The blade is first purple; in the middle is a gold stripe which runs into the narrow part. (At this point, the child drew and painted from memory, on the margin of her protocol, a picture of the petal.) Between the purple and gold the blade is white. These petals curve outward and downward, so that the gold stripe comes on top. The bees see it and come for the pollen. (First introduction of a Darwinian law.) 2. Three petals, which are entirely purple, are vertical, smaller, and stand between the others. (The child made another drawing by opening the flower on the page and tracing its outlines.) It is as if six girls were standing in a circle (here was introduced a botanical outline of the whorl, instinctively devised by the child, the circle being drawn accurately with compasses). Every other one leans back and stretches her arms out horizontally, as if to show her gold bracelet. The three others lean forward, and hold their arms up above their heads. (Prolonged contemplation of this lovely group tended to evoke such instinctive æsthetic conceptions as are at the basis of many pieces of statuary, notably Thorwaldsen's Graces.) The gold stripe is like the orange feathers on the head of the bee-martin. The bees think it is a flower, and come and settle on the bird's head; then he catches them. (This illustration was suggested by the child, shortly after having seen such a bird which had been shot. She thus learned to step from one section of natural history to another, and also to seek analogies of organs in their functions.) Mamma says (here knowledge by testimony is distinguished from that obtained by personal observation, which has not yet reached so far) that all flowers that want the bees to visit them have bright colors. This is like ladies who want the gentlemen to visit them, and then put on their finest clothes.

The Great Mistake.—We thought there were three more petals in the middle of the corolla. These were smaller than the others, and divided at the top like a funny M. (The child then made a drawing in illustration.) Each stands inside a gold-striped petal, and has a groove on the outer side like a bath-tub. In this a princess is bathing. She is a stamen, with a long, whitish anther like a veil over her head. So there were three stamens inserted with the petals.

How we found out the Truth.—(This process is introduced with some solemnity, as befits its importance.) 1. We looked to see how the pollen got on the stigma. (Introduction to the biological method of studying structure in association with function.) 2. We noticed that the pollen could slip down the groove into the tube leading to the ovary. 3. We saw that the petal-like pieces were fastened together in the middle of the perianth, making a solid white cylinder which passed into the green tube. (Another drawing from memory illustrated this.) 4. It was plain that the white cylinder was the style, because it went to the ovary. 5. Then mamma said (recognition of authority and testimony again) that the petal-like pieces were the stigma, immensely big. (The incident showed the function of the reason in unraveling the deceptions imposed by the senses and the superficial aspect of things.)

Ovary—at the bottom of the tube (ovary inferior)—has three lodges and a great many ovules.

(Thus the botanical analysis was rigidly accurate and complete. But, instead of being a dry schedule, it comprised a mass of vivid, glowing impressions destined to remain forever as a typical group of ideas in the child's mind. The prolonged, patient, sympathetic study of the individual preceded the abstract study of a class of flowers. In the future it was intended that the child should construct her own classes from among the botanical individuals she should really learn to know.)

THE FAUNA OF THE SEA-SHORE.

By Professor H. N. MOSELEY, F. R. S.

THE marine fauna of the globe may be divided into the littoral, the deep-sea, and the pelagic faunas. Of the three regions inhabited by these faunas, the littoral is the one in which the conditions are most favorable for the development of new forms through the working of the principle of natural selection. As Professor Lovèn writes, "The littoral region comprises the favored zones of the sea where light and shade, a genial temperature, currents changeable in power and direction, a rich vegetation spread over extensive areas, abundance of food, of prey to allure, of enemies to withstand or evade, represent an infinitude of agents competent to call into play the tendencies to vary which are embodied in each species, and always ready by modifying its parts to respond to the influences of external conditions." It is consequently in this littoral zone, where the water is more than elsewhere favorable for respiration, and where constant variation of conditions is produced by the tides, that all the main groups of the animal kingdom first came into existence ; and here also, probably, where the first attached and branching plants were developed, thus establishing a supply of food for the colonization of the region by animals.

The animals inhabiting the littoral zone are most variously modified, to enable them to withstand the peculiar physical conditions which they encounter there. Hence the origin of all hard shells and skeletons of marine invertebrata, various adaptations for boring in sand, the adoption of the stationary fixed condition, and similar arrangements. Almost all the shore forms of animals, however inert in the adult condition, pass through, in embryological development, free-swimming larval stages which are closely alike in form for very widely different groups of animals. Thus the oyster and most other mollusca of all varieties and shapes when adult, develop from a free-swimming pelagic trochosphere larva, and so do many annelids. Such larvæ can not be of subsequent origin to the adults of which they are phases. If such were the case, they would not have become so closely alike in structure. In reality they represent the common ancestors from which all the forms in which they occur were derived, and, as all these larvæ are pelagic in habits and structure, it follows that the inhabitants of the shores were derived from pelagic ancestors. The earliest plants were also probably free-swimming.

In the case of the cirripedia there can be no doubt, from the history of their development, that they were originally pelagic, and have become specially modified for coast-life ; and in the case of the echinoderms the only possible explanation of the remarkable similarity of the larval forms of the various groups of widely differing adults is that these pelagic larvæ represent a common ancestor of the group. The madreporarian corals all spring from a pelagic larva. The colonial forms probably owe their origin and that of their skeletons to the advantage gained by them in the formation of reefs, and the increase in facilities of respiration consequent on the production of surf. In the deep sea they are very scarce.

The vertebrata are sprung from a very simple free-swimming ancestor, as shown by the ciliated gastrula stage of Amphioxus. The ascidians afford another evident instance of the extreme modification of pelagic forms for littoral existence.

The peculiar mode of respiration of vertebrata by means of gill-slits occurs in no other animal group except in Balanoglossus, which will probably shortly be included among vertebrata. Possibly gill-slits as a respiratory apparatus first arose in a littoral form, such as Balanoglossus, and hence their presence at the anterior end of the body, that nearest to the surface in an animal buried in sand. The connection of Balanoglossus with the echinoderms through Tornaria is very remarkable. Possibly Amphioxus once had a Tornaria stage, and has lost it just as one species of Balanoglossus has lost it, as Mr. Bateson has lately discovered.

The littoral zone has given off colonists to the other three faunal regions. The entire terrestrial fauna has sprung from colonists contributed by the littoral zone. Every terrestrial vertebrate bears in its early stages the gill-slits of its aquatic ancestor. All organs of aërial respiration are mere modifications of apparatus previously connected with aquatic respiration, excepting, perhaps, in the case of Tracheata, tracheæ being most likely modifications of skin-glands, as appears probable from their condition in Peripatus. The oldest known air-breathing animals are insects and scorpions, which have lately been found in Silurian strata. Professor Ray Lankester believes the lungs of scorpions to be homogeneous with the gill-plates of Limulus. Birds were possibly originally developed in connection with the sea-shore, and were fish-eaters like the tooth-bearing Hesperornis.

The fauna of the coast has not only given rise to the terrestrial and fresh-water fauna; it has from time to time given additions to the pelagic fauna in return for having thence derived its own starting-points. It has also received some of these pelagic forms back again, to assume a fresh littoral existence.

The deep-sea fauna has probably been formed almost entirely from the littoral, not in the remotest antiquity, but only after food derived from the *débris* of the littoral and terrestrial faunas and floras became abundant.

It is because all terrestrial and deep-sea animal forms have passed through a littoral phase of existence, and that the littoral animals retain far better than those of any other faunal region the recapitulative larval phases by means of which alone the true histories of their origins can be recovered, that marine zoölogical laboratories on the coast have made so many brilliant discoveries in zoölogy during late years.

SIBERIA AND THE EXILES.

By Dr. ALFRED E. BREHM.

WHOEVER associates with the name of Siberia the idea of a vast prison is involved in as great an error as the person who conceives the country as an icy desert or an interminable *tundra*. The *tundras*, whose icy fields form a prominent feature in the polar regions, with the stunted vegetation of their southern parts, are no myths, nor is it a fiction that the Russian Government, following the example of France and England, has adopted a system of penal colonies, and has planted them in Siberia. But by far the larger part of this immense territory has been spared the presence of convicts; and the districts in which the residence of persons of that class will justify the application of such a designation occupy a relatively small space in the country. It can not be denied that the transported persons, so far as they do not work in the mines, are subjected to a very strong restraint, but it is in no respect more severe than that which is imposed in the houses of correction of our highly civilized lands. Siberia is regarded by the mass of readers as a country full of discomfort and misery, and it is very hard to controvert that view. It is too much the fashion to consider the Russians as barbarians, and to accuse them of inhumanity. I feel compelled to enter a decided protest against so unjust a condemnation, and to assert as a fact that there are greater barbarians in Europe than the Russians. We shall have to apologize for the whole human race, before we can describe the Russians as the greatest barbarians. I myself formerly believed that one had only to scratch Russians to bring out their barbarism, but I have more recently had occasion to form my judgment from my own unprejudiced observations on the spot, and I consider it my duty, and the duty of every just and truthful man, to bear witness to the incontrovertible truth, and give an energetic protest against such systematic *a priori* depreciation of a people I have learned to respect. It is true that there are, in the great Russian Empire, as well as in other countries, men who might, should, and ought to be better, but we curiously see only the shady side of Russian conditions, and then perversely suppose that there is nothing good on the other side of the Muscovite lines. I can readily and with perfect conviction declare that, among the educated Russians of Russia, there are manifest a spirit of progress and a striving after better and higher things such as exist nowhere else, and that many of them afford rare examples of magnanimity and generosity. If we consider it from a purely geographical point of view, we shall find that Siberia is in no way, as a whole, a land of misery and terror. It is true that away up in the north are the immense ice-fields and the high moors, and the short, insignificant vegetation of the *tundra* does not offer an attractive picture; but there is also a larger Southern Siberia, where there is room for all kinds of enterprise, reward for every kind of work, and good living for every industrious man. Material suffering can not be spoken of in this part of the land; but in an intellectual sense there is much lacking without which we can hardly think of life. Thus, it seems to us something to be lamented that the people are four or five weeks behind the current events of the world. But if the question is one of making a living by means of hard work and a rugged constitution, and particularly of making a new start in life, then Siberia is to be preferred to nearly every other country. Yes, a new era has dawned over Siberia, and along the highways famous for "sighs, where night and day, with the frightful clang of chains, with lamentations, groans, and agony, the prisoners were driven on by the cruel knout," are now wending free men, joyous with hope, with their families and goods, going to build up a more comfortable home than the old one in the rich fields of the Southeast. And all those who give themselves earnestly to it see their enterprise crowned with success. The false representations which are so widely spread respecting Siberia originate in the numerous maliciously colored descriptions of the country, and judgments of its condition, that flow from the pens of famous convicts. I can not exactly pronounce these reports unjust, but they should not be taken as wholly correct. It is a recognized fact that misery and wickedness pain the eye and the heart and provoke erroneous and unjust statements ; particularly when, as is the case with the majority of the exiles in question, the conditions are complicated with politics. The situation of the ordinary exiles in the mines and of the settled convicts is relatively much better than that of the miners who are laboring under the despotism of capital in Germany. If one has no especial backsets in Siberia, if he can and will work, he will be able under all ordinary circumstances to earn a most comfortable living there. When I crossed the Ural the first time, I had only the ethnographic side of my journey in view, and thought little or nothing of the ethical side, which bore no relation to the object I was then seeking. I was not concerned with the exiles, nor in general could any man who stood in open conflict with the laws, not even a political dynamiter or murderer, have aroused any interest in me. But, from the moment when I found myself in the heart of Siberia and came in contact with its exiles, I felt it my duty to examine the ethical question more closely. I have gone down into the dens of vice, and made the acquaintance of the most common criminals—of thieves, robbers, and murderers ; I have associated with political exiles ; I have sought information everywhere ; have made inquiries of officers and private persons, have visited prisons, collected statistics, taken down numerous biographies as given by the exiles from their own mouths, or as recorded by impartial persons ; in short, I have become a regular philanthropist. I am aware of one thing, that I have taken all pains to discover the truth, and, if I have not been successful in it, the want of success must not be attributed to lack of good-will, but to the defects of my sources of information.

To make possible an impartial view of the condition of the exiles and prisoners in Siberia, we must first try to learn what the free-born Siberians may attain ; and it is therefore incumbent on me to describe the general conditions before proceeding to the illustration and estimation of the situation of the convicts.

It is the region of the mines of the Altai, which, like most of Siberia, is an imperial crown-land, that should more especially be brought under view, for thither are sent those offenders whose sentences to death have been commuted ; and the district plays an important part in the more or less romantically tinged accounts of affairs that are sent out. The region, which comprises 8,200 geographical miles, is rich, immensely rich, in subterranean treasures. It is penetrated by veins of silver and gold. Up to the year 1861, seven hundred and thirty mines were opened, and two hundred and sixty abandoned. The precious metals are not the principal treasure; the region also contains copper, tin, antimony, lead, and iron, and includes an immense coal-field. The surface of the land is correspondingly productive, and will compare well in agricultural capacity with the best parts of Germany. The climate is generally mild. During four months a hot summer prevails, which is followed by two months of autumn, four of winter, and two of spring. The mean temperature is not high enough perfectly to ripen grapes, but oranges grow well in the southern parts. The fact that the people live to be very old is the best testimony to the good qualities of the climate. When I traveled over the country, in 1876, I was assured that only four doctors were settled within the whole of the vast territory, and they did not live in very great luxury. Men die here of old age without the help of medicine, and live long and happily without doctors.

Since the house of Romanoff has taken possession of the country, any one can settle there, cultivate such land as suits him, and erect factories, on the single condition of paying an annual rent of thirty copeks—about seventeen cents—per acre; but the fee of the land remains the Czar's; the tenant can cut the wood, but the soil belongs to the imperial domain. He can not mine for gold and silver, or other metals, for these go with the title to the land. As it always has been and is now generally in the Russian Empire, the old ways are encroached upon in every direction. The Romanoffs had for the exploitation of the mines mingled a number of their serfs from Russia with the men already there, and no one could enter upon a systematic or regular cultivation of the soil. The serf-laborers, with their wives and children, received as much as was necessary to satisfy their wants. Till 1861 the population consisted, with rare exceptions, of imperial officers and socage-laborers, mining experts, and superintendents, who were always trained men, and contributed much to the amelioration of the manners of their underlings, who, in other respects, had much to complain of in their treatment. On the 1st of March, 1861, there were living on the crown-lands 145,630 souls, or, in round numbers, 350,000 persons—for in Russia women and minors are not enumerated in the statistical reports. In the mines alone more than 25,000 men were employed, when Czar Alexander, with a stroke of the pen, abolished serfdom, not out of humanity, but in order to weaken the political power of the Staroste.

The serfs in the mines represented only about half of the 25,000 miners—or 12,000 men—and became free peasants without owning any property in the real sense of that word, all lands belonging to the Czar; but they received as much land as they needed, on the usual terms of a ground-rent of thirty copecks per acre. The other half of the miners continued at their old employment, and are now efficient laborers, who accomplish more in freedom than they formerly did in servitude, so that the mines are becoming more profitable every year. Up to the year 1861 the return in most cases did not cover the outlay. In order to cover the deficiency of laboring forces, persons condemned to death and then pardoned were added to the free miners.

From this time agriculture improved rapidly, and in the year 1876 half of Siberia was already settled. A free peasantry was formed, such as we might desire to see in the whole of the country. There are no servile persons like the Russian peasants, and, when I occasionally by inadvertence called them "Russians," they would immediately inform me that I was mistaken, they were "Siberians." "There is no servitude here," they would add; "we are all free men. Heaven is high and the Czar rich, but we have nothing to fear, for we are in Siberia." Not the farmers alone, but the officers also, are inflated with this air of freedom, and not unfrequently may we hear from the mouth of one of the latter such words as, "If you want to see slaves, you must go back over the Ural into Russia, where their home is." And these people speak with truth, for, although serfdom is legally abolished in Russia, it continues to exist in fact, even among the mercantile classes.

I had already been told in Russia that prosperity was generally prevailing in Siberia, and shone in strong contrast with Russian poverty, and I am again obliged to say here that even Russian poverty is not so repulsively conspicuous as the misery in the German factory and mining districts. I do not go too far in asserting that the Siberians lead a happy life; and the best evidence in confirmation of this opinion is found in the fact that the idea of an independent Siberia, not attached to Russia, has already begun to dawn in a few speculative minds. I must guard myself against the suspicion that I am falling into a merely subjective judgment. My opinion is founded on careful observations and conscientious inquiries. It is generally known that in all countries and governments the farmers are always complaining of hard times and high taxes, and I therefore took special pains to compare these peculiar complaints with the representations of the officers. I had arranged a kind of informal catechism in my head, and used it on every suitable opportunity. The answers were, in all cases, if not literally, substantially alike, and I can not forbear repeating one set of them here. My conductor and myself were staying a short time in a little mountain-town, and in one of my excursions I overtook an old peasant who I afterward learned was the head-man of a small village. I invited him to take a seat in my carriage, and at once opened my catechism upon him:

"How is it with you here?" said I.

"God bears with our sins," he replied.

"Yes, he is very merciful, but how are affairs otherwise?"

"We are contented."

"How are the wife and daughters?"

"They are contented."

"And the other children?"

"They are all contented."

This peasant answered my first three questions with the words "We are contented." I was born among farmers, and believe that I know them well, as I have had much to do with them, but no German farmer ever told me he was contented.

I next turned from the family to the live-stock, and asked, "How many horses have you?

"Thirty or thirty-five."

"Don't you know exactly?"

"No, there may be some new colts, and some may have been stolen or eaten by wolves. I sometimes use six, sometimes eight, and sometimes fourteen."

"Then you have twenty more than you use. You will sell them?"

"That may be."

"But what will you do with so many extra beasts?"

"That's nothing to you."

I would remark that the last answer is a polite form of expression among Siberian farmers. I continued:

"And how many head of cattle have you?"

"That is my wife's affair."

"And how many hogs?"

"Nobody knows."

"How large crops do your fields return?"

"I am satisfied if I get ten times as much as I sow."

"Are your taxes heavy?"

"We are satisfied with them."

"Have you farmers nothing to complain of?"

"Oh, yes, we are getting crowded here; there are beginning to be too many people in the country. If I were not so old, I should move farther east."

"But," I replied, in surprise, "where are the villages? I don't see any."

My village-chief was silent, and shook his head doubtfully. The fact was, the nearest village was ten miles away. The man was satisfied with himself and his family, satisfied with his live-stock and his crops, and satisfied with his taxes, and over-population was apparently the only thing which he and his peers conceived needed to be set right. On this point we should remember that not nearly all the land is yet taken up, and that many of the farms are as large as, and sometimes larger than, the most extensive German manors. Even a spoiled American farmer would be satisfied with such an area. In the midst of these extensive estates stands the spacious log-house, surrounded with barns and sheds, which, possibly, are not large enough. Hardly anything is large enough for the Siberian. I have made personal confirmation of this greed for extension and space in the towns, where it is often carried to excess ; thus I have seen parlors where the mirrors and sofas could be counted by the dozen. In bright contrast with the stereotyped complaints of the farmers concerning the too thick population is the fact that they are all proud of having a numerous progeny. The farmer loves his land, his cattle, his summer and fall, but he loves above everything a large family, while, notwithstanding his prejudice against strangers, he lives in the perfect conviction that the country needs men, and he governs his conduct accordingly. In every other country in the world there are foundling-hospitals ; in Russia they are numerous, but in Siberia there are none. If a mother is not able to take care of her child, she will offer it to the nearest farmer, and he will be as glad to have such an increase in his family as if it were a fine colt foaled to him. Till 1856, marriage of free persons was permitted at any age ; now the marriageable age is fixed by law at eighteen years. To show how little in earnest the people are in their deprecation of over-population, they as a rule marry immediately after they have passed the legal age, and their families increase, with mathematical regularity, by at least one member every year. It may sound strange if I mention the fact that, notwithstanding the low marriageable age fixed by law, elopements are common. It is true they are of a quite peculiar sort, and they might be divided into elopements with and elopements without the consent of the parents on either side. This custom so illustrates the character of the peasantry of all regions, that I must not dismiss it with too brief a mention. Elopement with consent is an important matter. The young pair are agreed, and have the full acquiescence of the parents on both sides. But every marriage calls for a wedding, and a farmer's wedding is, under ordinary circumstances, no child's play. The relatives and friends must be invited from distances extending to fifty or a hundred miles. The substantial part of the feast is rather a secondary affair to the farmer richly provided with farm products and cattle, but then drink must be furnished, and the national drink is dear, and will be consumed on such occasions in immense quantities. In order to escape the expense of this provision, which would be borne equally by both families, the parents of the bridegroom advise him to elope with his beloved, and her parents advise her to consent to the elopement. After receiving the blessings of the crafty parents, the young people steal away into the bush. On the next day the friends set up a cry as of murder, beat around for a while, and laugh in their sleeves. The young couple must of course come back after a little while and receive forgiveness, but there can be no wedding-feast after such a "scandal." The latter is confined to a narrow circle, and the brandy is saved. The second kind of elopement is of a more serious nature, but in it also thrift and brandy play the chief parts, the latter that of a propitiator. The custom prevails for the bridegroom to pay to his future mother-in-law before she will give her acquiescence a definite sum of "bride-money," the amount of which is regulated according to the standing of the parties. The Siberian youth, having thus made things all right for his future, escapes with his beloved by night and under favor of darkness, and with the scandal of the abduction of the daughter a second matrimonial candidate is out of the question. The mother screams and curses the couple for a little while, but the storm soon ceases. The bridegroom knows the people he is dealing with, and, after the first spurt of vexation is over, returns with a stout brandy-flask, from which he pours out to the angry mother-in-law till she is propitiated. Then the ruined daughter appears, and a general forgiveness follows, with a family wedding-feast, in which immense quantities of brandy are consumed.

The young pair go right to housekeeping, and in the course of ten years the former abductor will be able to stretch himself before the door of his own unencumbered residence. In the reception-room will hang waving tapestries, and in the bedrooms will rustle silken curtains and canopies. I have seen hundreds of such cheerful family pictures and rejoiced over them. The people form a splendid race, and are happy. "I am a Siberian!" sounds from the mouth of one of them like a shout of exultation; "I have nothing more to desire."

A similar happy future awaits the convict-exile, if long life and success are given him, and he is endowed with courage and energy. "He is consigned to the mines, and will die there by inches with chains on his hands and feet," is the current expression when speaking or writing of a Siberian convict. But here, too, as in other cases, the colors are too darkly painted. I do not feel called upon to deplore the excessive harshness of Russian justice, or to indulge in general criticism, but it is true that not only criminals, but also disagreeable persons, vagrants, and political oppositionists, are sent to Siberia under cover of judicial proceedings. What is now imposed in Russia as a punishment was also administered not so very long ago in Germany and even in free Switzerland.

Whoever, by a judicial sentence, or by an administrative measure, is exiled to Siberia, is first lodged in a district prison, whence he is transferred to a government prison. The transportation to Siberia is carried on by railroad and boats to Tobolsk, where a division of the gang takes place, and destinations are appointed for the prisoners according to the character of their offenses. Those who have been condemned to death, and had their sentences commuted to exile, are bound with chains and all sent together to the mines of the Altai. Formerly the convicts were driven in gangs, chained about two feet apart. So at least I have read and heard it generally believed. I was once myself a witness of a spectacle of this kind, but it was not in Russia nor in Siberia, but in Olmütz, in Austria, in the year of grace 1872. The worst part of the journey is when the steamers come into requisition. They are long boats with a high deck, designed to carry six hundred persons at once. The deck is inclosed and covered with strong grating, in order to prevent any attempts to escape. Fore and aft of these are the kitchens and hospitals, while the six hundred convicts are confined in a mass under the deck in a space which is far too narrow, and where, for lack of efficient ventilation, a stifling atmosphere always prevails. The Russian law allows a divorce to the wives of convicts sentenced to exile, but the communes, on the other hand, are anxious to cast off the burden of their possibly pauper families, and the government encourages this disposition by permitting the wives and children of the exiles to go with them. In most cases, the families are ready to share the fate of the father; the Jewish wife always goes with her husband. The relatives are also sent off with the prisoner. This measure has evil consequences on the vessels, where, as we have said, six hundred persons, including those of the worst character, are crowded into a single apartment, and can see, hear, and talk with one another at every hour of the day and night. When we consider that many children are mingled with the crowd, we can easily conceive what horrible scenes besides the physical torments are enacted there, and how brutalizing must be the impression they make upon young and old. In such cases the reproach of inhumanity against the government is fully justified, and it is not spared, for I have frequently heard the officers condemn the decrees of the courts. The journey by steamer requires ten times less time, but it is also ten times worse, more degrading, and more barbarous than the march on foot. When the change is made from the steamer to the railroad the situation assumes a little better shape. The prisoners, with their wives and children around them, cling to the benches along the bare walls, and the chains clink weirdly in the confusion of screaming, moaning, and cursing voices. Here also is a deficiency of space and air, and the conditions are hardly endurable. But the few observations of strangers are contradicted by the stereotyped view. "The farmers do not travel differently, and what they freely endure for themselves certainly ought to be good enough for criminals." Gangs on foot are still usual, but only the strongest men are taken in them, and the treatment is more humane than it was. The average day's journey is about seven geographical miles, and every third day is a rest-day. Complaints may be heard that seven miles a day is too much, but it seems to be forgotten that the soldier has to perform the same march, and he is encumbered with his baggage. At the present time the deportation takes place only in the summer, and the exiles are settled before the approach of winter.

At the beginning of the journey, each prisoner is given a gray cloak, and he receives daily for his maintenance from ten to fifteen copecks, about from five and two thirds to eight and a half cents. This may seem very little in our conception, but it must not be forgotten that the men are permitted to beg on the way and to work on the rest-days, whereby each one may, if he will, obtain a considerable addition to his allowance. Great sympathy is felt in Siberia with the prisoners, who are never called by any other name than "unfortunates." Every one gives readily, and recollects that he himself, perhaps, or his father or grandfather, may have made the journey thither under similar circumstances. On the whole, transportation on foot is now quite well conducted. Such a journey can not be called a pleasure-trip, but it does not in any way bear the stamp of inhumanity and the terrible character which the sensational reports would impute to it.

Finally, the prisoner has reached his destination, either alone or with his wife and children, and is allotted accordingly a larger or smaller hut for a dwelling—I am speaking particularly of those who had been condemned to death. The chains are not taken off from his hands and feet, but he must work with them on. It often happens that he dies shortly—that is his luck; or that he will not accommodate himself to the situation, and leads a wretched existence, and finally goes to ruin, unless he has energy enough left to escape. He is himself committed to the most arduous exertions to better his fate, but, of the thousands and thousands who arrive there, only a very small per cent have the earnest will to do it. The great majority brood over their lot, and think and dream only about the ways and means of bringing about their escape. The convicts are mingled in work with the free laborers, go in and out with them, and do not have to exert themselves any more or do any harder work than they. The mine is not a prison as we are accustomed to regard prisons. The convict lives free and unwatched, alone or with his family, and the only limitation of freedom imposed upon him consists in his being always shackled with chains, whether at work or at recreation, by day and by night, and in his never being allowed to go out of the bounds that are assigned to him. In a district of six thousand square versts (about eight hundred and sixty geographical square miles), there are only a hundred soldiers stationed to watch the thousands of convicts. Escape under these circumstances is easy, and is a daily event. No one runs away alone; they generally go in pairs, and after careful preparation. The mine-smith is always ready, for a fee of ten copecks, to be a help in time of need and take off the chains. The fugitives gather up whatever seems useful to them, and travel under cover of darkness on their hazardous journey. On the next morning the director mentions the fact that A and B have disappeared. "No matter," he coolly remarks, and with that the affair is over for him. The fugitives spend the first three or four days in the woods, traveling at night, when they can pass on the highways undisturbed, and will rarely have to take the trouble to hide themselves. More than once have we met such desperadoes on the road, been begged from and given, in regular Siberian style. If a police-officer casually comes in the way, he will offer his mite very quietly, without asking a question. "Let them go, it's no matter," is the refrain of the officers. The farmers take the best of care of the fugitives, and that quite systematically. At night, before bedtime, provisions for any passing "unfortunates" are placed at the windows in all the villages on the roads leading to Russia. When a pair of such men come into the village, they go around from house to house, take the food they find set out, as much as they want, with a little provision for the road, and proceed to the bath-house, at the end of the village, where it is always pleasantly warm, to sleep ; and this they do with the greatest security, for they know that, in case of danger from the military patrol, the nearest farmer will send his son or a servant to the bath-house to warn any "unfortunates" that may be lodging there. The farmer is the providence of these people.

After the fugitives have put a distance of one hundred and fifty or two hundred miles between themselves and the mines, the journey becomes easier and they appear more openly. They can venture to ask for a lodging from any of the farmers, and to take horses from the back of the village and ride on them to the next village. There they will unbridle the beasts and start them back toward where they came from, mount fresh horses, and so on for hundreds and hundreds of miles. But the horses are every time carefully started back to their homes. Everything goes smoothly, and the sympathy of the people is inexhaustible, so long as the "unfortunate" does not steal. As soon as he appropriates the smallest portion of strange goods, he seals his fate. The whole village turns out and pursues the thief, who is beaten down like a dog, wherever and whenever he is found ; and he is always found. The result of this inexorable popular justice is, that hardly any thieves are to be found in Siberia, and that no country enjoys greater security than this colony of criminals. But, one may ask, "Are not the people punished who execute this lynch-law ?" It must be remembered that the mining district embraces an area at least five times as large as that of the State of New York, that the population is relatively small, and that in most cases no one cares for slain fugitives. If the officers are informed of the occurrence, they will simply remark that no harm has been done. The report is sent to St. Petersburg, and is lost in the flood of similar documents. The escape of convicts is, as we have remarked, a daily event, and it is of little consequence to the magistrates whether one more or less has been captured or killed. Of the fifteen thousand prisoners annually brought into the district, an average of five thousand escape. These are the desperate ones who stake everything to obtain freedom again. If they are brought back, they flee again. The number of those who escape two or three or more times, and are brought back as often, is great; and many "unfortunates" spend the last days of their lives in trying to get back to Russia, and being retransported to the colony.

This is the shadow-side of the convict's existence: I will now briefly sketch the bright side. A convict, who has become skilled in mining, repents of his offense, submits to his fate, works industriously, and conducts himself well in every respect, and ventures in time to open his heart to the director and ask to have his situation improved. The officer encourages him, gives him good advice, and permits him, after he has suffered three, four, or five years of punishment, to have his chains replaced by lighter ones, and, when he is convinced that the man is really reformed, grants him a settlement. Thus the prisoner has become a free man, except that he is never permitted to leave the district to which he is assigned. Now, the advantage of the system that permits the family of the prisoner to go with him to the place of punishment is manifested. The man has, during his long years of hard labor, been with his wife and children, has gained courage and strength in this family life, and has become a good man. The presence of his family has been a blessing to him. When in other countries the doors of the prison close upon a condemned man, the world is no more to him—all connection between him and his is severed; while to the Russian prisoner is left the comfort of his family, a strong anchor that holds his heart fast against the tumult of his sufferings. The released miner goes with his family to the settlement which has been designated for him. He has nothing but the bare land, his own strong will, and his energy inured to suffering. The village must extend a hand to him and advance the means for setting up an independent establishment. He is furnished a house—of course a very poor one—farming-tools, seed-corn, and a start in live-stock. Now, he begins a new life. After the first harvest is gathered, and what is necessary for his bare support has been reserved, he goes bravely to work to discharge his obligations to the commune. After ten years at latest, he will have made good to the last grain of corn, and he then becomes the owner of an estate free of debt, for which he has only to pay a small ground-rent, and has the satisfaction of knowing that after his death his children will be free men in a home founded by him.

Now, how does the condition of a person discharged from prison in one of the so-called civilized countries compare with that of this Siberian? The last spark of self-respect that may be left in him is extinguished by the reception society gives him. Contempt, suspicion, and scorn meet him at every step. Neither Government nor society will give him the means of rehabilitating himself by labor and of founding a new existence, and he sinks deeper and deeper, with no way of escape open to him, into crime and ever again into crime.

Pardoned convicts or their children are living in nearly every town and village of the Altai region, and this fact is the origin of the most curious relations. I sojourned for a short time at an inn in Tomsk. The host and his wife made an unfavorable, I might say a repulsive, impression upon me. I could not refrain from expressing my suspicions to the chief of police, to whom I had been introduced. To my edification I learned that the host had been condemned to twenty-five years in prison for fraudulent bankruptcy, and his wife to twenty years as his accessory ; that the porter was an old house-breaker, and the four butlers had been compelled to take the involuntary tour to the East for thefts ; the two maids were child-murderers ! Such is the environment in which the people of that district constantly live. On the next day I dined by invitation with a merchant. I met a polite, cultivated company, and learned afterward from my friend the police-officer that the apothecary, who sat next to me, had been transported for poisoning, that three of the guests were fraudulent directors of exploded banks, and two were counterfeiters ! The last two had made a bad impression on me from the beginning, and I could not afterward repress the thought that they were continuing in Siberia to increase as much as they could the circulation of cash in the Russian Empire. If one expresses surprise at such social conditions, the answer is, "Oh, please remember that we are in Siberia !" It is, moreover, not considered necessary to avoid speaking of these matters with reference to any one. The party concerned himself will converse on the subject with the greatest ease, and his frankness respecting it is really astonishing. I inquired one day in a matter-of-course-way of a Jew named Ephraim, who carried on a small banker's business, a very prepossessing man socially, how he came to settle there. He replied jestingly, and with a wink : "Circumstances are to blame for that ; they compelled me to establish my business here some two-and-twenty years ago."

Real prisons with locks and walls are comparatively rare in Siberia, and form in all cases, unless the positively evil disposition of the convict prolongs his stay, a transitional abode between the unlimited freedom he enjoyed before his offense and the limited freedom that follows his sentence. Offenders are not cast into narrow cells for the full term of their punishment, but go around free after a short confinement, and are supported by the contributions of their former colleagues, while they are afforded full opportunity to found a new existence. The contrasts between the positions which released prisoners may attain in Siberia and the offense which led to their exile are frequently quite comical. The child-murderer becomes a trusted nurse, the burglar an overseer, the thief a confidential servant ! But a practical Christianity is exercised toward the fallen one. The Government and private persons rival one another in pointing out and clearing the way of reform for the wanderer. In Kazmetak, we visited the local prison, which is unique in its way. It was of immense capacity, and was so arranged as to permit a complete separation of the several confessions—Mohammedans, Jews, and Christians. All the prisoners assured us that they had no complaints to make. The few political prisoners confirmed these statements, so that their condition, too, must certainly have been endurable; for it is well known that the political prisoners are the most discontented. A school is connected with the prison, in which a young priest was serving as teacher; the only text-book was a Russian catechism, which was used by Mohammedans and Jews as well as by Christians. The great point was that all learned to read and write. The priest received no pay, but was performing a work of mercy. In the same place are a hospital for the sick and an orphan-house for the children of those convicts whose imprisonment is prolonged. The foundation of this institution was the work of a lady who gave her whole fortune to it, and then devoted herself to the solicitation of means for its support.

When one has studied these conditions on the spot, and has satisfied himself that while the situation of the prisoner condemned to death and pardoned to the mines is hard, it nevertheless depends upon himself whether he shall improve it and make his children free, independent, and prosperous citizens; when one sees how the opportunity is given to all convicts, without distinction as to what their crime may have been, to found by their own exertions a new and honorable career, and that the Government aids the earnest efforts of such persons with counsel and act; when one, finally, contrasts the magnanimity, fidelity, and touching sympathy, existing among private persons, with the sad lot of convicts in Europe and America, he will have to admit that there may be worse countries than Siberia.

HOW SPELLING DAMAGES THE MIND.

By FREDERIK A. FERNALD.

LEARNING to read the English language is one of the worst mind-stunting processes that has formed a part of the general education of any people. Its evil influence arises from the partly phonetic, partly lawless character of English spelling. Although each letter represents some sound oftener than any other, there is hardly a letter in the alphabet that does not represent more than one sound, and hardly a sound in the language that is not represented in several ways, while many words are written with as many silent letters as significant ones. There is nothing in any word to indicate in which of these ways its component sounds are represented, nothing in the written group of letters to show which sounds they stand for, and which of them, if any, are silent, so that a learner can never be sure of pronouncing rightly an English word that he has not heard spoken, nor of spelling correctly one that he has never seen written. The spelling of each word must be learned by sheer force of memory. In this work the pupil's reasoning powers can not be utilized, but must be subdued, while his memory is sadly overworked. In the affairs of the child's daily life, the logical following out of rules is rewarded ; in learning to spell, it brings him only discomfiture and bewilderment. He is taught that *b-o-n-e* stands for *bōn* (not *bo-ne*), and *t-o-n-e* for *tōn*, but that *d-o-n-e* stands for *dun*, that *g-o-n-e* spells *gŏn*, *m-o-v-e* spells *moov*, and *b-r-o-n-z-e bronz.* Now when he comes in reading to another similar word, as *none*, he has no means of telling whether to call it *nōn*, *nun*, *nŏn*, *noon*, or *non ;* he can only look up at his teacher and wait to be told. The influence of the spelling-class quickly drives him to repress any inclination to reason, and he gives himself up to a blind following of authority. No child learns English spelling without getting the pernicious notion that cram is better than thinking, and that common sense is a treacherous guide. The child who can take what he is told without asking why, who can repeat a rule without troubling himself about its meaning, gets along best. On the other hand, the child who has difficulty in learning to spell may be expected to develop strong logical faculties. He is constantly trying to spell according to some principle, and, of course, constantly coming to grief. Thus a boy who had long been at the foot of his spelling-class was one day given the word *ghost*, and, making a desperate attempt at the sort of spelling he had oftenest heard succeed, he spelled it *g-h-o-g-h-j-s-t.* This bringing upon him shouts of laughter, he said, with clinched fist and tearful eyes : "You needn't laugh ; you all spell homelier 'n that!" So much attention is given to spelling that children obtain false ideas of its importance. The *spelling,* or representation, becomes to them the word, while the real *word* is called the pronunciation, and is thought of as an appendage. They learn to despise the poor speller, a prejudice which is never outgrown, and above all they become so absorbed in the manipulation of words that they have little chance to grasp the ideas which the words stand for.

If our notation of numbers were as irregular as our notation of speech, so that the numbers from forty to forty-five, for instance, should be written, say as follows : 40, 741, 420, 43, 414, 225 ; and if no one could tell at sight whether a number like 7,243,812 contained several figures which were "silent," or had exceptional values, who can doubt that the study of arithmetic, instead of being a valuable discipline, would be mere mentally enervating drudgery ? If it were proposed that children should learn a style of writing music which gave different values to the same characters, similarly placed, in different pieces, and added a host of "silent" notes, the evils of learning such a system would be plainly seen. Yet many people, who have forgotten their own sufferings in the spelling-class, can not see that children are so very much perplexed in learning to spell, or perhaps maintain that the struggle involved is "good for them."

"I know," says Max Müller, "there are persons who can defend anything, and who hold that it is due to this very discipline that the English character is what it is; that it retains respect for authority; that it does not require a reason for everything; and that it does not admit that what is inconceivable is therefore impossible. Even English orthodoxy has been traced back to that hidden source, because a child accustomed to believe that *t-h-o-u-g-h* is *though*, and that *t-h-r-o-u-g-h* is *through*, would afterward believe anything. It may be so; still I doubt whether even such objects would justify such means. Lord Lytton says: 'A more lying, roundabout, puzzle-headed delusion than that by which we confuse the clear instincts of truth in our accursed system of spelling was never concocted by the father of falsehood. . . . How can a system of education flourish that begins by so monstrous a falsehood, which the sense of hearing suffices to contradict?'"

Here is a chief source of the incapacity for thinking which academy and college students bring into the science laboratories. This irrational process, taken up when the child enters school, occupying a large share of his time, and continued for six or eight years, has a powerful influence in shaping his plastic mind. When at last he is allowed to take up the study of nature, at the wrong end of his school course, what wonder that he sits with folded hands, waiting to be told facts to commit to memory, that he can not realize what a law is, and does not know how to use his reason in obtaining knowledge? Rational education will never flourish as it should till a reformation in the teaching of reading and spelling has been accomplished. Further, Mr. J. H. Gladstone, member of the English School Board for London, has computed the number of hours spent by children in learning to read and spell English to be 2,320, while, in gaining an equal knowledge of their native language, Italian children spend only 945 hours. The difference amounts to nearly two school years, and shows under what a disadvantage English-speaking children labor. Can any one believe that 4,923,451, or 13·4 per cent, of our population over ten years of age would be illiterate if learning to read were not so formidable an undertaking? In Norway, Sweden, Denmark, Switzerland, and some German states, there are hardly any illiterates.

The most striking testimony to the irregularity of our spelling is the adoption by some teachers of a sort of Chinese mode of teaching reading. The children are not taught that letters represent constituent sounds of words, but they learn to recognize each group of letters as an arbitrary compound symbol standing for a word. This is more of a dead drag on the memory than even the A-B-C method, and, if it could be completely carried out, would be a vastly longer process.

The effect on the mind is certainly no better. The Chinese have to memorize a compound symbol for each word in learning to read, but the patient endurance of such a burden is not consistent with the character of any other people than the submissive, imitative, unprogressive Chinese. The Japanese, who have long been clogged by the same system, have recently taken measures to throw it off.

"But what can be done?" will be asked; "shall children grow up without learning to spell?" No, but the memorizing of these anomalies and contradictions can be, at least, put off till the pupils' minds are in little danger of being perverted by it. Enough of the enormous amount of time spent in this drudgery can be saved to make possible the introduction of the study of *things* into the primary schools, and many of the one hundred millions of dollars which we spend each year for public education can be turned to imparting real knowledge instead of the mere tools of knowledge. These ends may be attained by the use of phonetic spelling as an introduction to the customary spelling. Children can and do learn to read English spelled phonetically in a very few lessons, and learn the traditional spelling so quickly afterward that much less time is required for the whole process than is commonly devoted to memorizing the current spelling alone. Classes taught to read in this way, in Massachusetts, so early as 1851, proved the advantage of the method to the satisfaction of that able educator, Horace Mann, and the method has been successfully employed in many places in this country and in the British Isles. The following extract from a letter written by Mr. William Colbourne, manager of the Dorset Bank, at Sturminster, England, since deceased, furnishes a special example, though it may be conceded to be exceptionally favorable:

"My little Sidney, who is now a few months more than four years old, will read any phonetic book without the slightest hesitation; the hardest names or the longest words in the Old or New Testament form no obstacle to him. And how long do you think it took me—for I am his teacher—to impart to him this power? Why, something less than eight hours! You may believe it or not as you like, but I am confident that not more than that amount of time was spent on him, and that was in snatches of five minutes at a time, while tea was getting ready. I know you will be inclined to say: 'All that is very well, but what is the use of reading phonetic books? He is still as far off, and may be farther, from reading romanic books.' But in this you are mistaken. Take another example. His next elder brother, a boy of six years, has had a phonetic education so far. What is the consequence? Why, reading in the first stage was so delightful and easy a thing to him, that he *taught himself* to read romanically, and it would be a difficult matter to find one boy in twenty, of a corresponding age, that could read half so well as he can in any book. Again, my oldest boy has written more phonetic short-hand and long-hand, perhaps, than any boy of his age (eleven years) in the kingdom; and no one I dare say has had less to do with that absurdity of absurdities, the spelling-book! He is now at a first-rate school in Wiltshire, and in the half-year preceding Christmas he carried off the prize for *orthography* in a contest with boys, some of them his senior by years!"

Mrs. E. B. Burnz, of New York, says, in regard to her experience at Nashville, soon after the civil war: "The phonetic teaching in the Fisk School, as elsewhere, proved beyond all cavil that with phonetic books as much could be accomplished in four months in teaching to read as by a year with the common method. And, moreover, it showed that there is no difficulty experienced by children in passing from the phonetic to the ordinary printed books. After going through the phonetic primer and First and Second Reader, the children passed at once into the Second Reader in common print, and from the phonetic Gospel into the common New Testament." Successful experiments in common schools are on record in sufficient numbers to prove the practicability of the method.

Several phonetic primers have been published and are used in some American and English schools, for teaching English in the schools of Paris, and by missionaries among the Indians and other peoples. With one of these books, parents will find it a light task to teach their children to read at home in a few lessons. Since there are only twenty-six (or, counting *æ* and *œ*, twenty-eight) letters in our alphabet, while for phonetic printing means of representing forty sounds are needed, each of these books uses an extended form of the alphabet. Unfortunately, no one alphabet for the phonetic printing of English has yet been agreed upon; still, any of these systems can be adopted for the schools of a city or town, with the certainty of good results. The alphabet devised by the American Philological Association may be said to be the most authoritative; it has also the merit of employing only three new letters. I am not unaware of the efforts being made to replace the current spelling by a phonetic system for all purposes, but that is a matter quite distinct from the subject of this article; and all who believe that the orderly and vigorous development of the mental faculties should be the chief end in education, whether they favor or oppose the spelling reform, can work together for the spread of the phonetic method of teaching reading.

SUNLIGHT AND THE EARTH'S ATMOSPHERE.*

By Professor S. P. LANGLEY.

THERE is, we may remember, a passage in which Plato inquires what would be the thoughts of a man who, having lived from infancy under the roof of a cavern, where the light outside was inferred only by its shadows, was brought for the first time into the full splendors of the sun.

We may have enjoyed the metaphor without thinking that it has any physical application to ourselves, who appear to have no roof over our heads, and to see the sun's face daily; while the fact is, that if we do not see that we have a roof over our heads in our atmosphere, and do not think of 'it as one, it is because it seems so transparent and colorless.

Now, I wish to ask your attention to-night to considerations in some degree novel, which appear to me to show that it is not transparent as it appears, and that this seeming colorlessness is a sort of delusion of our senses, owing to which we have never in all our lives seen the true color of the sun, which is in reality blue rather than white, as it looks, so that this air all about and above us is acting like a colored glass roof over our heads, or a sort of optical sieve, holding back the excess of blue in the original sunlight, and letting only the white sift down to us.

I will first ask you, then, to consider that this seeming colorlessness of the air may be a delusion of our senses, due to habit, which has never given us anything else to compare it with.

If that cave had been lit by sunshine coming through a reddish glass in its roof, would the perpetual dweller in it ever have had an idea but that the sun was red? How is he to know that the glass is "colored" if he has never in his life anything to compare it with? How can he have any idea but that this is the sum of all the sun's radiations (corresponding to our idea of white or colorless light); will not the habit of his life confirm him in the idea that the sun is red; and will he not think that there is no color in the glass so long as he can not go outside to see? Has this any suggestion for us, who have none of us ever been outside our crystal roof to see?

We must all acknowledge, in the abstract, that habit is equally strong in us, whether we dwell in a cave or under the sky; that what we have thought from infancy will probably appear the sole possible explanation; and that, if we want to break its chain, we should put ourselves, at least in imagination, under conditions where it no longer binds us.

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The Challenger has dredged from the bottom of the ocean fishes which live habitually at great depths, and whose enormous eyes tell of the correspondingly faint light which must have descended to them through the seemingly transparent water. It will not be as futile a speculation as it may at first seem, to put ourselves in imagination in the condition of creatures under the sea, and ask what the sun may appear to be to them ; for, if the fish who had never risen above the ocean-floor were an intelligent being, might *he* not plausibly reason that the dim greenish light of his heaven—which is all he has ever known—was the full splendor of the sun shining through a medium which all his experience shows is transparent ?

We ourselves are, in very fact, living at the floor of a great aërial sea, whose billows roll hundreds of miles above our heads. Is it not at any rate conceivable that we may have been led into a like fallacy from judging only by what we see at the bottom ? May we not, that is, have been led into the fallacy of assuming that the intervening medium above us is colorless because the light which comes through it is so ?

I freely admit that all men, educated or ignorant, appear to have the evidence of their senses that the air is colorless, and that pure sunlight is white, so that if I venture to ask you to listen to considerations which have lately been brought forward to show that it is the sun which is blue, and the air really acts like an orange veil or like a sieve which picks out the blue and leaves the white, I do so in the confidence that I may appeal to you on other grounds than those I could submit to the primitive man who has his senses alone to trust to ; for the educated intelligence possesses those senses equally, and in addition the ability to interpret them by the light of reason, and before this audience it is to that interpretation that I address myself.

Permit me a material illustration. You see through this glass, which may typify the intervening medium of air or water, a circle of white light, which may represent the enfeebled disk of the sun when so viewed. Is this intervening glass colored or not ? It seems nearly colorless ; but have we any right to conclude that it is so because it seems so ? Are we not *taking it for granted* that the original light which we see through it is white, and that the glass is colorless, because the light seems unaltered ; and is not an appeal to be made here from sense to reason, which, in the educated observer, recalls that white light is made of various colors, and that whether the original light is really white and the glass transparent, or the glass really colored and so *making* the white, is to be decided only by experiment, by taking away the possibly deceptive medium ? I can take away this glass, which was not colorless, but of a deep orange, and you see that the original light was not white, but intensely blue. If we could take the atmosphere away between us and the sun, how can we say that the same result might not follow ? To make the meaning of our illustration clearer, observe that this blueness is not a pure spectral blue. It has in it red, yellow, blue, and all the colors which make up white, but blue in superabundance ; so that, though the white is, so to say, latent there, the dominant effect is blue. The glass colored veil does not put anything *in*, but acts I repeat like a sieve straining *out* the blue, and letting through to us the white light which was there in the bluishness, and so may not our air do so too ?

I think we already begin to see that it is at any rate conceivable that we *may* have been hitherto under a delusion about the true color of the sun, though of course this is not proving that we have been so, and it will at any rate, I hope, be evident that here is a question raised which ought to be settled, for the blueness of the sun, if proved, evidently affects our present knowledge in many ways, and will modify our present views in optics, in meteorology, and in numerous other things. In optics, because we should find that white light is *not* the sum of the sun's radiations, but only of those dregs of them which have filtered down to us ; in meteorology, because it is suggested that the temperature of the globe and the condition of man on it depend in part on a curious selective action of our air, which picks out parts of the solar heat (for instance, that connected with its blue light), and holds them back, letting other selected portions come to us, and so altering the conditions on which this heat by which we live depends ; in other ways, innumerable, because, as we know, the sun's heat and light are facts of such central importance that they affect almost every part of scientific knowledge.

It may be asked, What suggested the idea that the sun may be blue rather than any other color ?

My own attention was first directed this way many years ago when measuring the heat and light from different parts of the sun's disk. It is known that the sun has an atmosphere of its own which tempers its heat, and, by cutting off certain radiations and not others, produces the spectral lines we are all familiar with. These lines we customarily study in connection with the absorbing vapors of sodium, iron, and so forth, which produce them ; but my own attention was particularly given to the regions of absorption, or to the color it caused, and I found that the sun's body must be deeply bluish, and that it would shed blue light except for this apparently colorless solar atmosphere, which really plays the part of a reddish veil, letting a little of the blue appear on the center of the sun's disk where it is thinnest, and staining the edge red, so that to delicate tests the center of the sun is a pale aqua-marine, and its edge a garnet. The effect I found to be so important, that if this all but invisible solar atmosphere were diminished by but a third part, the temperature of the British Islands would rise above that of the torrid zone, and this directed my attention to the great practical importance of studying the action of our own terrestrial atmosphere on the sun, and the antecedent probability that our own air was also and independently making the really blue sun into an apparently white one. We actually know, then, beyond conjecture, by a comparison of the sun's atmosphere, where it is thickest and where it is thinnest, that an apparently colorless atmosphere *can* have such an effect, and analogous observations which I have carried on for many years, but do not now detail, show that the atmosphere of our own planet, this seemingly clear air in which we exist like creatures at the bottom of the sea, does do so.

We look up through our own air as through something so limpid in its purity that it appears scarcely matter at all, and we are apt to forget the enormous mass of what seems of such lightness, but which really presses with nearly a ton to each square foot, so that the weight of all the buildings in this great city, for instance, is less than that of the air above them.

I hope to shortly describe the method of proof that it too has been acting like an optical sieve, holding back the blue; but it may naturally be asked, "Can our senses have so entirely deceived us that they give no hint of this truth, if it be one? is the appeal wholly to recondite scientific methods, and are there no indications, at least, which we may gather for ourselves?" I think there are, even to our unaided eyes, indications that the seemingly transparent air really acts as an orange medium, and keeps the blue light back in the upper sky.

If I hold this piece of glass before my eyes, it seems colorless and transparent, but it is proved not to be so by looking through it edgewise, when the light, by traversing a greater extent, brings out its true color, which is yellow. Every one knows this in every-day experience. We shall not get the color of the ocean by looking at it in a wine-glass, but by gazing through a great depth of it; and so it is with the air. If we look directly up, we look through where it is thinnest; but, if we look horizontally through it toward the horizon, through great thicknesses, as at sunrise or sunset, is it not true that this air, where we see its real color most plainly, makes the sun look very plainly yellow or orange?

We not only see here, in humid English skies, the "orange sunset waning slow," but most of us in these days of travel can perfectly testify that the clearest heavens the earth affords, the rosy tint on the snows of Mont Blanc, forerunning the dawn, or the warm glow of the sun as he sets in Egyptian skies, show this most clearly—show that the atmosphere holds back the blue rays by preference, and lets the orange through.

If, next, we ask, "What has become of the blue that it has stopped?" does not that very blue of the midday sky relate the rest of the story —that blue which Professor Tyndall has told us is due to the presence of innumerable fine particles in the air, which act selectively on the solar waves, diffusing the blue light toward us? I hope it will be understood that Professor Tyndall is in no way responsible for my own inferences ; but I think it is safe at least to say that the sky is not self-luminous, and that, since it can only be shining blue at the expense of the sun, all the light this sky sends us has been taken by our atmosphere away from the direct solar beam, which would grow both brighter and bluer if this were restored to it.

If all that has been said so far renders it possible that the sun may be blue, you will still have a right to say that "possibilities" and "may-bes" are not evidence, and that no chain of mere hypotheses will draw Truth out of her well. We are all of one mind here, and I desire next to call your attention to what I think is evidence.

Remembering that the case of our supposed dweller in the cave who could not get outside, or that of the inhabitants of the ocean-floor who can not rise to the surface, is really like our own, over whose heads is a crystalline roof which no man from the beginning of time has ever got outside of, an upper sea to whose surface we have never risen—we recognize that if we could rise to the surface, leaving the medium whose effect is in dispute wholly beneath us, we should see the sun as it is, and get proof of an incontrovertible kind ; and that, if we can not entirely do this, we shall get nearest to proof under our real circumstances by going as high as we can in a balloon, or by ascending a very high mountain. The balloon will not do, because we have to use heavy apparatus requiring a solid foundation. The proof to which I ask your kind attention, then, is that derived from the actual ascent of a remarkable mountain by an expedition undertaken for that purpose, which carried a whole physical laboratory up to a point where nearly one half the whole atmosphere lay below us. I wish to describe the difference we found in the sun's energy at the bottom of the mountain and at the top, and then the means we took to allow for the effect of that part of the earth's atmosphere still over our heads even here, so that we may be said to have virtually got outside it altogether.

Before we begin our ascent, let me explain more clearly what we are going to seek. We need not expect to find that the original sunlight is a pure monochromatic blue by any means, but that, though its rays contain red, orange, blue, and all the other spectral colors, the blue, the violet, and the allied tints were originally there in disproportionate amounts, so that, though all which make white were present from the first, the refrangible end of the spectrum had such an excess of color that the dominant effect was that of a bluish sun. In the same way, when I say briefly that our atmosphere has absorbed this excess of blue and let the white reach us, I mean, more strictly speaking, that this atmosphere has absorbed *all* the colors, but, selectively, taking out more orange than red, more green than orange, more blue than green ; so that its action is wholly a taking *out*—an action like that which you now see going on with this sieve, sifting a mixture of blue and white beads, and holding back the blue while letting the white fall down.

This experiment only rudely typifies the action of the atmosphere, which is discriminating and selective in an amazing degree, and, as there are really an infinite number of shades of color in the spectrum, it would take forever to describe the action in detail. It is merely for brevity, then, that we now unite the more refrangible colors under the general word "blue," and the others under the corresponding terms "orange" or "red."

All that I have the honor to lay before you is less an announcement of absolute novelty than an appeal to your already acquired knowledge, and to your reason as superior to the delusions of sense. I have, then, no novel experiment to offer, but to ask you to look at some familiar ones in a new light.

We are most of us familiar, for instance, with that devised by Sir Isaac Newton to show that white light is compounded of blue, red, and other colors, where, by turning a colored wheel rapidly, all blend into a grayish white. Here you see the "seven colors" on the screen; but, though all are here, I have intentionally arranged them so that there is too much blue, and the combined result is a very bluish white which may roughly stand for that of the original sun-ray. I now alter the proportion of the colors so as to virtually take out the excess of blue, and the result is colorless or white light. White, then, is not necessarily made by combining the "seven colors," or any number of them, unless they are there in just proportion (which is in effect what Newton himself says); and white, then, may be made out of such a bluish light as we have described, not by putting anything to it, but by taking away the excess which is there already.

Here, again, are two sectors—one blue, one orange-yellow with the blue in excess, making a bluish disk where they are revolved. I take out the excess of blue, and now what remains is white.

Here is the spectrum itself on the screen, but a spectrum which has been artificially modified so that the blue end is relatively too strong. I recombine the colors (by Professor Rood's ingenious device of an elastic mirror), and they do not make a pure white, but one tinted with blue. I take out the original excess of blue, and what remains combines into a pure white. Please bear in mind that, when we "put in" blue here, we have to do so by straining out other light through some obscuring medium, which makes the spectrum darker; but that, in the case of the actual sunlight, introducing more blue introduces more light and makes the spectrum brighter.

The spectrum on the screen ought to be made still brighter in the blue than it is—far, far brighter—and then it might represent to us the original solar spectrum before it has suffered any absorption either in the sun's atmosphere or our own. The Fraunhofer lines do not appear in it, for these, when found in the solar spectrum, show that certain individual rays have been stopped, or selected for absorption by the intervening atmospheres; and, though even the few yards of atmosphere between the lamp and the screen absorb, it is not enough to show.

Our spectrum, as it appears before absorption, might be compared to an army divided into numerous brigades, each wearing a distinct uniform, one red, one green, one blue, so that all the colors are represented each by its own body. If, to represent the light absorbed as it progresses, we supposed that the army advances under a fire which thins its numbers, we should have to consider that (to give the case of nature) this destructive fire was directed chiefly against those divisions which were dressed in blue, or allied colors, so that the army was thinned out unequally, many men in blue being killed off for one in red, and that by the time it has advanced a certain distance under fire the proportion of the men in each brigade has been altered, the red being comparatively unhurt. Almost all absorption is thus selective in its action, and often in an astonishing degree, killing off, so to speak, certain rays in preference to others, as though by an intelligent choice, and destroying most, not only of certain divisions (to continue our illustration), but even picking out certain files in each company. Every ray, then, has its own individuality, and on this I can not too strongly insist; for just as two men retain their personalities under the same red uniform, and one may fall and the other survive, though they touch shoulders in the ranks, so in the spectrum certain parts will be blotted out by absorption, while others next to them may escape.

To illustrate this selective absorption, I put a piece of didymium glass in the path of the ray. It will, of course, absorb some of the light, but, instead of dimming the whole spectrum, we might almost say it has arbitrarily chosen to select one narrow part for action, in this particular case choosing a narrow file near the orange, and letting all the rest go unharmed. In this arbitrary way our atmosphere operates, but in a far more complex manner, taking out a narrow file here and another there, in hundreds of places, all through the spectrum, but on the whole much the most in the blue, the Fraunhofer lines being merely part of the evidence of this wonderful *quasi*-intelligent action which bears the name of selective absorption.

Before we leave this spectrum, let us recall one most important matter. We know that here beyond the red is solar energy in the form of heat which we can not see, but not on that account any less important. More than half the whole power of the sun is here invisible, and, if we are to study completely the action of our atmosphere, we shall have to pay great attention to this part, and find out some way of determining the loss in it, which will be difficult, for the ultra-red end is not only invisible, but compressed, the red end being shut up like the closed pages of a book, as you may notice by comparing the narrowness of the red with the width of the blue.

Now, refraction by a prism is not the only way of forming a spectrum. Nature furnishes us color not only from the rainbow, but from non-transparent substances like mother-of-pearl, where the iridescent hues are due to microscopically fine lines. Art has lately surpassed Nature in these wonderful "gratings," consisting of pieces of polished metal, in which we see at first nothing to account for the splendid play of color apparently pouring out from them like light from an opal, but which, on examination with a powerful microscope, show lines so narrow that there are from fifty to one hundred in the thickness of a fine human hair, and all spaced with wonderful precision.

This grating is equal in defining power to many such prisms as we have just been looking at, but its light does not show well upon the screen. You will see, however, that its spectrum differs from that of the prism, in that in this case the red end is expanded, as compared with the violet, and the invisible ultra-red is expanded still more, so that this will be the best means for us to use in exploring that "dark continent" of invisible heat found not only in the spectrum of the sun, but of the electric light, and of all incandescent bodies, and of whose existence we already know from Herschel and Tyndall.

Now, we can not reproduce the actual solar spectrum on the screen without the sun itself, but here are photographs of it, which show parts of the losses the different colors have suffered on their way to us. We have before us the well-known Fraunhofer lines, due, you remember, not only to absorption in the sun's atmosphere, but also to absorption in our own. We have been used to think of them in connection with their cause, one being due to the absorption of iron-vapor in the sun, another to that of water-vapor in our own air, and so forth; but now I ask you to think of them only in connection with the fact that each is due to the absorption of some part of the original *light*, and that collectively they tell much of the story of what has happened to that light on its way down to us. Observe, for instance, how much thicker they lie in the blue end than in the red—another evidence of the great proportionate loss in the blue.

If we could restore all the lost light in these lines, we should get back partly to the original condition of things at the very fount, and, so far as our own air is concerned, that is what we are to ascend the mountain for—to see, by going up through nearly half of the atmosphere, what the rate of loss is in each ray by actual trial; then, knowing this rate, to be able to allow for the loss in the other part still above the mountain-top; and, finally, by recombining these rays, to get the loss as a whole. Remember, however, always, that the most important part of the solar energy is in the dark spectrum which we do not see, but which, if we could see, we should probably find to have numerous absorption-spaces in it corresponding to the Fraunhofer lines, but where heat has been stopped out rather than light. To make our research thorough, then, we ought not to trust to the eye only, or even chiefly, but have some way of investigating the whole spectrum; the invisible in which the sun's power chiefly lies, as well as the visible, and both with an instrument that would discriminate the energy in these very narrow spaces, like an eye to see in the dark; and if science possesses no such instrument, then it may be necessary to invent one.

The linear thermopile is nearest to it of any, and we all here know what good work it has done, but even that is not sensitive enough to measure in the grating spectrum, in some parts of which the heat is four hundred times weaker than in that of a prism, and we want to observe this invisible heat in very narrow spaces. Something like this has been provided since by Captain Abney's most valuable researches, but these did not at the time go low enough for my purpose, and I spent nearly a year before ascending the mountain in inventing and perfecting the new instrument for measuring these, which I have called the "bolometer" or "ray-measurer." The principle on which it is founded is the same as that employed by my late friend, Sir William Siemens, for measuring temperatures at the bottom of the sea, which is that a smaller electric current flows through a warm wire than through a cold one.

One great difficulty was to make the conducting wire very thin, and yet continuous, and for this purpose almost endless experiments were made, among other substances pure gold having been obtained by chemical means in a plate so thin that it transmitted a sea-green light through the solid substance of the metal. This proving unsuitable, I learned that iron had been rolled of extraordinary thinness in a contest of skill between some English and American iron-masters, and, procuring some, I found that fifteen thousand of the iron plates they had rolled, laid one on the other, would make but one English inch. Here is some of it, rolled between the same rolls which turn out plates for an ironclad, but so thin that, as I let it drop, the iron plate flutters down like a dead leaf. Out of this the first bolometers were made, and I may mention that the cost of these earlier experiments was met from a legacy by the founder of the Royal Institution, Count Rumford. The iron is now replaced by platinum, in wires or rather tapes from $\frac{1}{2000}$ to $\frac{1}{20000}$ of an inch thick, one of which is within this button, where it is all but invisible, being far finer than a human hair. I will project it on the screen, placing a common small pin beside it as a standard of comparison. This button is placed in this ebonite case, and the thread is moved by this micrometer-screw, by which it can be set like the spider line of a reticule; but by means of this cable, connecting it to the galvanometer, this thread acts as though sensitive, like a nerve laid bare to every indication of heat and cold. It is then a sort of sentient thing: what the eye sees as light it feels as heat, and what the eye sees as a narrow band of darkness (the Fraunhofer line) this feels as a narrow belt of cold, so that when moved parallel to itself and the Fraunhofer lines down the spectrum it registers their presence.

It is true we can see these in the visible spectrum, but you remember we propose to explore the invisible also, and since to this the dark is the same as the light, it will feel absorption lines in the infra-red which might remain otherwise unknown.

I have spent a long time in these preliminary researches; in indirect methods for determining the absorption of our atmosphere, and in experiments and calculations which I do not detail, but it is so often supposed that scientific investigation is a sort of happy guessing, and so little is realized of the labor of preparation and proof, that I have been somewhat particular in describing the essential parts of the apparatus finally employed, and now we must pass to the scene of their use.

We have been compared to creatures living at the bottom of the sea, who frame their deceptive traditional notions of what the sun is like from the feeble changed rays which sift down to them. Though such creatures could not rise to the surface, they might swim up toward it; and, if these rays grew hotter, brighter, and bluer as they ascended, it would be almost within the capacity of a fish's mind to guess that they are still brighter and bluer at the top.

Since we children of the earth, while dwelling on it, are always at the bottom of the sea, though of another sort, the most direct method of proof I spoke of is merely to group as far as we can and observe what happens, though as we are men, and not fishes, something more may fairly be expected of our intelligence than of theirs.

We will not only guess, but measure and reason, and in particular we will first, while still at the bottom of the mountain, draw the light and heat out into a spectrum, and analyze every part of it by some method that will enable us to explore the invisible as well as record the visible. Then we will ascend many miles into the air, meeting the rays on the way down, before the sifting process has done its whole work, and there analyze the light all over again, so as to be able to learn the different proportions in which the different rays have been absorbed, and, by studying the action on each separate ray, to prove the state of things which must have existed before this sifting—this selective absorption—began.

It may seem at first that we can not ascend far enough to do much good, since the surface of our aërial ocean is hundreds of miles overhead; but we must remember that the air grows thinner as we ascend, the lower atmosphere being so much denser that about one half the whole substance or mass of it lies within the first four miles, which is a less height than the tops of some mountains. Every high mountain, however, will not do, for ours must not only be very high but very steep, so that the station we choose at the bottom may be almost under the station we are afterward to occupy at the top.

Besides, we are not going to climb a lofty, lonely summit like tourists to spend an hour, but to spend weeks; so that we must have fire and shelter, and above all we must have dry air to get clear skies. First I thought of the Peak of Teneriffe, but afterward some point in the Territories of the United States seemed preferable, particularly as the Government offered to give the expedition, through the Signal Service, and under the direction of its head, General Hazen, material help in transportation and a military escort, if needed, anywhere in its own dominions. No summit in the eastern part of the United States rises much over seven thousand feet; and, though the great Rocky Mountains reach double this, their tops are the home of fog and mist, so that the desired conditions, if met at all, could only be found on the other side of the continent in Southern California, where the summits of the Sierra Nevadas rise precipitously out of the dry air of the great wastes in lonely peaks, which look eastward down from a height of nearly fifteen thousand feet upon the desert lands.

This remote region was, at the time I speak of, almost unexplored, and its highest peak, Mount Whitney, had been but once or twice ascended, but was represented to be all we desired could we once climb it. As there was great doubt whether our apparatus, weighing several thousand pounds, could possibly be taken to the top, and we had to travel three thousand miles even to get where the chief difficulties would begin and make a desert journey of one hundred and fifty miles after leaving the cars, it may be asked why we committed ourselves to such an immense journey to face such unknown risks of failure. The answer must be that mountains of easy ascent and fifteen thousand feet high are not to be found at our doors, and that these risks were involved in the nature of our novel experiment, so that we started out from no love of mere adventure, but from necessity, much into the unknown. The liberality of a citizen of Pittsburg, to whose encouragement the enterprise was due, had furnished the costly and delicate apparatus for the expedition, and that of the transcontinental railroads enabled us to take this precious freight along in a private car, which carried a kitchen, a steward, a cook, and an ample larder besides.

In this we crossed the entire continent from ocean to ocean, stopped at San Francisco for the military escort, went three hundred miles south so as to get below the mountains, and then turned eastward again on to the desert, with the Sierras to the north of us, after a journey which would have been unalloyed pleasure except for the anticipation of what was coming as soon as we left our car. I do not indeed know that one feels the triumphs of civilization over the opposing forces of Nature anywhere more than by the sharp contrasts which the marvelous luxury of recent railroad accommodation gives to the life of the desert. When one is in the center of one of the great barren regions of the globe, and, after looking out from the windows of the flying train on its scorched wastes for lonely leagues of habitless desolation, turns to his well-furnished dinner-table, and the fruit and ices of his dessert, he need not envy the heroes of Oriental story, who were carried across dreadful solitudes in a single night on the backs of flying genii. Ours brought us over three thousand miles to the Mohave Desert. It was growing hotter and hotter when the train stopped in the midst of vast sand wastes a little after midnight. Roused from our sleep, we stepped on to the brown sand, and saw our luxurious car roll away in the distance, experiencing a transition from the conditions of civilization to those almost of barbarism, as sharp as could well be imagined. We commenced our slow toil northward with a thermometer at 110° in the shade, if any shade there be in the shadeless desert, which seemed to be chiefly inhabited by rattlesnakes of an ashen-gray color, and a peculiarly venomous bite. There is no water save at the rarest intervals, and the soil at a distance seems as though strewed with sheets of salt, which aids the delusive show of the mirage. These are, in fact, the ancient beds of dried-up salt lakes or dead seas, some of them being below the level of the ocean; and such a one on our right, though only about twenty miles wide, has earned the name of "Death Valley," from the number of human beings who have perished in it. Formerly an emigrant train, when emigrants crossed the continent in caravans, had passed through the great Arizona deserts in safety until, after their half-year's journey, their eyes were gladdened by the snowy peaks of the Sierras looking delusively near. The goal of their long toil seemed before them; only this one more valley lay between, and into this they descended, thinking to cross it in a day—but they never crossed it. Afterward the long line of wagons was found with the skeletons of the animals in the harness, and by them those of men, women, and little children dead of thirst, and some relics of the tragedy remained at the time of our journey. I cite this as an indirect evidence of the phenomenal dryness of the region—a dryness which, so far, served our object, which was, in part, to get rid as much as possible of that water vapor which is so well known to be a powerful absorber of the solar heat.

Everything has an end, and so had that journey, which finally brought us to the goal of our long travel, at the foot of the highest peak of the Sierras, Mount Whitney, which rose above us in tremendous precipices, that looked hopelessly insurmountable and wonderfully near. The whole savage mountain-region, in its slow rises from the west and its descent to the desert plains in the east, is more like the chain called the Apennines, in the moon, than anything I know on the earth. The summits are jagged peaks like Alpine "needles," looking in the thin air so delusively near that, coming on such a scene unprepared, one would almost say they were large gray stones a few fields off, with an occasional little white patch on the top, that might be a handkerchief or a sheet of paper dropped there. But the telescope showed that the seeming stones were of the height of many Snowdons piled on one another, and the white patches occasional snow-fields, looking how invitingly cool, from the torrid heat of the desert, where we were encamped by a little rivulet that ran down from some unseen ice-lake in that upper air. Here we pitched our tents and fell to work (for you remember we must have two stations, a low and a high one, to compare the results), and here we labored three weeks in almost intolerable heat, the instruments having to be constantly swept clear of the red desert dust which the hot wind brought. Close by these tents a thermometer covered by a single sheet of glass, and surrounded by wool, rose to 237° in the sun, and sometimes in the tent, which was darkened for the study of separate rays, the heat was absolutely beyond human endurance. Finally, our apparatus was taken apart and packed in small pieces on the backs of mules, who were to carry it by a ten days' journey through the mountains to the other side of the rocky wall which, though only ten or twelve miles distant, arose miles above our heads; and, leaving these mule-trains to go with the escort by this longer route, I started with a guide by a nearer way to those white gleams in the upper skies, that had daily tantalized us below in the desert with suggestions of delicious, unattainable cold. That desert sun had tanned our faces to a leather-like brown, and the change to the cooler air as we ascended was at first delightful. At an altitude of five thousand feet we came to a wretched band of nearly naked savages, crouched around their camp-fire, and at six thousand found the first scattered trees; and here the feeble suggestion of a path stopped, and we descended a ravine to the bed of a mountain-stream, up which we forced our way, cutting through the fallen trees with an axe, fighting for every foot of advance, and finally passing what seemed impassable. It was interesting to speculate as to the fate of our siderostat mirrors and other precious freight, now somewhere on a similar road, but quite useless. We were committed now, and had to make the best of it—and, besides, I had begun to have my attention directed to a more personal subject. This was that the colder it grew the more the sun burned the skin—quite literally burned I may say, so that by the end of the third day my face and hands, case-hardened, as I thought, in the desert, began to look as if they had been seared with red-hot irons, here in the cold where the thermometer had fallen to freezing at night; and still as we ascended the paradoxical effect increased; the colder it grew about us, the hotter the sun blazed above.

We have all heard probably of this curious effect of burning in the midst of cold, and some of us may have experienced it in the Alps, where it may be aided by reflection from the snow, which we did not have about us at any time except in scattered patches, but here by the end of the fourth day my face was scarcely recognizable, and it almost seemed as though sunbeams up here were different things, and contained something which the air filters out before they reach us in our customary abodes. Radiation here is increased by the absence of water vapor too, and on the whole this intimate personal experience fell in almost too well with our anticipations that the air is an even more elaborate trap to catch the sunbeams than had been surmised, and that this effect of selective absorption and radiation was intimately connected with that change of the primal energies and primal color of the sun which we had climbed toward it to study.

On the fourth day, after break-neck ascents and descents, we finally ascended by a ravine, down which leaped a cataract, till, at nightfall, we reached our upper camp, which was pitched by a little lake, one of the sources of the waterfall, at a height of about twelve thousand feet, but where we seemed in the bottom of a valley, nearly surrounded as we were by an amphitheatre of rocky walls which rose perpendicularly to the height of Gibraltar from the sea, and cut off all view of the desert below or even of the peak above us.

The air was wonderfully clear, so that the sun set in a yellow rather than an orange sky, which was reflected in the little ice-rimmed lakes and from occasional snow-fields on the distant waste of lonely mountain-summits on the west.

The mule-train sent off before by another route had not arrived when we got to the mountain-camp, and we realized that we were far from the appliances of civilization by our inability to learn about our chief apparatus, for here, without post or telegraph, we were as completely cut off from all knowledge of what might be going on with it in the next mountain ravine as a ship at sea is of the fate of a vessel that sailed before from the same port. During the enforced idleness we ascended the peak nearly three thousand feet above us, with our lighter apparatus, leaving the question of the ultimate use of the heavy ones to be settled later. There seemed little prospect of carrying it up, as we climbed where the granite walls had been split by the earthquakes, letting a stream of great rocks, like a stone river, flow down through the interstices by which we ascended, and, in fact, the heavier apparatus was not carried above the mountain-camp.

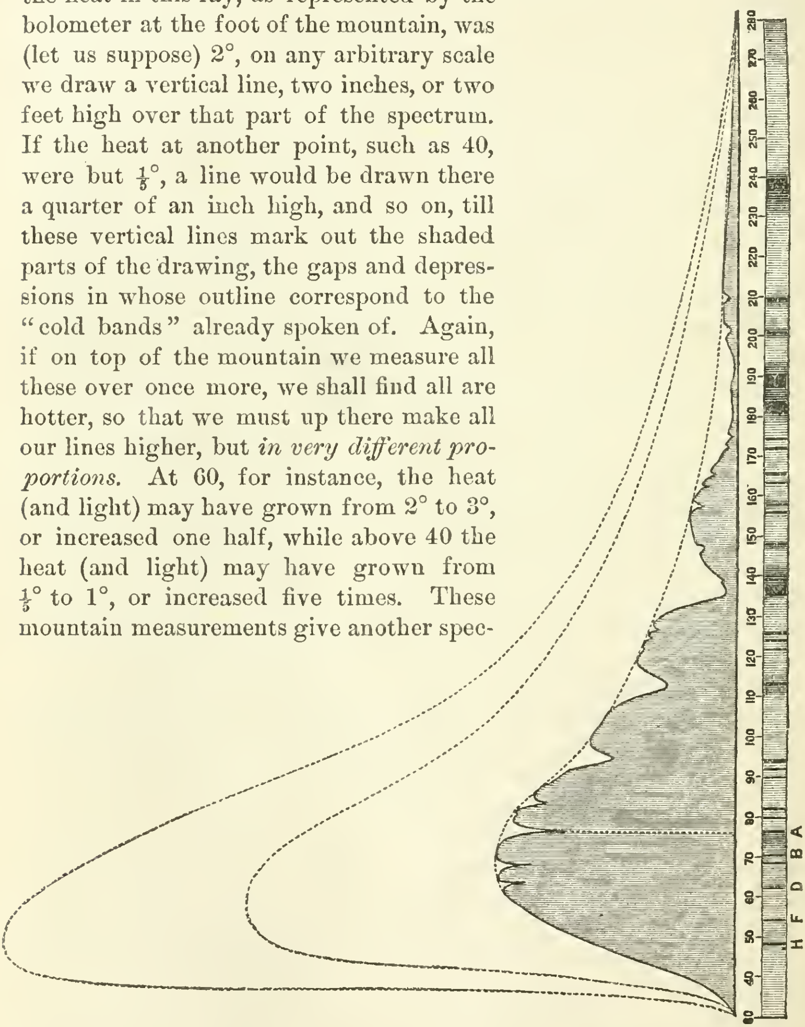
The view from the very summit was over numberless peaks on the west to an horizon fifty miles away, of unknown mountain-tops, for, with the exception of the vast ridge of Mount Tyndall, and one or two less conspicuous ones, these summits are not known to fame, and, wonderful as the view may be, all the charm of association with human interest which we find in the mountain landscape of older lands is here lacking.

It was impossible not to be impressed with the savage solitude of this desert of the upper air, and our remoteness from man and his works, but I turned to the study of the special things connected with my mission. Down far below the air seemed filled with reddish dust that looked like an ocean. This dust is really present everywhere (I have found it in the clear air of Etna), and, though we do not realize its presence in looking up through it, to one who looks down on it the dwellers on the earth seem indeed like creatures at the bottom of a troubled ocean. We had certainly risen toward the surface, for about us the air was of exquisite purity, and above us the sky was of such a deep violet blue as I have never seen in Egypt or Sicily, and yet even this was not absolutely pure, for, separately invisible, the existence of fine particles could yet be inferred from their action on the light near the sun's edge, so that even here we had not got absolutely above that dust-shell which seems to encircle our whole planet. But we certainly felt ourselves not only in an upper, but a different region. We were on the ridge of the continent, and the winds which tore by had little in common with the air below, and were bearing past us (according to the geologists) dust which had once formed part of the soil of China, and been carried across the Pacific Ocean ; for here we were lifted into the great encircling currents of the globe, and, "near to the sun in lonely lands," were in the right conditions to study the differences between his rays at the surface and at the bottom of that turbid sea where we had left the rest of mankind. We descended the peak and hailed with joy the first arrival of our mule-trains with the requisite apparatus at the mountain-camp, and found that it had suffered less than might be expected, considering the pathless character of the wilderness. We went to work to build piers and mount telescopes and siderostats, in the scene shown by the next illustration on the screen, taken from a sketch of my own, where these rocks in the immediate foreground rise to thrice the height of St. Paul's. We suffered from cold (the ice forming three inches deep in the tents at night) and from mountain-sickness, but we were too busy to pay much attention to bodily comfort, and worked with desperate energy to utilize the remaining autumn days, which were all too short.

Here, as below, the sunlight entered a darkened tent, and was spread into a spectrum, which was explored throughout by the bolometer, measuring, on the same separate rays which we had studied below in the desert, all of which were different up here, all having grown stronger, but in very different proportions. On the screen is the spectrum as seen in the desert, drawn on a conventional scale, neither prismatic nor normal, but such that the intensity of the energy shall be the same in each part, as it is represented here by these equal perpendiculars in every color. Fix your attention on these three as types, and you will see better what we found on the mountain, and what we inferred as to the state of things still higher up, at the surface of the aërial sea.

You will obtain, perhaps, a clearer idea, however, from the following statement, where I use, not the exact figures used in calculation, but round numbers, to illustrate the process employed. I may premise that the visible spectrum extends from H (in the extreme blue) to A (in the deepest red), or from near 40 (the ray of $\frac{40}{100,000}$ of a millimetre in wave-length) to near 80. All below 80, to the right, is the invisible infra-red spectrum.

Now, the shaded curve above the spectrum represents the amount of energy in the sun's rays at the foot of the mountain, and was obtained in this way: Fix your attention for a moment on any single part of the spectrum, for instance, that whose wave-length is 60. If the heat in this ray, as represented by the bolometer at the foot of the mountain, was (let us suppose) 2°, on any arbitrary scale we draw a vertical line, two inches, or two feet high over that part of the spectrum. If the heat at another point, such as 40, were but $\frac{1}{5}$°, a line would be drawn there a quarter of an inch high, and so on, till these vertical lines mark out the shaded parts of the drawing, the gaps and depressions in whose outline correspond to the "cold bands" already spoken of. Again, if on top of the mountain we measure all these over once more, we shall find all are hotter, so that we must up there make all our lines higher, but *in very different proportions.* At 60, for instance, the heat (and light) may have grown from 2° to 3°, or increased one half, while above 40 the heat (and light) may have grown from $\frac{1}{5}$° to 1°, or increased five times. These mountain measurements give another spectrum, the energies in each part of which are defined by the middle dotted line, which we see indicates very much greater energy whether heat or light in the blue end than below. Next, the light or heat which would be observed at the surface of the atmosphere is found in this way. If the mountain-top rises through one half the absorbing mass of this terrestrial atmosphere (it does not quite do so, in fact), and, by getting rid of that lower half, the ray 60 has grown in bright-



Distribution of Solar Energy at Sea-level and at various Altitudes.

ness from two to three, or half as much again, in going up to the top it would gain half as much more, or become $4\frac{1}{2}$, while the ray near 40, which has already increased to five times what it was, would increase five times more, or to 25. Each separate ray increasing thus nearly in some geocentric progression (though the heat, as a whole, does not), you see how we are able, by repeating this process at every point, to build up our outer or highest curve, which represents the light and heat at the surface of the atmosphere. These have grown out of all proportion at the blue end, as you see by the outer dotted curve, and now we have attained, by actual measurement, that evidence which we sought, and by thus reproducing the spectrum outside the atmosphere, and then recombining the colors by like methods to those you have seen on the screen, we finally get the true color of the sun, which tends, broadly speaking, to blue.

It is so seldom that the physical investigator meets any novel fact quite unawares, or finds anything except that in the field where he is seeking, that he must count it an unusual experience to come unexpectedly on even the smallest discovery. This experience I had on one of the last days of work on the spectrum on the mountain. I was engaged in exploring that great invisible heat-region, still but so partially known, or, rather, I was mapping in that great "dark continent" of the spectrum, and by the aid of the exquisite sky and the new instrument (the bolometer) found I could carry the survey further than any had been before. I substituted the prism for the grating, and measured on in that unknown region till I had passed the *ultima Thule* of previous travelers, and finally came to what seemed the very end of the invisible heat-spectrum beyond what had previously been known. This was in itself a return for much trouble, and I was about rising from my task, when it occurred to me to advance the bolometer still farther, and I shall not forget the surprise and emotion with which I found new and yet unrecognized regions below—a new invisible spectrum beyond the farthest limits of the old one.

I will anticipate here by saying that after we got down to lower earth again the explorations and mapping of this new region were continued. The amount of solar energy included in this new extension of the invisible region is much less than that of the visible spectrum, while its length upon the wave-length scale is equal to all that previously known, visible and invisible, as you will see better by this view, having the same thing on the normal as well as the prismatic scale. If it be asked which of these is correct, the answer is, "Both of them." Both rightly interpreted mean just the same thing, but in the lower one we can more conveniently compare the ground of the researches of others with these. These great gaps I was at first in doubt about, but more recent researches at Allegheny make it probable that they are caused by absorption in our own atmosphere, and not in that of the sun.

We would gladly have stayed longer, in spite of physical discomfort, but the formidable descent and the ensuing desert journey were before us, and certainly the reign of perpetual winter around us grew as hard to bear as the heats of the desert summer had been. On September 10th we sent our instruments and the escort back by the former route, and, ourselves unencumbered, started on the adventurous descent of the eastern precipices by a downward climb, which, if successful, would carry us to the plains in a single day. I at least shall never forget that day, nor the scenery of more than Alpine grandeur which we passed in our descent, after first climbing by frozen lakes in the northern shadow of the great peak, till we crossed the eastern ridges, through a door so narrow that only one could pass it at a time, by clinging with hands and feet as he swung round the shoulder of the rocks—to find that he had passed in a single minute from the view of winter to summer, the prospect of the snowy peaks behind shut out, and instantly exchanged for that below of the glowing valley and the little oasis where the tents of the lower camp were still pitched, the tents themselves invisible, but the oasis looking like a green scarf dropped on the broad floor of the desert. We climbed still downward by scenery unique in my recollection. This view of the ravine on the screen is little more than a memorandum made by one of the party in a few minutes' halt part-way down, as we followed the ice-stream between the tremendous walls of the defile which rose two thousand feet, and between which we still descended, till, toward night, the ice-brook had grown into a mountain-torrent, and, looking up the long vista of our day's descent, we saw it terminated by the Peak of Whitney, once more lonely in the fading light of the upper sky.

This site, in some respects unequaled for a physical observatory, is likely, I am glad to say, to be utilized, the President of the United States having, on the proper representation of its value to science, ordered the reservation for such purposes of an area of one hundred square miles about and inclusive of Mount Whitney.

There is little more to add about the journey back to civilization, where we began to gather the results of our observation, and to reduce them—to smelt, so to speak, the metal from the ore we had brought home—a slow but necessary process, which has occupied a large part of two years.

The results stated in the broadest way mean that the sun is blue—but mean a great deal more than that; this blueness in itself being perhaps a curious fact only, but, in what it implies, of practical moment.

We deduce in connection with it a new value of the solar heat, so far altering the old estimates that we now find it capable of melting a shell of ice sixty yards thick annually over the whole earth, or, what may seem more intelligible on its practical bearings, of exerting over one horse-power for each square yard of the normally exposed surface. We have studied the distribution of this heat in a spectrum whose limits on the normal scale our explorations have carried to an extent of rather more than twice what was previously known, and we have found that the total loss by absorption from atmosphere is nearly double what it has been heretofore supposed.

We have found it probable that the human race owes its existence and preservation even more to the heat-storing action of the atmosphere than has been believed.

The direct determination of the effect of water-vapor in this did not come within our scope ; but that the importance of the blanketing action of our atmospheric constituents has been in no way overstated may be inferred when I add that we have found by our experiments that, if the planet were allowed to radiate freely into space without any protecting veil, its sunlit surface would probably fall, even in the tropics, below the temperature of freezing mercury.

I will not go on enumerating the results of these investigations, but they all flow from the fact, which they in turn confirm, that this apparently limpid sea above our head, and about us, is carrying on a wonderfully intricate work on the sunbeam, and on the heat returned from the soil, picking out selected parts in hundreds of places, sorting out incessantly at a task which would keep the sorting demons of Maxwell busy, and, as one result, changing the sunbeam on its way down to us in the way we have seen.

I have alluded to the practical utilities of these researches, but, practical or not, I hope we may feel that such facts as we have been considering about sunlight and the earth's atmosphere may be stones useful in the future edifice of science, and that if not in our own hands then in those of others, when our day is over, they may find the best justification for the trouble of their search, in the fact that they prove of some use to man.

May I add an expression of my personal gratification in the opportunity with which you have honored me of bringing these researches before the Royal Institution, and of my thanks for the kindness with which you have associated yourselves for an hour, in retrospect at least, with that climb toward the stars which we have made together, to find, from light in its fullness, what unsuspected agencies are at work to produce for us the light of common day ?

THE SCIENCE OF MORALITY.

By SELIM M. FRANKLIN.

BY morals, or the science of morality, is meant that body of principles and laws, relating to conduct, which are conducive to the well-being of humanity. Morality, or, more accurately, the art of morality, is the carrying out in practice the laws which the science has established.

To understand clearly the definition of the science, it is necessary to ascertain what the well-being of humanity is. This can be done only by tracing all motives and feelings to their ultimate cause. This ultimate cause is the most powerful instinct implanted in human nature—the preservation of life, which includes our own life and that of our offspring. We live and we want to live. Unconsciously we will flee from danger. We will fight frantically against death. In the presence of great danger we lose our reason, and yet, though volition is powerless, reflex action makes us struggle for safety. Why we want to live, why we were ever endowed with life, is more than man can know; but of this he is certain, that he does not want to die. The fact that a mother will sacrifice herself for her child; that the man who suffers the tortures of the rack, or of incurable disease, or of great mental affliction, will prefer oblivion to existence, does not alter the truth that the love of life is the most powerful instinct implanted in animals and in man. These exceptions, like many apparent exceptions to the law of gravitation, can be satisfactorily explained away.

By the phrase "conducive to the well-being of humanity" is meant not merely the bare preservation of life, but includes all that which makes life itself more pleasant and happy, which will insure a more complete and rounded existence.

All those actions which are conducive to the well-being of humanity, we call good or right; all those actions which are not so conducive, we call bad or wrong. Thus there is an absolute standard of right and wrong.

Already, long ages ago, it was discovered by experience that a tribe or nation, and every member thereof, would better serve his own prosperity and success by generally telling the truth than by telling falsehoods; so nine times out of ten he would tell the truth. The confusion that would arise were every one to tell nine falsehoods to one truth is inconceivable. The man who had been placed on sentinel duty, when asked whether he had seen the enemy, would answer no, although he knew the enemy to be within the hearing of his voice. The mother would tell her child that certain herbs, which she knew to be poisonous, were good to eat; the child would eat, and die. The father would deny his ability to provide food for his family, although but an hour before he had slain a buffalo or a deer. Telling the truth sometimes, and most of the time, is an absolute necessity, depending not on theological injunctions, but on the very existence of life. Our rude forefathers of the prehistoric age were aware of this fact, and they enunciated the general principle that it is wrong to lie. This is a scientific generalization. It is a law deduced by experience and observation from a great number of facts, and it is as justly entitled to be considered a generalization as Newton's law of gravitation or Pascal's principle of hydrostatics. The experience of nations and of ages has firmly established this principle ; it is incorporated into all codes of morals.

In the physical sciences we explain any particular phenomenon by laws already established. We explain the reason why any particular candle burns and gives off light, by laws already discovered of oxidation and incandescence. So in the science of morality we determine whether any particular action is right or wrong, by referring the action under consideration to laws that have eebn already established.

Certain laws conduce more to the well-being of humanity than others. Thus, the law, It is wrong to murder, is of vastly more importance than the law, It is wrong to lie. Because, if we all committed murder, the world would be depopulated ; while, if we all told lies, there would be a sad confusion, yet some of us would manage to exist. Hence, to commit murder is a greater wrong than to tell a lie, and a man would be perfectly justified in telling a lie in order to escape either becoming a murderer or being himself murdered. In this manner we can test the relative importance of moral laws.

As the attraction of gravitation differs under different circumstances, although the law of gravitation always remains the same, so can a falsehood, according to circumstances, be a greater or lesser wrong—be a so-called white lie of society, be the business lie of the dishonest tradesman, or the criminal lie of the perjurer—and still the law, It is wrong to lie, would remain unassailed. We determine by deduction whether any particular action is right or wrong : If the act is in conflict with a law of morality, it is wrong ; if not in conflict, it is right.

The laws of morality are not all of the same relative importance. Those laws which are more vital to the well-being of humanity are more important than those laws which are less vital. Hence, occasions can arise when we are justified in breaking one law, in order that we may escape breaking another of greater importance.

The thinking mind of to-day asks, Is there a scientific basis for morality? I think there is. The modified doctrine of utility, or, as I have expressed it, conducive to the well-being of humanity, is the basis which science seeks. We deduce, from the experience of races and nations for centuries and for ages, the laws in regard to conduct which are for man's best welfare. These laws, systematically arranged, would constitute the science of morality or morals. As yet such a science does not exist. The material is all at hand ; it but awaits the master-workman to fashion it into shape.

An incidental question here arises. Had we a most complete science of morality, would it affect, either for better or for worse, the morality of the masses? At present the dictates of morality are enforced in three ways : By the so-called criminal or penal laws of the land ; by public opinion, or the opinion of society ; by the teachings of punishment after death. These three sanctions must always exist. The science of morality might not have any effect in compelling its laws to be observed, but it undoubtedly would explain to many minds which now are groping in darkness and disbelief the why and wherefore of moral codes.

RECENT PROGRESS IN BIOLOGY.

By E. RAY LANKESTER.

THE English universities have at various times in their history been remarkable as centers of scientific investigation and progress. The Royal Society took its origin in Oxford about two hundred and forty years ago, and from time to time there have been brilliant groups of scientific investigators in either university who have, though separated by intervals of darkness, sufficed to maintain the character of these institutions as something more than schools of classical training or mathematical gymnastic. At the present moment the energy of the Biological school, which has grown up in Cambridge within the last fifteen years, forms one of the most remarkable features among the many recent evidences of healthy life and of capacity for the performance of its great national duties which that time-honored institution has afforded.

One of the most fascinating problems of biology is that involved in the attempt to trace out the pedigrees of the immense variety of living plants and animals according to the teachings of Charles Darwin. Every animal grows from a perfectly simple homogeneous egg to the more or less complicated form which it presents when adult, and we have reason to believe that the changes through which the growing developing "embryo" passes correspond to a large extent, according to certain definite laws, with the changes through which its ancestors have passed in the greater evolution of the world. Accordingly, these embryonic changes, if rightly understood, can furnish us with the most important evidence as to the ancestry, and therewith the pedigree and family relationships, of the various kinds of existing animals. The study of embryology, from this point of view, was followed with great success by the late Professor Frank Balfour (whose early death has caused incalculable loss to science), and is being prosecuted in Germany and America, but nowhere more energetically than by Balfour's pupils. It will be readily understood that if the history of growth from the egg can furnish a clew to the ancestral relationships of various animals, then the discovery of this history in the case of curious and abnormal animals must be especially important. The histories of whole groups of common animals will necessarily be very much alike, and there is no likelihood of one differing from another in essential respects. Thus the facts with regard to the growth of birds from the egg are, in regard to large features, the same which have been carefully ascertained with regard to the common fowl. The growth from the egg of ordinary hairy quadrupeds presents the same characters as that of the rabbit, the dog, and man. The history of the changes of the eggs of fish on their way from simple homogeneity to the rich complexity of adult life is practically the same for all fish truly so called ; and so we may say of insects—that one insect furnishes the history which is true of all. This, be it remembered, relates only to large and general features. But naturalists are acquainted with a number of strangely abnormal animals which will not enter into large groups and even defy classification, being neither "flesh, fowl, nor good red herring." These recalcitrant animals are not objectionable to the zoölogist ; on the contrary, they are his favorites. It is these which he is most eager to study, and it is from them that he expects to obtain information which will clear up doubtful points in the scheme of relationships or pedigree which he has provisionally constructed on the basis of his acquaintance with less isolated forms. These exceptional forms of animal life are found in various parts of the world, and are often difficult of access. Nevertheless, if the naturalist is to study the growth from the egg of these animals, he must follow them to their native homes. Botanists have a great advantage over zoölogists in the fact that most plants are readily transported from one locality to another, and can be cultivated in artificial climates produced in glass houses. We have at present no such skill in the treatment of animals, and accordingly the energetic Cambridge naturalists have risen to the necessities of the case. Within the last three years special journeys have been undertaken from Cambridge by members of its biological school to the uttermost parts of the earth, with the sole purpose of studying the growth from the egg of strange and interesting animals, only to be obtained in the remote regions thus visited. Mr. Caldwell, Fellow of Caius College, has gone to Australia, and is still there, for the purpose of studying the history of the growth from the egg of the duck-billed Platypus or duck-mole (*Ornithorhynchus*) and the spiny ant-eater (*Echidna*), as well as of the extraordinary lung-bearing, and therefore air-breathing, fish of Queensland known as the Barra-munda (*Ceratodus Forsteri*). Mr. Adam Sedgwick, Fellow of Trinity College, went in 1883 to the Cape of Good Hope expressly for the purpose of collecting live specimens and, if possible, eggs and young, of a creature very much like a caterpillar in appearance, and known as *Peripatus*. He obtained the most complete success, brought home to England three hundred living specimens of the extraordinary *Peripatus*, and has obtained from them since they have been in England young in all stages of development, which will enable him very soon to give a most valuable account of the growth from the egg of this strange form. A third member of the

Cambridge school—Mr. William Bateson, of Pembroke College—has been twice across the Atlantic, in 1883 and 1884, to the coast of Maryland, U. S. A., in order to study the growth from the egg of *Balanoglossus*, the most important and (to the zoölogist) entertaining of all worms, since it has gill-slits like a fish and rudiments of a backbone. Mr. Bateson has made and already published (in a special supplement of the "Quarterly Journal of Microscopical Science," 1885) a complete study of the development of this worm. It is perhaps as well briefly to mention here that a "complete study" in these questions means the preparation and preservation in alcohol of hundreds of specimens of different stages of growth (often very minute) of the animal under investigation, and the subsequent cutting into series of consecutive slices, each about $\frac{1}{4000}$ of an inch thick, of a sample of each of these stages; the scrutiny of these sections with the microscope, and the reconstruction or building up of the actual structure of the animal at each stage by a mental combination of the sections.

The expedition undertaken by Mr. Caldwell (who was aided in his equipment by funds from the Government Grant Committee of the Royal Society) is perhaps the most interesting, because the animals which he has gone to study are of large size and already more or less familiar. The Ornithorhynchus and the Echidna are hairy quadrupeds (mammals) peculiar to Australasia, which differ from all other hairy quadrupeds in having, like birds, but a single aperture to the exterior for the intestine and the urino-genital canals, and in having the skeleton of the shoulder-girdle and some other features of structure similar to those of reptiles. Like those of reptiles, their bodies are comparatively cold, instead of being kept to a definite "blood-heat" (100° Fahr.) as are those of all other mammals. It had often been reported, and some kind of evidence had been given to support the statement, that these strange beasts lay their eggs like birds and reptiles, instead of retaining the egg-like structure within the body and allowing it there to develop to a certain condition of maturity as do all other hairy quadrupeds. One of Mr. Caldwell's objects was definitely to ascertain whether these animals lay eggs or not, and, of more importance than that, to examine minutely the whole history of the growth in the egg, and to compare it on the one hand with the corresponding development of birds and reptiles, on the other with that of ordinary hairy quadrupeds or mammals.

Mr. Caldwell has found out all about the eggs of these animals and collected them in quantities. The Echidna lays a single egg, which she then carries about with her in a pouch formed by a fold of skin on the ventral surface of the body, similar to the kangaroo's pouch.

The duck-mole, on the other hand, lays two eggs at a time and does not carry them about, but deposits them in her nest, an underground burrow like that of the mole. Naturalists are awaiting with great interest Mr. Caldwell's account of what goes on inside these eggs while the young one is growing there ; that is to say, an account of the differences and resemblances between the structures which gradually arise in these mammals' eggs and those which are familiar to us as occurring in the case of the common fowl.

With regard to the strange fish, *Ceratodus*, Mr. Caldwell has been no less successful, after much disappointment and persevering search. He has lately sent home a series of photographs showing groups of the black men and women whom he employed to catch the fish, standing by the river-side and holding each one in his arms a newly captured specimen, while some twenty or thirty more of the fish are heaped on the ground. Four years ago, zoölogists were glad to buy spirit-preserved specimens of this fish in London for twenty pounds apiece. Mr. Caldwell has as yet sent home so few reports of his doings in Australia, that every one will be interested in the following letter written from New South Wales in February last :

I shall give you a short account of my doings without apologizing for talking about myself, because you asked for this. When I wrote you last I was just beginning my camp-life on the Burnett River, and was very much concerned about my failure in the search for Ceratodus-eggs. I had invested in an American trap and horses and all the necessaries for camping out. I remained under canvas from the end of July to the end of November. Roget, my Belgian servant, was the only white man with me, but the blacks kept continually coming and adding to the number of my retainers. I had in the end about fifty of all ages—men, women, and children. I have sent you some photographs which I took during these months. I carried my camera everywhere, and the pictures will give you a fine idea of bush scenery and the roads (?) we had to traverse. I became very expert with my four-in-hand. It is a very different thing from driving a team along good roads; but I was fortunate in never having a serious smash. The blacks were more than useful: I could have done little or nothing without them. They found over five hundred Echidna in four weeks, while the "gins" searched the weeds of the river for Ceratodus-eggs. Let me tell you how I found Ceratodus-spawn. From the 24th of April (1884), when I found males ready to spawn, I had a pair, male and female, under constant observation in a small water-hole. Up to the beginning of September, though I was constantly dredging and turning up the river, I got no clew to the spawning-ground. I determined to give up the search for the year, as further stay on the Burnett interfered with my plans for collecting the eggs of the duck-mole. All August I had been getting the eggs of the duck-mole, containing very early stages of the young; but with September the eggs had all been laid, and my plan was to shift my camp south to the colder district of New England, where, as I found in 1883, the duck-mole is a month or six weeks later in breeding. One evening early in September I was shooting duck-moles as usual, when I came to a place on the bank of the river where I could see several Ceratodus swimming about backward and forward in shallow water. It was too dark to look for anything that night, so I marked the place and described to the blacks what I expected. They were down at the river by daylight, and shortly afterward returned with Ceratodus-eggs. The egg is like that of a newt, and is laid in the water-weed, every egg separately. This changed my plans. I hoped then to get all stages in the growth of Ceratodus in a few weeks, and to try for the duck-moles again in December about the Snowy River in the extreme south of New South Wales. But it was not until the end of November that I got away. I could not succeed for a long time in rearing the larvæ (tadpoles) of the Ceratodus after they were hatched. At last I succeeded, and have now I believe every stage preserved. I have now in my laboratory in Sydney some young living specimens reared from the eggs under my eyes.

Is it not extraordinary that Echidna has not learned to contain her egg in the uterus a little longer? The plan of laying it only to carry it in a pouch is an awkward habit that might be so easily reformed. The duck-mole has two eggs at a time. The papers here have copied from "Nature" a notice about my work, and mention an old paper by Geoffroy St.-Hilaire where Platypus (duck-mole) eggs are figured. These eggs, however, happen not to be duck-mole's eggs at all. St.-Hilaire obtained them from bushmen who found them in the Hawkesbury River. They were eggs of the common river-turtle, as is clear from the figures. The duck-mole's egg is one quarter of their size. . . . I am at present in the northwestern district of New South Wales—up the McIntyre River—collecting the embryos of marsupials (kangaroos, etc.). I have bought a light buggy, and move about from station to station in search of kangaroo-drives. The kangaroos have decreased in number, owing to the drought in the last few years, and the place I am in now is, I believe, almost the only one where it is still possible to get a thousand kangaroos into a "yard" in one day. "Yarding" has been generally superseded by shooting. A camp of kangaroo-shooters will travel about on a run for months, being paid so much a scalp. It is very slow work collecting embryos with these shooting-parties, and, besides this, the embryos are too delicate to be carried on horseback. Accordingly, I have tried hard to get to a yarding-drive where I could put up a table and do all the preserving in one place. On Tuesday, Wednesday, and Thursday next week the whole district is going to muster to drive kangaroos into a pit, and we hope to get five thousand. My plans after this are pretty well settled. I have made up my mind to stay out until another season is over. I go after "native cats" in March and April, opossums in April and May in the south of New South Wales. In June I shall get emu on the western downs of Queensland, two hundred miles west of Roma. In July and August I shall have a camp of one or two hundred blacks on the Burnett River. At the end of August and September I shall camp with some white shooters on the rivers near where I am now (the Dumeresq, McIntyre, Mole, and Severn). In November I shall see you in London. I shall send you a description of some of the important features in the early growth of the young in the egg of the duck-mole and the Echidna when I get down to Sydney. I shall have no time to make sections until I have brought my material safely home to England.—*Nineteenth Century.*

THE PRIMITIVE GHOST AND HIS RELATIONS.

By JAMES G. FRAZER.

IN his "Roman Questions," that delightful storehouse of old-world lore, Plutarch asks, "When a man who has been falsely reported to have died abroad returns home alive, why is he not admitted by the door, but gets up on the tiles, and so lets himself down into the house?" The curious custom to which Plutarch here refers prevails in modern Persia, for we read in "Hajji Baba" (c. 18) of the man who went through "the ceremony of making his entrance over the roof, instead of through the door; for such is the custom, when a man who has been thought dead returns home alive." From a passage in Agathias (ii, 23) we may, perhaps, infer that the custom in Persia is at least as old as the sixth century of our era. A custom so remote from our modern ways must necessarily have its roots far back in the history of our race. Imagine a modern Englishman, whom his friends had given up for dead, rejoining the home circle by coming down the chimney instead of entering by the front door! In this paper I propose to show that the custom originated in certain primitive beliefs and observances touching the dead—beliefs and observances by no means confined to Greece and Rome, but occurring in similar if not identical forms in many parts of the world.

The importance attached by the Romans in common with most other nations to the due performance of burial rites is well known, and need not be insisted on. For the sake of my argument, however, it is necessary to point out that the attentions bestowed on the dead sprang not so much from the affections as from the fears of the survivors. For, as every one knows, ghosts of the unburied dead haunt the earth and make themselves exceedingly disagreeable, especially to their undutiful relatives. Instances would be superfluous; it is the way of ghosts all the world over, from Brittany to Samoa.* But burial by itself was by no means a sufficient safeguard against the return of the ghost; many other precautions were taken by primitive man for the purpose of excluding or barring the importunate dead. Some of these precautions I will now enumerate. They exhibit an ingenuity and fertility of resource worthy of a better cause.

In the first place, an appeal was made to the better feelings of the ghost. He was requested to go quietly to the grave, and at the grave he was requested to stay there.†

But to meet the possible case of hardened ghosts, upon whom moral persuasion would be thrown away, more energetic measures were resorted to. Thus among the South Slavonians and Bohemians, the bereaved family, returning from the grave, pelted the ghost of their deceased relative with sticks, stones, and hot coals.‡ The Tschuwasche, a tribe in Finland, had not even the decency to wait till he was fairly in the grave, but opened fire on him as soon as the coffin was outside the house.#

Again, heavy stones were piled on his grave to keep him down, on

* Sebillot, "Traditions et Superstitions de la Haute-Bretagne," i, p. 238; Turner, "Nineteen Years in Polynesia," p. 233.

† Gray, "China," i, pp. 300, 304.

‡ Ralston, "Songs of the Russian People," p. 319; Bastian, "Mensch," ii, p. 329.

Castren, "Finnische Mythologie," p. 120.

the principle of "sit tibi terra *gravis.*" This is the origin of funeral cairns and tombstones. As the ghosts of murderers and their victims are especially restless, every one who passes their graves in Arabia, in Germany, and in Spain, is bound to add a stone to the pile. In Oldenburg (and no doubt elsewhere) if the grave is shallow the ghost will certainly walk.*

One of the most striking ways of keeping down the dead man is to divert the course of a river, bury him in its bed, and then allow the river to resume its course. It was thus that Alaric was buried, and Commander Cameron found the same mode of burial still in vogue for chieftains among a tribe in Central Africa.†

The expedient of inclosing the grave with a fence too high for the ghost to "take" it, especially without a run, is common to Finland and the South Seas.‡

Another simple but effectual plan was to nail the dead man to the coffin (the Tschuwasche again),# or to tie his feet together (among the Arabs), or his neck to his legs (among the Troglodytes, Damaras, and New-Zealanders).‖ The Wallachians drive a long nail through the skull and lay the thorny stem of a wild rose-bush on the corpse.^ The Californians clinched matters by breaking his spine.◊ The corpses of suicides and vampires had stakes run through them.‡

Other mutilations of the dead were intended not so much to keep the dead man in his grave as to render his ghost harmless. Thus the Australians cut off the right thumb of a slain enemy, that his ghost might not be able to draw the bow,‡ and Greek murderers used to hack off the extremities of their victims with a similar object.‡

Again, various steps were taken to chase away the lingering ghost from the home he loved too well. Thus the New-Zealanders thrash the corpse in order to hasten the departure of the soul; ** the Algonquins †† beat the walls of the death-chamber with sticks to drive out the ghost; the Chinese knock on the floor with a hammer; ‡‡ and the Ger-

* Sonntag, "Todtenbestattung," p. 197; Brand's "Popular Antiquities," ii, p. 309; Wuttke, "Deutsche Aberglaube," § 754, cp. 739, 748, 756, 758, 761; Klemm, "Culturgeschichte," ii, p. 225; Waitz, "Anthropologie der Naturvölker," ii, pp. 195, 324, 325, 524; Id., iii, p. 202.

† "Across Africa," i, p. 110.

‡ Castren, *op. cit.*, 121; Bastian, ii, p. 368.

Bastian, ii, pp. 337, 365.

‖ Strabo, xvi, 17; Diodorus, iii, 33; Wood, "Natural History of Man," i, p. 348; Yates, "New Zealand," p. 136.

^ H. F. Tozer, "Researches in the Highlands of Turkey," ii, p. 92.

◊ Bastian, ii, p. 331.

‡ Bastian, ii, p. 365; Ralston, p. 413; heads of vampires cut off (Wuttke, § 765; Toppen, "Aberglauben aus Masuren," p. 114; Tettau u. Temme, "Volkssagen," p. 275).

‡ Tylor, "Primitive Culture," i, p. 451.

‡ Suidas, *s. μασχαλισθῆναι, μασχαλίσματα.*

** Klemm, iv, p. 325; Yates, "New Zealand," p. 136.

†† Brinton, "Myths of the New World," p. 255. ‡‡ Gray, "China," i, p. 280.

mans wave towels about, or sweep the ghost out with a besom,* just as in old Rome the heir solemnly swept out the ghost of his predecessor with a broom made specially for the purpose.† In ancient Mexico professional "chuckers-out" were employed, who searched the house diligently till they found the lurking ghost of the late proprietor, whom they there and then summarily ejected.‡

The favorite "beat" of the ghost is usually the spot where he died. Hence, in order to keep him at least from the house, the Caffres carry a sick man out into the open air to die, and the Maoris used to remove the sick into sheds. If a Caffre or Maori died before he could be carried out, the house was tabooed and deserted.# There are traces in Greece, Rome, and China of this custom of carrying dying persons into the open air.‖

But in case the ghost should, despite all precautions, make his way back from the grave, steps were taken to barricade the house against him. Thus, in some parts of Russia and East Prussia an axe or a lock is laid on the threshold, or a knife is hung over the door,^ and in Germany as soon as the coffin is carried out of the house all the doors and windows are shut, whereas, so long as the body is still in the house, the windows (and sometimes the doors) are left constantly open to allow the soul to escape.◊ In some parts of England every bolt and lock in the house is unfastened, that the ghost of the dying man may fly freely away.‡

But, if primitive man knew how to bully, he also knew how to outwit the ghost. For example, a ghost can only find his way back to the house by the way by which he left it. This little weakness did not escape the vigilance of our ancestors, and they took their measures accordingly. The coffin was carried out of the house, not by the door, but by a hole made for the purpose in the wall, and this hole was carefully stopped up as soon as the body had been passed through it; so that, when the ghost strolled quietly back from the grave, he found to his surprise that there was no thoroughfare. The credit of this ingenious device is shared equally by Greenlanders, Hottentots,

* Wuttke, §§ 725, 737; F. Schmidt, Sitten u. Gebraüche in Thüringen," p. 85; Köhler, "Volksbrauch," p. 254.

† Festus, *s. v. everriator;* cf. Gray, "China," i, p. 287.

‡ Bancroft, "Native Races of the Pacific States," i, p. 641.

\# Lichtenstein, "Travels in Southern Africa," i, pp. 258, 259; J. Campbell, "South Africa," p. 515, *sq.*; Taylor, "New Zealand," p. 170; Yates, "New Zealand," p. 86.

‖ Euripides, "Alcestis," v, 234 *sqq.*, cf. 205; Scholiast on Aristophanes, "Lysistrata," v, 611; Seneca, Epist. I, xii, 3; Gray, "China," i, p. 279. In modern Greece, as soon as the corpse is out of the house, the whole house is scoured (C. Wachsmuth, "Das alte Griechenland im neuem," p. 120).

^ Ralston, p. 318; Wuttke, §§ 736, 766.

◊ Sonntag, p. 169; Wuttke, §§ 737, 725; Gubernatis, "Usi funebri," p. 47; Lammert, "Volksmedezin," pp. 103, 105, 106.

‡ Dyer, "English Folk-lore," p. 230; Brand, "Popular Antiquities," ii, p. 231.

Bechuanas, Samoieds, Ojibways, Algonquins, Laosians, Hindoos, Thibetans, Siamese, Chinese, and Feejeeans. These special openings, or "doors of the dead," are still to be seen in a village near Amsterdam, and they were common in some towns of central Italy, as Perugia and Assisi.* A trace of the same custom survives in Thüringen, where it was thought that the ghost of a man who has been hanged will return to the house if the body be not taken out by a window instead of the door.†

The Siamese, not content with carrying the dead man out by a special opening, endeavor to make assurance doubly sure by hurrying him three times round the house at full speed—a proceeding well calculated to bewilder the poor soul in the coffin.‡

The Araucanians adopt the plan of strewing ashes behind the coffin as it is being borne to the grave, in order that the ghost may not be able to find his way back.#

The very general practice of closing the eyes of the dead appears to have originated with a similar object; it was a mode of blindfolding the dead, that he might not see the way by which he was carried to his last home. At the grave, where he was to rest forever, there was of course no motive for concealment; hence the Romans,‖ and apparently the Siamese,^ opened the eyes of the dead man at the funeral pyre, just as we should unbandage the eyes of an enemy after conducting him to his destination. The notion that, if the eyes of the dead be not closed, his ghost will return to fetch away another of the household, still exists in Germany, Bohemia, and England.◊ In some parts of Russia they place a coin on each of the dead man's eyes.‡

With a similar object, the corpse is carried out of the house feet foremost, for if he were carried out head foremost his eyes would be turned toward the door, and he might therefore find his way back. This custom is observed, and this reason is assigned for it, in many parts of Germany and among the Indians of Chili.‡ Conversely, in

* Yule on Marco Polo, i, p. 188; Crantz, "Greenland," i, p. 237; 'Tylor, "Prim. Cult.," ii, p. 26; Waitz, "Anthropologie," iii, p. 199; Williams and Calvert, "Feejee," p. 168; Sonntag, p. 51; Bastian, "Mensch," ii, p. 322; Klemm, ii, pp. 221, 225; id., iii, p. 293; C. Bock, "Temples and Elephants," p. 262; Pallegoix, "Siam," i, p. 245; Bowring, "Siam," i, p. 222; Gubernatis, p. 52; C. J. Anderson, "Lake Ngami," 466. A dead pope is carried out by a special door, which is then blocked up till the next pope dies.

† Wuttke, § 756.

‡ Pallegoix, "Siam," i, p. 245; Bowring, "Siam," i, p. 222. In some parts of Scotland the body used to be carried three times round the church (C. Rogers, "Social Life in Scotland," i, p. 167).

Klemm, v, p. 51; Wood, "Natural History of Man," ii, p. 565.

‖ Pliny, N. H., xi, 150.

^ C. Bock saw that the eyes of a dead man at the pyre were open (in Siam), and he says that in Lao it was the custom to close the eyes of the dead ("Temples and Elephants," pp. 58, 261).

◊ Wuttke, § 725; Dyer, "English Folk-lore," p. 230; Grohmann, "Aberglauben," p. 188.

‡ Gubernatis, "Usi funebri," p. 50.

‡ Wuttke, § 736; Klemm, ii, p. 101.

Persia, when a man is setting out on a journey, he steps out of the house with his face turned toward the door, hoping thereby to secure a safe return.* In Thüringen and some parts of the north of England it used to be the custom to carry the body to the grave by a roundabout way.†

I venture to conjecture that the old Roman usage of burying by night ‡ may have originally been intended, like the customs I have mentioned, to keep the way to the grave a secret from the dead, and it is possible that the same idea gave rise to the practice of masking the dead—a practice common to the prehistoric inhabitants of Greece and to the Aleutian-Islanders.#

To a desire to deceive the dead man I would also refer the curious custom among the Bohemians of putting on masks and behaving in a strange way as they returned from a burial.‖ They hoped, in fact, so to disguise themselves that the dead man might not know and therefore might not follow them. Whether the wide-spread mourning customs of smearing the body with mud or paint, mutilating it by gashes, cutting off the hair or letting it grow, and putting on beggarly attire or clothes of an unusual color (black, white, or otherwise), may not have also originated in the desire to disguise and therefore to protect the living from the dead, I can not here attempt to determine. This much is certain, that mourning customs are always as far as possible the *reverse* of those of ordinary life. Thus, at a Roman funeral, the sons of the deceased walked with their heads covered, the daughters with their heads uncovered, thus exactly reversing the ordinary usage, which was that women wore coverings on their heads, while men did not. Plutarch, who notes this, observes that in like manner in Greece men and women during a period of mourning exactly inverted their usual habits of wearing the hair—the ordinary practice of men being to cut it short, that of women to leave it long.^

The objection, deeply rooted in many races, to utter the names of deceased persons,◊ sprang no doubt from a fear that the dead might hear and answer to his name. In East Prussia, if the deceased is called thrice by his name, he appears.‡ This reluctance to mention the names of the dead has modified whole languages. Thus among

* "Hajji Baba," c. i, *fin.*

† F. Schmidt, p. 94.

‡ Servius on Virg. Æn., i, 186. Night burial was sometimes practiced in Scotland (C. Rogers, "Social Life in Scotland," i, p. 161), and commonly in Thüringen (F. Schmidt, p. 96). Cf. Mungo Park, "Travels," p. 414.

Schliemann, "Mycenæ," pp. 198, 219–223, 311 *sq.*; Bancroft, "Native Races," i, p. 93. The Aztecs masked their dead kings (Bancroft, ii, 606), and the Siamese do so still (Pallegoix, "Royaume de Siam," i, p. 247).

‖ Bastian, ii, p. 328.

^ Plutarch, "Rom. Quæst.," 14.

◊ Tylor, "Early History of Mankind," p. 142.

‡ Wuttke, § 754.

the Australians, Tasmanians, and Abipones, if the name of a deceased person happened to be a common name—e. g., the name of an animal, or plant—this name was abolished, and a new one substituted for it.* During the residence of the Jesuit missionary Dobritzhoffer among the Abipones, the name for tiger was thus changed three times.† Among the Indians of Columbia near relatives of a deceased person often change their names, under the impression that the ghost will return if he hears the familiar names.‡

I must pass lightly over the kindlier modes of barring the dead by providing for the personal comforts of the poor ghost in his long home. One instance, however, of the minute care with which the survivors will provide for the wants of the dead, in order that he may have no possible excuse for returning, I can not refrain from mentioning. In the German district of Voigtland,# with its inclement sky, they never forget to place in the coffin an umbrella and a pair of goloshes. Whether these utensils are intended for use in heaven, or elsewhere, is a question which I must leave to theologians.

A pathetic example is afforded by some Indian tribes of New Mexico, who drop milk from the mother's breast on the lips of her dead babe.‖

The nearly universal practice of leaving food on the tomb, or of actually passing it into the grave by means of an aperture or tube, is too well known to need illustration. Like the habit of dressing the dead or dying in his best clothes,^ it probably originated in the selfish but not unkindly desire to induce the perturbed spirit to rest in the grave, and not come plaguing the survivors for food and raiment.

Merely mentioning the customs of building a little house for the accommodation of the soul either on the grave or on the way to it,◊ and of leaving straw on the road, in the hope that the weary ghost would sit down on it and never get as far as the house,‡ I now come to two modes of barring the ghost, which from their importance I have reserved to the last—I mean the methods of barring the ghost by fire and water.

First, by fire. After a funeral certain heathen Siberians, who greatly fear the dead, seek to get rid of the ghost of the departed by leaping over a fire.↕ Similarly at Rome, mourners returning from a

* Tylor, ibid., p. 144 *sqq.*

† Klemm, ii, p. 99; Dobritzhoffer, "The Abipones," ii, p. 208 *sqq.*

‡ Bancroft, "Native Races," i. p. 248.

\# Wuttke, § 734.

‖ Bancroft, i, p. 360.

^ Gray, "China," i, pp. 278–280; Klemm, ii, pp. 104, 221, 225; id. iv, p. 38; Marshall, "Travels among the Todas," p. 171.

◊ Klemm, ii, p. 297; Bastian, ii, p. 328; Marco Polo, i, c. 40; Waitz, "Anthropologie," ii, p. 195; id., iii, p. 202; Chalmers and Gill, "New Guinea," p. 56.

‡ Wuttke, § 739; Töppen, p. 109.

↕ Meiners, "Geschichte der Religionen," ii, p. 303.

funeral stepped over fire,* and in China they sometimes do so to this day.† Taken in connection with the Siberian custom, the original intention of this ceremony of stepping over fire at Rome and in China can hardly have been other than that of placing a barrier of fire between the living and the dead. But, as has been the case with so many other ceremonies, this particular ceremony may well have been practiced long after its original intention was forgotten. For customs often live on for ages after the circumstances and modes of thought which gave rise to them have disappeared, and in their new environment new motives are invented to explain them. As might have been expected, the custom itself of stepping over fire often dwindled into a mere shadow of its former self. Thus the South Slavonians returning from a funeral are met by an old woman carrying a vessel of live coals. On these they pour water, or else they take a live coal from the hearth and fling it over their heads.‡ The Brahmans contented themselves with simply touching fire,# and in Ruthenia the mourners merely look steadfastly at the stove or place their hands on it.‖

So much for the barrier by fire. Next for the barrier by water. "The Lusatian Wends," says Ralston,^ "still make a point of placing water between themselves and the dead as they return from a burial, even breaking ice for the purpose if necessary." In many parts of Germany, in modern Greece, and in Cyprus, water is poured out behind the corpse when it is carried from the house, in the belief that, if the ghost returns, he will not be able to cross it.◊ Sometimes by night they pour holy water before the door; the ghost is then thought to stand and whimper on the farther side.‡ The inability of spirits to cross water might be further illustrated from the Bagman's ghastly story in Apuleius,‡ from Paulus's "History of the Lombards,"‡ from Giraldus Cambrensis's "Topography of Ireland,"** and from other sources.††

Another way of enforcing the water barrier was for the mourners to plunge into a stream in the hope of drowning, or at least shaking off, the ghost. Thus, among the Matamba negroes, a widow is bound

* Festus, *s. v. aqua et igne.*

† Gray, "China," i, pp. 287, 305.

‡ Ralston, "Songs," p. 319.

Monier Williams, "Religious Life and Thought in India," pp. 283, 288.

‖ Ralston, *l. c.*

^ "Songs of the Russian People," p. 320.

◊ Wuttke, § 737; A. Kuhn, "Märkische Sagen," p. 368; Temme, "Volkssagen der Altmark," p. 77; Lammert, p. 105; Panzer, "Beitrag," i, p. 257; "Folk-lore Journal," ii, p. 170; Töppen, "Aberglauben aus Masuren," p. 108; C. Wachsmuth, "Das Alte Griechenland im neuem," p. 119.

‡ Wuttke, § 748.

‡ "Metamorphoses," i, 19, cf. 13.

‡ iii, c. 34.

** Ch. 19.

†† Grimm, "Deutsche Mythologie," iii, p. 434; Theocritus, 24, 92, 93; Homer, "Odyss," xi, 26 *sqq.*, Ovid, "Fasti," v, 441; Brent, "The Cyclades," pp. 441, 442; Dennys, "Folk-lore of China," p. 24; Lammert, "Volksmedezin," p. 103.

hand and foot by the priest, who flings her into the water several times over, with the intention of drowning her husband's ghost, who may be supposed to be clinging to his unfeeling spouse.* In Angola, for a similar purpose, widows adopt the less inconvenient practice of ducking their late husbands.† In New Zealand all who have attended a funeral betake themselves to the nearest stream and plunge several times, head under, in the water.‡ In Feejee the sextons always washed themselves after a burial.# In Tahiti all who assisted at a burial fled precipitately and plunged into the sea, casting also into the sea the garments they had worn.‖ In some parts of West Africa, after the corpse has been deposited in the grave, "all the bearers rush to the water-side and undergo a thorough ablution before they are permitted to return to the town." ^

But the barrier by water, like the barrier by fire, often dwindled into a mere stunted survival. Thus, after a Roman funeral it was enough to carry water three times round the persons who had been engaged in it and to sprinkle them with the water.◊ In China, on the fifth day after a death, the mourners merely wash their eyes and sprinkle their faces three times with water.‡ In Cappadocia and Crete persons returning from a funeral wash their hands.‡ In Samoa they wash their faces and hands with hot water.‡ In ancient India it was enough merely to touch water.** In Greece, so long as a dead body was in the house, a vessel of water stood before the street-door that all who left the house might sprinkle themselves with it.†† Note that in this case the water had to be fetched from another house—water taken from the house in which the corpse lay would not do. The significance of this fact I shall have occasion to point out presently.

When considered along with the facts I have mentioned, it can hardly be doubted that the original intention of this sprinkling with water was to wash off the ghost who might be following from the house of death; and in general I think we may lay down the rule that, wherever we find a so-called purification by fire or water from pollution contracted by contact with the dead, we may assume with much probability that the original intention was to place a physical

* Sonntag, p. 113. † Id., p. 115.

‡ Yates, "New Zealand," p. 137; Klemm, iv, p. 305.

\# Williams and Culvert, "Feejee," p. 163, ed. 1870.

‖ Ellis, "Polynesian Researches," i, p. 403.

^ Wilson, quoted by Gardner, "Faiths of the World," i, p. 938; cf. Brinton, "Myths of the New World," p. 133; Ellis, "History of Madagascar," i, p. 238.

◊ Virgil, "Æn.," vi, 228, where Servius speaks of carrying *fire* round similarly.

‡ Gray, "China," i, p. 305.

‡ Wachsmuth, p. 120.

‡ Turner, "Polynesia," p. 228.

** Monier Williams, "Religious Thought and Life in India," pp. 283, 288.

†† Pollux, viii, 65; Hesychius and Suidas, *s.v.*, ἀρδάνιον. Cf. Wachsmuth, ibid., p. 109.

barrier of fire or water between the living and the dead, and that the conceptions of pollution and purification are merely the fictions of a later age, invented to explain the purpose of a ceremony of which the original intention was forgotten. Time forbids me to enter into the wider question whether *all* forms of so-called ceremonial purification may not admit of a similar explanation. I may say, however, that there is evidence that some at least of these forms are best explained on this hypothesis. To one of the most important of these forms of purification—that of mothers after childbirth—reference will be made in the course of this paper.

Such, then, are some of the modes adopted for the purpose of excluding or barring the ghost. Before quitting the subject, however, I wish to observe that, as the essence of these proceedings was simply the erection of a barrier against the disembodied spirit, they might be, and actually were, employed for barring spirits in other connections. Thus, for example, since to early man death means the departure of the soul out of the body, it is obvious that the very same proceedings which serve to exclude the soul after it has left the body—i. e., to bar the ghost, may equally well be employed to bar the soul *in* the body—i. e., to prevent it escaping; in other words, they may be employed to prevent a sick man from dying—in fact, they may be used as cures. Thus the Chinese attempt to frighten back the soul of a dying man into his body by the utterance of wild cries and the explosion of crackers, while they rush about with extended arms to arrest its progress.* The use of water as a means of intercepting the flying soul is perhaps best illustrated by the Circassian treatment of the sick. It is well known that according to primitive man the soul of a sleeper departs from his body to wander far away in dreamland; in fact, the only distinction which early man makes between sleep and death is that sleep is a temporary, while death is a permanent, absence of the soul. Obviously, then, on this view, sleep is highly dangerous to a sick man, for if in sleep his soul departs, how can we be sure that it will come back again? Hence, in order to insure the recovery of a sick man, one of the first requisites is to keep him from sleeping. With this intention the Circassians will dance, sing, play, and tell stories to a sick man by the hour. Fifteen to twenty young fellows, naturally selected for the strength of their lungs, will seat themselves round his bed and make night hideous by singing in chorus at the top of their voices, while from time to time one of their number will create an agreeable variety by banging with a hammer on a plowshare which has been thoughtfully placed for the purpose by the sick man's bed. But if, in spite of these unremitting attentions, the sick man should have the misfortune to fall asleep—mark what follows—they immediately dash

* Huc, "L'Empire Chinois," ii, p. 241.

water over his face.* The intention of this latter proceeding can hardly be doubtful—it is a last effort to stop the soul about to take flight forever. So among the Abipones, a dying man is surrounded by a crowd of old crones brandishing rattles, stamping and yelling, while every now and then one of them flings water over his face so long as there is breath left in his body.† The same practice of throwing water over the sick is observed also in China, Siam, Siberia, and Hungary.‡

By analogy, the origin of the Caffre custom of kindling a fire beside a sick person,# the Russian practice of fumigating him,‖ and the Persian practice of lighting a fire on the roof of a house where any one is ill,[△] may perhaps be found in the intention of interposing a barrier of fire to prevent the escape of the soul. For, with regard to the custom of lighting a fire on the roof, it is a common belief that spirits pass out and in through a hole in the roof.◊ In the same way I would explain the extraordinary custom in Lao and Siam of surrounding a mother after childbirth with a blazing fire, within which she has regularly to stay for weeks after the birth of the child.‡ The object, I take it, is to hem in the fluttering soul at this critical period with an impassable girdle of fire. Conversely, among the Caffres a widow must stay by herself beside a blazing fire for a month after her husband's death—no doubt in order to get rid of his ghost.‡ If any confirmation of this interpretation of the Siamese practice were needed, it

* Klemm, iv, p. 34.

† Dobritzhoffer, "Account of the Abipones," ii, p. 266. Among the Indians of Lower California, if a sick man falls asleep, they knock him about the head till he wakes, with the sincere intention of saving his life (Bancroft, i, p. 569). Similarly, Caffres when circumcised at the age of fourteen are not allowed to sleep till the wound is healed (Campbell, "Travels in South Africa," p. 514).

‡ Gray, i, p. 278; Pallegoix, i, p. 294; Bowring, i, p. 121; Klemm, x, 254: "Folklore Journal," ii, p. 102. In Tiree a wet shirt is put on the patient, id., i, p. 167.

\# Lichtenstein, i, p. 258.

‖ Ralston, "Songs of the Russian People, p. 380.

△ Klemm, vii, p. 142.

◊ Wuttke, §§ 725, 755; Bastian, "Mensch," ii, pp. 319, 323; id., "Die Seele," p. 15; Ralston, "Songs," p. 314; J. T. Brent, "The Cyclades," p. 437; Dennys, "Folk-lore of China," p. 22; Lammert, "Folksmedezin," p. 103.

‡ Carl Bock, "Temples and Elephants," p. 259; Bowring, i, p. 120; Pallegoix, i, p. 223. Cf. Forbes, "British Burmah," p. 46; Darmesteter, "Zend-Avesta," i, p. xciii; Ellis, "History of Madagascar," i, p. 151. A relic of this custom is seen in the old Scotch practice of whirling a fir-candle three times round the bed on which the mother and child lay (C. Rogers, "Social Life in Scotland," i, p. 135). Among the Albanians a fire is kept constantly burning in the room for forty days after birth; the mother is not allowed to leave the house all this time, and at night she may not even leave the room; and any one during this time who enters the house by night is obliged to leap over a burning brand (Hahn, "Albanesische Studien," p. 149). In the Cyclades, for many days after a birth, no one may enter the house by night. The mother does not go to church for forty days after the birth (Brent, pp. 180, 181).

‡ Lichtenstein, i, p. 259.

would seem to be found in the fact that, during her imprisonment within the fiery circle, the woman washes herself daily for a week with a mixture of salt and water,* for salt and water, as we know from Theocritus,† is a regular specific against spirits.

Of course it is possible that these fiery barriers may also be intended to keep off evil spirits, and this is the *second* supplementary use to which the proceedings for barring ghosts may be turned. This would appear to have been the object with which, in Siberia, women after childbirth cleansed themselves by leaping several times over a fire, exactly as we saw that in Siberia mourners returning from a funeral leap over a fire for the express purpose of shaking off the spirit of the dead.‡

In China, the streets along which a funeral is to pass are previously sprinkled with holy water, and even the houses and warehouses along the street come in for their share, in case some artful demon might be lurking in a shop, ready to pounce out on the dead man as he passed.# Special precautions are also taken by the Chinese during the actual passage of the funeral; in addition to the usual banging of gongs and popping of crackers, an attempt is made to work on the cupidity of the demons. With this view bank-notes are scattered, regardless of expense, all along the road to the grave. The notes, I need hardly observe, are bad, but they serve the purpose, and, while the ingenuous demons are engaged in the pursuit of these deceitful riches, the soul of the dead man, profiting by their distraction, pursues his way tranquilly behind the coffin to the grave.‖

In the Hervey Islands, in the South Pacific, after a death the ghosts or demons are fought and soundly pummeled by bodies of armed men, just as the Samogitians and old Prussians used to repel the ghostly squadrons by sword-cuts in the air.^

In Christian times bells have been used for a like purpose; this, of course, was the intention of the passing-bell.◊ The idea that the sound of brass or iron had power to put spirits to flight prevailed also in classical antiquity,‡ from which it was perhaps inherited by mediæval Christianity.

I have still one observation to make on the means employed to bar ghosts, and it is this. The very same proceedings which were resorted

* Bock, *op. cit.*, p. 260. † xxiv, 95, 96.

‡ Meiners, "Geschichte der Religionen," ii, p. 107.

\# Gray, "China," i, p. 299.

‖ Huc, "L'Empire Chinois," ii, p. 249; Gray, *l. c.*; Doolittle, "Social Life of the Chinese," p. 153 (ed. Paxton Hood).

^ Gill, "Myths and Songs from the South Pacific," p. 269; Bastian, ii, p. 341. Cf. Wood, "Nat. Hist. of Man," ii, p. 562.

◊ Brand, "Popular Antiquities," ii, p. 202; Forbes Leslie, "Early Races of Scotland," ii, p. 503.

‡ Lucian, "Philopseudes," c. 15; Ovid, "Fasti," v, 441; cf. Professor Robertson Smith in "Journal of Philology," vol. xiii, No. 26, p. 283, *note*.

to *after* the burial for the purpose of barring the ghost were *avoided* so long as the corpse was in the house, from fear no doubt of hurting and offending the ghost. Thus we saw that an axe laid on the threshold or a knife hung over the door after the coffin has been carried out, has power to exclude the ghost, who could not enter without cutting himself. Conversely, so long as the corpse is still in the house, the use of sharp-edged instruments should be avoided in case they might wound the ghost. Thus for seven days after a death, the corpse being still in the house, the Chinese refrain from the use of knives and needles and even of chopsticks, eating their food with their fingers.* So at the memorial feasts to which they invited the dead, the Russians ate without using knives.† In Germany a knife should not be left edge-upward, lest it hurt the ghosts or the angels.‡ They even say that if you see a child in the fire and a knife on its back, you should run to the knife before the child.# Again, we saw that the Romans and the Germans swept the ghost, without more ado, out of his own house. On the other hand, the more considerate negroes on the Congo abstain for a whole year from sweeping the house where a man has died, lest the dust should annoy the ghost.‖ Again, we have seen the repugnance of ghosts to water. Hence, when a death took place, the Jews used to empty all the water in the house into the street, lest the ghost should fall in and be drowned.^ In Burmah, when the coffin is being carried out, every vessel in the house containing water is emptied.◊ In some parts of Bohemia, after a death, they turn the water-butt upside down, because, if the ghost happened to bathe in it and any one drank of it afterward, he would be a dead man within the year.‡ We can now appreciate the significance of the fact mentioned above, that in Greece the lustral water before the door of a house where a dead body lay had always to be fetched from a neighboring house. For, if the water had been taken from the house of death, who could tell but that the ghost might be disporting himself in it?‡ In Pomerania, even *after* a burial, no washing is done in the house for some time, lest the dead man should be wet in his grave.‡ Among the old Iranians no moisture was allowed to rest on the bread

* Gray, "China," i, p. 288.

† Ralston, "Songs of the Russian People," p. 321.

‡ Grimm, "Deutsche Mythologie," iii, pp. 441, 454; Tettau u. Temme, p. 285; Grohmann, p. 198.

\# Grimm, ibid., p. 469.

‖ Bastian, "Mensch," ii, p. 323. On the day of the funeral the Albanians refrain from sweeping the place on which the corpse lay. Hahn, "Albanesische Studien," p. 152.

^ Gardner, "Faiths of the World," i, p. 676.

◊ Forbes, "British Burmah," p. 95.

‡ Grohmann, § 193.

‡ Hence among the Jews all *open* vessels in the chamber of death were "unclean" Numbers xix, 15).

‡ Wuttke, § 737.

offered to the dead, for, of course, if the bread was damp, the ghost could not get at it.*

Once more, we saw that fire was a great stumbling-block to ghosts. Hence in the Highlands of Scotland and in Burmah the fires in a house used always to be extinguished when a death took place, no doubt lest they should burn the ghost. † So in old Iran no fire was allowed to be used in the house for nine days after a death,‡ and in later times every fire in the Persian Empire was extinguished in the interval between the death and burial of a king.#

It might perhaps be thought that the common practice of *fasting* after a death was a direct consequence of this disuse of fire ; and there are facts which appear at first sight to show that it was so. Thus the Chinese, though they are not allowed to cook in the house for seven days after a death, are not prohibited from eating food which has been prepared elsewhere ; indeed, during this period of mourning their wants are regularly supplied by their neighbors.‖ From this it would appear that the prohibition only extends to food cooked in the house of mourning. But this explanation will not suit the German superstition, that while the passing-bell is tolling no one within hearing should eat.^ For here the prohibition evidently extends to all the food in the neighborhood. The key to the solution of this problem will perhaps be found in the Samoan usage.◊ We are told that in Samoa, "while a dead body is in the house, no food is eaten under the same roof ; the family have their meals outside or in another house. Those who attended the deceased were formerly most careful not to handle food, and for days were fed by others as if they were helpless infants." Observe here, firstly, that the objection is not to *all* eating, but only to eating under the same roof with the dead ; and, secondly, that those who have been in contact with the dead may eat but may not touch their food. Now, considering that the ghost could be cut, burned, drowned, bruised with stones, and squeezed in a door (for it is a rule in Germany not to slam a door on Saturday for fear of jamming a ghost),‡ it seems not unreasonable to suppose that a ghost could be

* Spiegel, "Eranische Alterthumskunde," iii, p. 705.

† Brand, ii, p. 235 ; James Logan, "The Scottish Gaël," ii, p. 387 ; Forbes, "British Burmah," p. 94.

‡ Spiegel, ibid., p. 706.

Diodorus, xvii, c. 114.

‖ Gray, "China," i, pp. 287, 288. Cf. Apuleius, "Metam.," ii, c. 24. Similarly among the Albanians there is no cooking in the house for three days after a death, and the family is supported by the food brought by friends. Hahn, "Albanesische Studien," p. 151. So among the Cyclades, Brent, "The Cyclades," p. 221.

^ W. Sonntag, "Todtenbestattung," p. 175. Similar superstition in New England ("Folk-lore Journal," ii, p. 24).

◊ Turner, "Nineteen Years in Polynesia," p. 228 ; cf. Taylor, "New Zealand," p. 163 ; "Old New Zealand, by a Pakeha Maori," p. 124 *sqq.* ; Ellis, "Polynesian Researches," i, p. 402.

‡ Wuttke, § 752.

eaten, and if we make this supposition I venture to think that we have a clew to the origin of fasting after a death. People in fact originally refrained from eating just in those circumstances in which they considered that they might possibly in eating have devoured a ghost. This supposition explains why, so long as the corpse is in the house, the mourners may eat outside of the house but not in it. Again, it explains why those who have been in contact with the dead and have not yet purified themselves (i. e., have not yet placed a barrier between themselves and the ghost) are not allowed to touch the food they eat; obviously the ghost might be clinging to them and might be transferred from their person to the food, and so eaten.

This theory further explains the German superstition mentioned above, that no one within hearing must eat while the passing-bell is tolling. For the passing-bell is rung when a soul is issuing for the last time from its mortal tabernacle, and, if any one in the neighborhood were at this moment to eat, who knows but that his teeth might close on the passing soul? This explanation is confirmed by the companion superstition that no one should sleep while the passing-bell is tolling, else will his sleep be the sleep of death.* Put into primitive language, this means that, as the soul quits the body in sleep, if it chanced in this, its temporary absence, to fall in with a soul that was taking its eternal flight, it might, perhaps, be coaxed or bullied into accompanying it, and might thus convert what had been intended to be merely a ramble, into a journey to that bourn from which no traveler returns.

All this time, however, Plutarch has been waiting for his answer; but, perhaps, as he has already waited two thousand years, he will not object to be kept in suspense a very little longer. For the sake of brevity in what remains, I will omit all mention of the particular usages upon a comparison of which my answer is based, and will confine myself to stating in the briefest way their general result.

We have seen the various devices which the ingenuity of early man struck out for the purpose of giving an "iron welcome to the dead." In all of them, however, it was presupposed that the body was in the hands of the survivors, and had been by them securely buried; that was the first and most essential condition, and, if it was not fulfilled, no amount of secondary precautions would avail to bar the ghost.

But what happened when the body could not be found, as when the man died at sea or abroad? Here the all-important question was, What could be done to lay the wandering ghost? For wander he would, till his body was safe under the sod, and, by supposition, his body was not to be found. The case was a difficult one, but early man

* Sonntag, ibid.; cf. Wuttke, § 726. In Scotland it was an old custom not to allow any one to sleep in the house where a sick person was at the point of death (C. Rogers, "Social Life in Scotland," i, p. 152).

was equal to it. He buried the missing man *in effigy*,* and, according to all the laws of primitive logic, an effigy is every bit as good as its original.† Therefore, when a man is buried in effigy with all due formality, that man is dead and buried beyond a doubt, and his ghost is as harmless as it is in the nature of ghosts to be.

But it occasionally happened that this burial by proxy was premature—that, in fact, the man was not really dead, and, if he came home in person and positively declined to consider himself as dead, the question naturally arose, Was he alive, or was he dead? It was a delicate question, and the solution was ingenious. The man was dead, certainly—that was past praying for. But then he might be born again; he might take a new lease of life. And so it was; he was put out to nurse, he was dressed in long-clothes—in short, he went through all the stages of a second childhood.‡ But, before he was eligible even for this pleasing experience, he had to overcome the initial difficulty of getting into his own house. For the door was as ghost-proof as fire and water could make it, and *he* was a ghost. As such, he had to do as ghosts do: in fact, not to put too fine a point on it, he had to come down the chimney.# And down the chimney he came—and this is an English answer to a Roman question.—*The Contemporary Review.*

THE PHYSIOLOGY OF COLORS.‖

By M. E. MASCART.

A LIGHT is defined by two qualities, brightness and color. The comparison of two lights of the same color can be made without the assistance of our eyes, and by physical means alone, but it is impossible to compare different colors without bringing in the intervention of the physiological impression. It has been known since Newton's experiments that white light, or, to be more precise, the light of the sun, is formed of a large number of different colors, and that the union of all these in equal proportion, acting upon the eye, either

* The practice of burial in effigy prevailed in ancient Greece, Mexico, and Samoa, and it prevails to this day in modern Greece, Albania, India, and China. See Chariton, iv, c. 1; Bancroft, "Native Races of the Pacific States," ii, p. 616; Turner, "Samoa," p. 150; C. Wachsmuth, "Das Alte Griechenland im neuem," p. 113; Hahn, "Albanesische Studien," p. 152; Monier Williams, "Religious Thought and Life in India," p. 300; Gray, "China," i, p. 295. Compare Doolittle, "Social Life of the Chinese," p. 164; Apuleius, "Metam.," i, c. 6; Brent, "The Cyclades," pp. 223, 224; Servius on Virgil, "Æn.," vi, 366.

† For evidence see Tylor's "Early History of Mankind," p. 116 *sqq.*

‡ Plutarch, "Rom. Quæst.," v.

See the passages cited in note ** to p. 678.

‖ An address before the Royal Institution of Great Britain. Translated from the French for "The Popular Science Monthly."

simultaneously or at very close intervals, produces the impression of white. Starting from a preconceived analogy with the notes of the gamut, Newton divided the solar spectrum, or the image obtained by decomposing white light with a refracting prism, into seven different colors. This division is really arbitrary, for the colors pass from one to another by insensible transitions, and each of them may be characterized either by the degree of its refraction in the prism, or by the length of the undulations to which it corresponds.

When we collect a part of the spectral rays in one point, we obtain either one of the primitive colors in a greater or less state of purity, or a new tint. If we divide the spectrum arbitrarily into two parts and collect the rays of these parts separately, we obtain two distinct colors, the superposition of one of which on the other gives white light. The experiment can be performed with an ordinary spectrum divided arbitrarily into two parts ; and it is effected, we might say naturally, in the phenomena of rotatory polarization in which the most brilliant hues are shown.

We mention these properties to deduce two conclusions from them. We remark, first, that the mixture of simple or homogeneous lights in any proportion always produces upon the eye a single impression, that of one color. While the ear can distinguish all the notes that go to make up a harmony, the eye can grasp only one color, without being able to distinguish whether it is really simple, or is formed of different lights.

In the second place, the mixture of colors provokes only one new impression, that of purple, for example, which we may obtain by mixing red and violet, while the varieties of rose are nothing but mixtures of purple and white. White may be produced by two simple colors alone, as by red and green ; more generally, if we isolate three suitably chosen colors in the spectrum, such as particular shades of red, green, and violet, we may, by mixing them in different proportions, imitate the impressions produced by all the colors. Artificial colors, formed, for example, of rays selected from the spectrum, may be simple or compound, without the eye being informed of the difference, except, perhaps, when they have a shade of purple or of rose, for we know then that those colors do not exist in a simple state.

The same is the case with the colors of nature, or of industry. An object appears colored to us because it sends us only a part of the light it borrows from the general illumination. The sorting out is made either by transmission, as in colored glasses, or by reflection, as in the case of the metals, or by diffraction, as in the wings of some butterflies, or in the coronas which we sometimes perceive around the moon ; the portion of the light that does not reach the eye having been absorbed or sent off in a different direction. Leaving out of the account the effects of fluorescence, we perceive that objects do not have colors of themselves, but simply borrow from the general lighting the tint that is suited to them, and present very different aspects according to the mode in which they are lighted. A red ribbon, for example, placed successively in the different colors of the spectrum, appears black, except in the red region ; it therefore returns by reflection an almost homogeneous light. A rose ribbon appears very unequally luminous in different parts of the spectrum. The light which it reflects is, therefore, complex.

We may ask, then, What would be the condition of nature if the light that shines upon us were absolutely homogeneous? Some bodies would absorb it completely, and would appear dark like black velvet ; others would reflect it more or less actively, and would have a corresponding degree of brilliancy. As there would be no criterion for comparison, the eye would have only the sensations of white, black, and the intermediate rays.

Pascal said that nothing better enabled him to comprehend the properties of the air than what took place where there was none. So, nothing better enables us to comprehend the properties of colors than the appearance of the world under an illumination of homogeneous light. The volatilization of a salt of soda in the flame of a Bunsen burner almost perfectly fulfills this condition. With such a light, cloths dyed in the richest colors show only white, black, and gray, and the art of painting has no place.

The estimation of color being connected with the impression produced upon the retina, it is readily to be seen that the human eye will not always equally well perform that function. The different points of the retina are not alike ready to appreciate colors. To distinguish the details of an object, it is necessary to direct the look toward it, or, in other words, to produce an image upon the central region of the retina, where the acuteness of physiological perception is much the greatest. The same is the case for colors. When we keep the look in a determined direction, and put a colored body in the visual field in such a way that its image is produced laterally, we remark that the notion of color is more and more weakened as we remove from central vision, and disappears at the limits of the field. But the most important fact is, that in the different views the colors are not distinguished from one another with equal facility, and that we sometimes come to the point of confounding colors which really seem to be most discordant, as green and red. The discovery of this particular form of infirmity is due to Dalton, who was very strongly affected by it, and who carefully analyzed the errors of his judgment. This fault, which remained unperceived for so long a time, is in reality quite frequent. About ten persons in a hundred make mistakes in the comparison of colors marked enough to be detected by an attentive examination. Generally the imperfection is not accompanied with grave inconveniences, and is corrected unconsciously by the operation of habit, the recollection of objects, and the judgments of others. But the annoyance becomes extreme when one can not distinguish, for example, red from green, a cherry or a ripe strawberry amid the foliage, or a green from a red light in railway or ship signals. Artists sometimes have marked predilections for certain colors. Lesueur put a profusion of blue into all his paintings, and Turner seems to have sought and found red everywhere. It might be worth while to investigate whether the choice of their favorite colors by some painters is wholly intentional, or is a consequence of a physiological state. Color-blind persons are generally so by birth, but the affection may sometimes be the result of an accident. In some nervous affections it is occasionally manifested temporarily and under the strangest forms. The sight may thus, more than the other senses, be the victim of numerous errors and illusions. To speak only of those which have relation to colors, I notice the effects of contrast of two neighboring colors, or those which follow the impression of an image, or the subjective colors we see with our eyes shut, the result of a mechanical action on the eye, and I shall limit myself to describing some experiments relative to the apparent relief of colors. When we examine on a screen the image of a spectrum produced by a direct-vision prism, the successive colors appear as if situated on the same plane; but, if we slowly turn the slit or the prism, we shall have the illusion of a colored blade in relief with the red extremity forward. The effect is more sensible when the slit is V-shaped, in which case the spectrum resembles a groove. If we substitute for the slit the word DAVY in transparent letters, there will appear to be produced on the screen an exaggerated form of letters in relief like those we see on some shop-signs.

Outside of the colors we are accustomed to see, the solar spectrum includes other rays, some less refrangible than the red, which make themselves manifest by their calorific properties, and others more refrangible than the violet, which are remarked by their photographic effects, and by the action they exercise on fluorescent substances. The solar ultra-violet spectrum produced in the prism occupies an extent nearly equal to that of the luminous spectrum; while Mr. Stokes has shown that the electric arc gives an ultra-violet spectrum five or six times more extended.

We may be surprised that the sight of man is restricted to so small a part of the rays emitted by a luminous source. We have to remark on this point that the case is the same with the other senses. The touch can give an idea of the temperature of bodies only within very narrow limits; the ear can perceive neither extremely grave nor extremely acute tones, and the highest sounds it can hear produce a painful impression. On the side of the infra-red, the visible spectrum stops very abruptly, and the efforts of Brewster extended the range of the rays that the eye can perceive only slightly. Visibility, on the other side of the spectrum, persists in a remarkable manner. Helmholtz had already discovered that with certain precautions he could perceive the whole ultra-violet spectrum as it is revealed by photography. Having had occasion to study the light emitted by metallic vapors, I have ascertained that, with a prism of Iceland spar, an ordinary sight can distinguish an ultra-violet spectrum three or four times as extended as the luminous spectrum ; one of my co-laborers saw much farther still, and pointed out in advance all the rays which it was possible for me to photograph. If instead of regarding the refraction of these rays, which varies with the nature of the substances, we define them by their wave-lengths or by the duration of their undulations, we may say that the ordinary luminous spectrum comprises the interval of an octave, and that it is possible to perceive a second higher or more acute octave.

Sir William Thomson has expressed surprise that Nature has forgotten to give us a special sense for perceiving the magnetic phenomena amid which we are living. In the case of light, we are in the presence of rays that are not luminous in sunlight, or at least are not seen by us, which are energetically absorbed by most transparent media and especially by the humors of the eye, for which we give ourselves no concern whatever in current life, and which nevertheless act upon the retina. Does it not seem as if we possessed in this respect a superfluous sensibility, and as if there were a lack of harmony between the structure of the organ and the wants to which it should respond? A question has been raised on this subject that presents a very great interest in the philosophical point of view, as to whether man is susceptible of an organic development, and if it is possible to detect a trace of any progress that may have been accomplished in the vision of colors, and consequently in the structure of the eye. An eminent Englishman has not disdained to engage himself with this question. Mr. Gladstone has summed up all the expressions used by Homer to designate the color of objects, from which it appears that the great poet was accustomed to apply the terms in a very uncertain manner, and confounded green with yellow and blue with black. Before concluding, from this curious observation, that the sense of color was but little developed in Homer's age, we should, perhaps, remark that the interval that separates us from him is but a short time in the history of mankind ; that the Greeks afterward made much use of colors in their pictures and in the painted statuettes of which we possess numerous specimens ; that the frescoes of Pompeii exhibit the most various colors ; and that a careful examination of modern authors might lead us to draw the same conclusions with respect to their time as would be drawn from the Homeric writings. Is it not singular that in the middle of the seventeenth century, when Lesueur was using blue extensively in painting, that emphatically naturalistic poet, La Fontaine, did not once employ the term blue to designate any colored object or the color of the sky?

Even if mankind were capable of a rapid progress toward perfection, it might be supposed that peoples who have continued in the conditions of the Stone age, like the natives of Cape Horn, should not have participated in the general progress. The French expedition, that recently spent a year at Terra del Fuego, made a special study of the natives in respect to this point. The Fuegian language has terms for only two colors, one for red and analogous tints, the other for blue and green. But it is thus poor only because colors do not play an important part in Fuegian life, for it was found that with a little practice the people learned to distinguish and classify colors and their different shades with all the exactness of the most civilized European. The organic development of their visual apparatus, therefore, leaves nothing to be desired. The question whether the vision of animals is the same as that of man, or whether some of them may not have the faculty of perceiving rays to which we are insensible, has been taken up by M. Paul Bert. He placed in a glass vessel a number of fresh-water crustaceans of the family of *Daphneæ*. When light was cast upon a point in the vessel, the Daphnias precipitated themselves upon it and arranged themselves along the beam. Most animals show a similar disposition, and seek the light when it is not too glaring. When a spectrum was thrown upon the vessel, the Daphnias still spread themselves over the illuminated region, but with some quite remarkable peculiarities of arrangement. The smallest ones were scattered through the whole spectrum, being rare in the red, abundant in the yellow and green, and more numerous in the blue and violet, while some of them fixed themselves in the ultra-violet. The largest ones, however, were almost exclusively localized upon a narrow band situated between the green and the blue. These animals, then, see the same rays as we, notwithstanding the distance that separates them from us in the zoölogical scale, and even seem to share our infirmities, for some of them behaved as if they were affected by color-blindness. Sir John Lubbock has made a series of brilliant researches, in the laboratory of the Royal Institution, on the vision of ants, bees, and wasps, from which the curious result has been deduced that the ultra-violet rays appear brighter to ants than the ordinary luminous spectrum. The history of animals regarding this point would therefore be of the highest interest.

We have, so far, considered colors only as one of Nature's decorations, but their influence on the development of living beings is exercised under the most various conditions. Without doubt, light and colors act upon the condition of our mind, and the moral impression thus produced can be nothing but the translation of a physiological action. In some sanitary establishments, where mental disorders are treated, patients are sometimes kept in a yellow light, which seems to exercise a happy influence on their disposition, and to promote calmer feelings. It is not the yellow light of soda that produces this result, but a kind of white light, in which the extreme blue and red rays have been softened so as to cause a predominance of the rose and yellow tones.

The predilection of animals for particular colors is not the result of an artistic preference. If the Daphnias seek the green light and the ants the ultra-violet, it is, doubtless, because they find better conditions of existence in them. Plants yield themselves more conveniently to studies of this kind. A common plant, like those we have habitually under our eyes, increases, develops itself in every quality, adds to its weight, produces leaves, flowers, and fruits, and respires, or keeps up a constant exchange between the elements it contains and the gases of the atmosphere. These different acts of vegetable life are very unequally affected by the various luminous or calorific radiations. The growth of plants, by the elongation and multiplication of cells, takes place mostly under the influence of the calorific rays, and there is for each plant a preferred temperature. If a plant receives heat only from one side, it is more developed on that side, and forms a curve in the opposite direction. This is the phenomenon of thermotropism. A plant grows less rapidly in the light than in the darkness, but with good effect on its general nutrition and transverse development. In this case the different colors have a very marked specific action. With a good light, the retarding action, insensible in the duller rays, exhibits a first maximum toward the red end, a minimum in the yellow, where the light is most intense, and a grand maximum in the violet. The rays of greater wave-length are, therefore, the more active ones. Hence results a very simple explanation of heliotropism, or of the marked tendency of plants to bend toward the light. When a plant is exposed to a lateral light, the illuminated parts lengthen less rapidly than those which remain in the shade, and the plant bends its head toward the light. We are able to go still further into the mechanism of nutrition. Besides the loss of water by evaporation, plants have two kinds of respiration—one which is continuous day and night, disengaging carbonic acid, a kind of combustion correlative with life and quite analogous to the respiration of animals ; and the other intermittent, and taking place only in the light, the result of which is to borrow from the carbonic acid of the atmosphere the carbon from which the plant makes sugar and wood, and to disengage oxygen. The coloring-matter of the leaves, chlorophyl, plays the principal part in this nutritive respiration. Now, chlorophyl has to be made first, and then to perform its respiratory functions ; and in this, again, the different colors act very unequally.

If we examine the formation of chlorophyl in the plant with a moderate light, we shall find that it takes place through the whole extent of the solar spectrum, very weakly in the infra-red, reaching a maximum in the deep yellow, and undergoing a regular diminution to the ultra-violet. The curve of this action takes a direction analogous to that which Fraunhofer has given for the distribution of luminous intensity in the spectrum, but is more prolonged toward the more refrangible rays. Here, again, is a preferred intensity, beyond which chlorophyl is formed less easily. Experiment has also shown that the production of oxygen takes place only where there are grains of chlorophyl. If we resolve with a prism a ray of white light that we have passed through a solution of chlorophyl, we will remark a strong absorption-band in the red, and two others in the blue and violet. These represent the rays that have been absorbed by the green substance, and which effect the reduction of carbonic acid.

In his experiments on fermentations, M. Pasteur distinguished the minute microscopic beings into *aërobes* and *anaërobes;* the former respire and are developed in the presence of the oxygen of the air, while the others are killed by oxygen. If we examine the aërobes of a liquid with the microscope, we will find them collected around bubbles of air, where they can find oxygen. If the liquid is deprived of air-bubbles and incloses a filament of a green alga, the bacteria will distribute themselves indifferently in the medium so long as it is illuminated with a very weak light, or, which is better, with a light that has been filtered through a solution of chlorophyl. In white light, the bacteria will be seen to precipitate themselves upon the grains of chlorophyl, to get the oxygen disengaged from them. They thus constitute a very delicate reagent. To witness the effect of the different colors, we let the microscopic spectrum fall upon a filament of conferva, or a transverse leaf-section. The bacteria will collect upon the plant in the red, at the point of maximum absorption, next in the blue, and the density of the population will nearly follow the absorption-curve of the coloring-matter.

I will not insist too long upon these facts in natural history; but I must add that great specific differences exist in the proper color of different plants, resulting from unequal absorption by their coloring-matters. One example of this kind will be enough. The color of sea-water varies according to the thickness through which we observe it, on account of the unequal absorption of the different rays; hence a marine plant will find itself in a condition more or less favorable, and be better or less equipped for the struggle for existence, according to the depth of the soil on which it rests. If we examine a bottom which the tide has just left, we will find blue sea-weeds on the edges of the deepest waters, farther down green sea-weeds, beyond these brown ones, and, lastly, red plants in the places which are least frequently uncovered. From the top of a bank we may thus perceive a series of concentric bands of different colors defining the limits within which each species, better fitted to the physical conditions, has overcome and eliminated the neighboring species. This is not a question of depth, because we find red sea-weeds at the water-level in sheltered places, the hollows of rocks, and deep caves, like the one at Capri, where the light comes in weakened.

Light, then, is an inexhaustible source from which living beings obtain energy under all forms and in the most unforeseen conditions; or, as Lavoisier has said, we might believe prophetically, considering the time when he spoke: "Organization, feeling, spontaneous movement, and life exist only at the surface of the earth, and in places exposed to the light. We might say that the fable of the torch of Prometheus was the expression of a philosophical truth that did not escape the ancients. Without light, nature would be bereft of life, dead, inanimate. A beneficent God in giving light has spread organization, feeling, and thought over the surface of the earth."

SKETCH OF DR. GUSTAV NACHTIGAL.

THE name of Dr. Gustav Nachtigal is associated with some of the most arduous achievements of African research, which were also not of inferior importance; and in the last year of his life he was prominent, as the designated servant of his Government, in those transactions which had for their object the establishment of German colonies and influence at commanding positions in the "Dark Continent."

Dr. Nachtigal was born on the 23d of February, 1834, at Eichstadt, near Stendal, in the former Prussian province of Altmark, where his father was a clergyman. He lost his father at an early age, and the burden of the support of himself and his little sister, as he used afterward to relate with grateful admiration of her heroic devotion, fell hard upon his poor widowed mother. Having received the usual primary education and completed his course at the gymnasium, he studied medicine at the schools in Berlin, Halle, Würzburg, and Greifswald. At the last place he was a pupil of the famous pathologist Niemeyer, and contracted from him, as he afterward told a friend, much of his enthusiasm for science. He received his doctor's degree here in the fall of 1857, passed the state examination during the ensuing winter, and was appointed under-physician to the thirtieth infantry regiment, which was stationed at Cologne. In 1859, he was promoted to be assistant-surgeon of the thirty-third regiment, also in Cologne. Two years later, when he received his furlough from active service, his superiors could say of him: "A thoroughly scientifically taught physician, Nachtigal is full of energy, and shows great devotion to his profession. His quiet self-possession, and his clear understanding, together with great tact in demeanor, attest that he is peculiarly well fitted to the higher positions of the military medical service."

In 1862, having been attacked with a disease of the lungs, which the North-German climate promised only to aggravate, Nachtigal was compelled to seek a milder atmosphere in the south, and removed to Algiers, and afterward to Tunis, where he found a lucrative practice, and obtained a knowledge of the Arabic language, and of the manners and customs of the people, that proved useful to him in his future explorations. At Tunis he became physician to the Bey, whom he accompanied upon a campaign against some of his rebellious subjects.

Toward the end of 1868 Gerhard Rohlfs came to Tripoli, charged with a commission by the King of Prussia to dispatch an assortment of presents to Sultan Omar, of Bornoo, in acknowledgment of the hospitality he had given and the valuable services he had rendered to the German travelers Barth, Vogel, Overweg, Von Beurmann, and Rohlfs, who had at various times visited his capital, and in return for a silver-mounted harness which he had sent to his Majesty. King William was sending, in response to these favors, a fine collection of European manufactured goods, a throne-chair, and a portrait of himself. The occasion of this visit was the decisive point in Nachtigal's life. Rohlfs found in him just the man to carry the gifts to their destination, and he, the choice having been approved by Bismarck, left Tripoli, with his caravan of eight camels, on the 18th of February, 1869, on his long southern journey, traveling under the name of Edris Effendi. The first stopping-place was at Moorzook, the capital of Fezzan, where Nachtigal found that the country beyond was in so unsettled a condition, and the roads were so infested, that it would be futile to attempt to continue the journey at that time. Probably a year would have to pass before he could go on. He would not wait idly, and he resolved to use the occasion to make an excursion to the highland country of Tibesti, southeast of Fezzan, the ancient land of the Troglodytes, or cave-dwellers, which had long excited the interest of European travelers, but which no one had ever been able to reach. Its people, the Tibbu, had the worst reputation for robbery and treachery of all the Africans. Nachtigal attempted and made the journey from which all others had shrunk. He was smuggled secretly into the country by his guides. The party lost their way and wandered for many days through the desert without food or water, making a near approach to death by thirst. This, as a German biographer describes it, condensing from Nachtigal's own account, in the midst of summer in the burning wilderness, where two days without water meant death. Amid stones and sand, through barren ravines and over rocks, marched the travelers, their parched tongues cleaving to their mouths, and the half skin of water which they still had having to suffice for ten persons. The guide went upon a knoll to look around, while the rest of the party hung anxiously upon his eyes as he made his report, "None yet." The exhausted camels lay down, and Nachtigal by the side of one of them, to die, while the Mohammedan servants prayed to be received into paradise. At last a few Tibbus attached to the caravan succeeded toward evening in getting some water and saved the lives of the party. Such was his manner of entering this forbidding land, while the savage inhabitants regarded him with suspicious hostility, believing that no good, only evil, could be in his intention. Nachtigal bought the protection of one of the chiefs at the expense of all he had, and was able to travel over the country and stay a month at the capital. Thence he returned, without guide or beast, with scant provision of food and a water-bag slung over his shoulders, and reached Moorzook, literally naked, at the end of October.

He was able, in the spring of 1870, to resume his journey to Bornoo, with the presents, which had remained at Moorzook while he was in Tibesti. He reached Kuka, the capital of Bornoo, on the 6th of June, and was received by Sultan Omar with a hospitality which would have been as marked had he brought no gifts, and with many expressions of appreciation of the presents. His mission here having been fulfilled, he availed himself of the friendship of the Sultan to make a journey of exploration to Berkû, Kânew, and Bagirmi, on Lake Chad. He spent a wretched life of nine months among highwaymen, but was able to accomplish much for science. He showed that the Bahr-el-Ghazul is an outlet from Lake Chad to the northeast during the rainy season, and made the acquaintance of the southern Tibbu, among whose northern relatives he had faced so many dangers a few months before.

Sultan Omar would not allow him to go to Wadai, east of Bornoo, for it was too dangerous a land ; but he readily gave him a letter to the Sultan of Bagirmi, in the south, although a war was then raging there. With a hundred and fifty Maria-Theresa thalers, which he borrowed from a Tripolitan merchant on a note for double the amount, he bought goods and fitted out a caravan, and started on his journey early in 1872. He was well received by the Sultan, but came very near being debarred intercourse with the court on a question of ceremony. Every one who sought audience with his Majesty had to come barefooted. Nachtigal was willing to take off his shoes, but insisted on keeping his stockings on. There was considerable discussion over the matter, but the traveler carried his point and introduced a novelty at the court, for no one there had ever seen a man in stockings before. The Sultan was about to start on a campaign against a rival chief, and Nachtigal embraced the opportunity to go with him and see a country which had not been explored. The gain to science was purchased at great expense in the witnessing of cruelties, without power to protest against them, inflicted upon all adversaries who came in the way, and others—murders, torture, capture of slaves, and barbarities indescribable. In one of the battles Nachtigal was in great peril during a temporary rout of the Sultan's forces, from which they afterward recovered, and for which they paid their customary vengeance. Yet he was able to render some aid to humanity by surgical treatment of the wounded, and he did what he could; but a large proportion of the cases, having received wounds in their vital parts, were past recovery. Having taken his leave of the Sultan of Bagirmi, Nachtigal, suffering a part of the time from fever, made his way through a flooded country, in which he had to wade or swim the rivers which he had before crossed almost dry, back to Kuka, in Bornoo, where he enjoyed another hospitable reception from Sultan Omar.

Nachtigal next undertook, in the face of what was considered extreme danger, to visit Wadai, on the eastern side of Lake Chad. It was a country of very bad repute. The only European who had ever reached it, Eduard Vogel, had been put to death by the command of the Sultan in 1856. Moritz von Beurmann, who had been sent out to learn Vogel's fate, had been murdered on the borders of the land. It took much courage even to think of a journey there, but Nachtigal had hope in the fact that a new Sultan, a more intelligent man than his predecessors, had come into power. He proceeded cautiously, in doubt as to what kind of a reception he might expect, but gradually found the way cleared, and was finally admitted to an audience from which he came away with a satisfaction he could not, he said in a letter to a friend, fully express. "I found Sultan Ali the most intelligent prince that reigns in all the Soudan, and was charmed with the friendly greeting he gave me. This was all the more remarkable, because, as I knew, he had at first hesitated to receive me, and was not at all glad that I had come." The murder of Vogel, eighteen years before, had been forgotten by most of the people, and the search for the papers he left was fruitless.

Nachtigal had by this time become quite exhausted with his five years of arduous travel and dangers, and early in 1874 started homeward. He went through Darfoor to Kordofan, where, meeting the Egyptian garrison, he almost felt as though he were in Europe. Khedive Ismail sent a steamer to bring him to Cairo, and was the first to receive him there. He stayed a year in Cairo to recover a degree of health, and then proceeded to Berlin, where he intended to make his home.

Here he at once assumed an active position among the scientific men interested in the promotion of geographical research. He was elected President of the German-African Society; was consulted by the King of the Belgians in the proceedings that have led to the formation of the Congo state, and was a most useful member of the Executive Committee of the "Association Internationale Africaine"; and was for three years in succession elected President of the German "Gesellschaft für Erdkunde," and was its representative at the International Congresses in Paris in 1875 and 1878, and in Venice in 1881. The Paris Geographical Society voted him its golden medal, and the other similar societies of the world gave him medals or diplomas of honor. He dwelt in Berlin till 1882, busily engaged most of the time in performing the duties of his scientific commissions, and in preparing the narrative of his travels, his great work, "Sahara und Sudan," or "Experiences of Six Years of Travel in Africa" of which the first volume was published in 1879, and the second, bringing up the story to his departure from Bagirmi, in 1881; while the third is unfinished. In 1882 Germany needed a diplomatic representative in Tunis; Dr. Nachtigal was chosen as the most suitable man in the nation to fill the position. After remaining there three years as consul-general, a more important duty fell upon him—also by the designation of the great Chancellor of the Empire—that of going to the west coast of Africa to superintend the planting of the German colonies in the Togo country and the Cameroons. This was in May, 1884. He was there attacked by the fever which seems to be the inevitable doom of all white men who stay long on the Guinea coast. To get him away, if possible, from this scourge, he was put upon the German corvette Möve and sent to sea. On board this vessel, a few miles out from Cape Palmas, he died on the 20th of April of this year. His body was brought ashore and buried at Cape Palmas.

Dr. Nachtigal, says one of his German biographers, was one of the "strong and enthusiastic representatives of German learning, uniting with complete devotion to science a heart warmly inspired with the idea of spreading abroad the power and civilization of the Fatherland; and he regarded it an object of life to press forward into unexplored lands and ever to be adding new objects to scientific cognizance."

"With Nachtigal," says Dr. Karl Müller, in "Die Natur," "has passed away one of the brightest stars of the literature of travel; a man who, treading in the footsteps of a Barth, was, like him, so happy as to come back and contribute no little in his turn to our knowledge of Central Africa. . . . With fifty-one years upon him, he still bore the expectancy of a longer life, even though the old chest-disease he had suffered from at home had not entirely passed away. For we had learned to know and esteem him all the more highly because in spite of his disease he was among the most active and most lively. His fate," Dr. Müller adds, "is a sad answer from West African Nature to German colonizing ambitions."

Everything living, said his friend Dr. Paul Güssfeldt, in a memorial address, "seemed to arouse his sympathy. His love for animals was particularly touching. I can hardly avoid a sorrowful laugh today when I think of his contracted house in Berlin, which he shared with a parrot and three little dogs as companions having equal rights. . . . What to others seemed a legitimate hunter's shot, to him, who himself had barely a hold on life, was murder. It is well known that Nachtigal, during the whole course of his travels, never fired a gun. The fact points out one of his strong characteristics. It shows that neither necessity nor fearful peril, such as he was exposed to in Bagirmi, could disturb the delicate stringing of his soul."

CORRESPONDENCE.

AERIAL NAVIGATION.

Messrs. Editors:

SIR: The writer of the paper in the July Monthly on aërial navigation is certainly mild in his predictions of success, and still he is much too sanguine, as it seems to me. Besides the employment of a new motor, the recent French experiments have accomplished nothing not done before. If anything, they have emphasized the difficulties long recognized by aëronauts, without bestowing an iota of anything valuable toward their solution.

An enormous gas-bag is employed to encounter atmospheric resistance, and then to overcome that resistance a motive power is employed. It is the old way. One would think that effort would stop in this direction. It seems to be an infatuation similar to the "perpetual-motion" craze, just as persistent and just as hopeless.

As long as atmospheric resistance on any sort of a gas-bag is so much greater than the power developed by any known motor it is capable of carrying, the task of making a practical air-traveling machine is an impossible one.

It is the humming-bird process, and seems unfitted to man's use. Why not try the albatross or condor method, where gravity is the motive power, all active mechanism being dispensed with, and shape and position brought into prominence as the factors of success? Respectfully,

I. LANCASTER.

335 WABASH AVENUE, CHICAGO, *June* 29, 1885.

HOW THE LOCUST LAYS ITS EGGS.

Messrs. Editors:

DEAR SIR: During the appearance of the so-called seventeen-year "locust" (*Cicada septendecim*) at this place in 1868, the commonly accepted account of the manner in which the female deposited her eggs in the twigs of trees included the statement that a transverse incision was made by the insect below the place where the eggs were deposited, causing the twig to break off and hang by the bark only. This was supposed to serve an important purpose in the hatching of the eggs, and was regarded as a remarkable exhibition of instinct on the part of the insect. The fact that the whole woods became brown with dead twigs seemed to give color to the statement. But, having carefully observed the process during the present appearance, it is very clear that the breaking is accidental, and disastrous to the eggs, rather than premeditated and beneficial. No incision is made, other than those in which the eggs are placed. Only a small part of the twigs break, and they without any regularity as to the place of fracture.

Another erroneous statement, which is frequently made, is that the eggs are laid in parallel furrows. The incisions in the wood are V-shaped, starting from a single small hole through the bark at the angle of the V. The furrows are sunk deeply into the hardest part of the wood, the eggs placed in the bottom, and left thickly covered with the hair-like fibers of the wood displaced in making the trench, and left attached at one end. The form of the incision seems to be due to the necessity of placing the eggs in solid wood, avoiding the pith. In a number of instances where the incision had accidentally penetrated the pith, the furrow was left incomplete, and no eggs were deposited.

As may be supposed, ovipositing is attended with great labor on the part of the female. Each thrust of the ovipositor requires a severe and prolonged struggle; each furrow, judging by the number of displaced fibers, must require from twenty-five to forty thrusts; and each female makes many separate furrows. CHARLES B. PALMER.

YELLOW SPRINGS, OHIO, *July* 7, 1885.

EDITOR'S TABLE.

SCIENCE VERSUS IMMORALITY.

SELDOM has the moral sentiment of the civilized world received so severe a shock as it has done in connection with the revelations which a prominent London newspaper has made, within the last couple of months, of the gross and inhuman vices practiced in the metropolis of the British Empire. One of the worst features in the case is the fact that the enormities referred to have been committed, not by the "dregs of the population," as that expression is commonly understood, but by men of wealth and social station. "Gentlemen" (!) of education (save the mark!) and leisure have employed, annually, in the corruption of female youth and childhood, sums that would have afforded decent maintenance to numbers of poor families. Men whose own condition of life had been made in every way desirable, so far as money could accomplish that object, have found nothing better to do than to employ their means in spreading moral contagion and destruction among the families of the poor. Men who boast the name of Englishmen have thought it not beneath them to trade in the souls and bodies of unfortunate children. England, as a nation, struck the manacles from the hands of her negro slaves over fifty years ago; but some Englishmen to-day, belonging to the most favored social class, do not hesitate to practice, upon weaker members of their own race, crimes worse than those which made slavery a hissing and an abomination among the civilized races of mankind.

It is needless, however, to dwell further on the facts. Words can but feebly express the shame and horror that they involve. What we may do with advantage is to consider whence such evils spring, and what is their most effectual remedy.

As regards the unhappy victims of the rich man's lust, there is an economic side to the problem which is doubtless difficult to deal with. That the pressure of life should be so hard upon some, as to render the path of virtue one almost impossible to tread, is in itself an evil of the first magnitude, and one which a more fully developed economic science must some day grapple with. The efforts at present being made, under the guidance of a purely sentimental impulse, to provide improved dwellings for the poor, and in other ways to force on them higher modes of living, we do not, we must confess, regard as very hopeful. It is seldom that the state succeeds in paying Peter without robbing Paul, or in closing the door to one social abuse without opening it to another and perchance a greater. The economic problem, however, is not the only one to consider, nor is it perhaps the most important. The educational problem demands equal and more immediate attention, seeing that the knowledge necessary for its solution is immediately available. As every one is aware, a vast amount has been done for popular education in England within the last fifteen years; yet it is precisely the children who have been growing up during the last fifteen years who are furnishing prey for the "Minotaurs" and other scoundrels of the metropolis.

The theory of state education is that the state is bound to see that its juvenile members do not grow up ignorant, and, as a result of ignorance, prone to vice. It is also held that the state owes it to every youthful citizen to furnish him or her with such elements of education as may be needed to fit them for employments requiring a knowledge of reading and writing. From the latter point of view reading and writing are looked upon in the light of tools; but why the state should be required to furnish mental tools rather than material ones—to furnish the child's head with the multiplication-table, but not to provide his hands with saw, axe, or hammer—has never, to our mind, been entirely evident. It seems to us that if the state is to educate, the whole strain and stress of its effort should be to produce good citizens; not to fit this boy for a counting-house or that girl for a position as "sales-lady," but to impart to both that knowledge and imbue both with those principles that make for the right ordering of life and for the good of society. The multiplication-table and the rules of grammar may be found valuable aids to these all-important objects—we do not say they are not—but we insist that they should be looked upon and treated as means always, as ends never; and as means to no other objects than the ones mentioned. It should be distinctly understood and continually repeated that the state has nothing to do with this or that individual's *success in life*, so far as that may be a matter of competition; that the only "success" the state can undertake to prepare any one for is the success of good conduct and of social adaptation.

Now it is evident that if State education were dominated by this idea, it would have to assume an essentially scientific character. For the conduct of life, what is wanted is not accomplishment of any kind whatever, but knowledge of what life is and a sense of its realities. A true education will, therefore, find its basis in the laws of life—physical, intellectual, and moral—and will aim at bringing each individual face to face with the great realities upon which happiness depends. From such an education all false prudery would be banished. No child would be allowed to grow up in an ignorance which might expose it to the gravest physical perils; on the contrary, the way of physical salvation would be clearly and plainly indicated, and the perils of every kind which wait upon violations of law would be faithfully exhibited. The chief impression, however, would be produced by the constant reference of all instruction to the grand aim of promoting integrity, purity, and harmony of life. Every branch of knowledge would be considered and treated in its bearing upon this aim, and not, as is now generally the case, in its bearing upon individual success in the competition of life. "Do so and so," children are now told, "and you will rise to positions of distinction in society." Yes, provided others fail to act with equal wisdom; but, supposing all to conduct themselves wisely and well, where is the distinction to come from? No doubt it may safely be predicted that all will not; but is it well to assume this in the appeals we make to the young, and so to accustom them to thought of profiting by the errors or weakness of others? The educator, we hold, should use only such modes of appeal as are applicable to all; and a promise of eminence, of distinction, of wealth, of power, is not applicable to all, but only to a few. To all it may be said: "Do so and so, and your life will rest upon solid foundations; you will be a healthful and helpful member of society, and, whatever your lot in life may be, you will have an inward fund of happiness and self-respect that will be secure against all vicissitude. Moreover, the world is so constituted that you can not give without receiving, and whatever you sow for others you will reap the same yourself."

We believe that were education dominated by these ideas, and by the one main purpose we have indicated, the result would soon be seen in quickened intelligences and improved dispositions; and at least the gross ignorance would be removed which at present is answerable for so large an amount of juvenile depravity.

There is, however, another aspect to the question with which we are now specially concerned. What shall be said of the "education" of the men of wealth and leisure, who find their highest pleasure in the most criminal and ruthless forms of vice? These men have passed through public schools, perchance through universities; some are said to be doctors of medicine; others to be eminent at the bar or on the bench; and some even to wear the livery of the Church. In what shape can life have been presented to such men? What sense can they ever have gained of the organic unity of society? What respect can they ever have been taught for the temple of their bodies, or for the cardinal institutes of nature and of society? What regard for others can ever have been inculcated upon them when they think that *money* can atone for the utter degradation of a fellow-creature? Surely it is time to cry aloud and spare not, when men can pass for "educated" to whom the very elements of a true science of life are unknown, and who, with all their literary, professional, and social acquirements, are willing to descend in their daily practice to the lowest depths of infamy. Think of the two things—"education" and brutal, merciless vice—going hand in hand! Alas! it is not education; it is that wretched, sophistical veneering of accomplishments which usurps the name of education. It may embrace—in the case of medical men must embrace—a certain amount of scientific instruction; but what it lacks is the true scientific grasp of life as a whole. We are no fanatical believers in the saving efficacy of a little smattering, nor even of much special knowledge, of physics and chemistry; but we are firm believers in the moralizing effects of a true philosophy of life, supported and illustrated by constant reference to verifiable facts. All sciences are but parts of one great science, and the highest function of universal science is to teach us how to live. The state, in so far as it undertakes to fit the young for "positions in life," acts upon the old sophistical idea of education as a thing of accomplishments designed to promote individual success. Such education can not of itself have any moralizing effect, and may have a demoralizing. The change that is needed is to abandon that view, and to make education a preparation for life in the broadest sense. Whether the state can adopt the latter principle, and bring its teaching up to the proper level, remains to be seen. If it can not, its condemnation is definitively pronounced, for no other conception of education will meet the requirements of the future.

THE STUDY OF FACTS.

The subject of education has been treated from many points of view, but we do not know that it can be more profitably considered than in its bearing upon the power of recognizing and dealing with facts. The educated man, according to our conception, is he who knows a fact when he sees it and knows what to do with it. The educated man is the man who has an instinct for facts, who searches for them as for hidden treasure, and, having got them, knows how to set them in logical and luminous order. It is the man who knows and feels that facts make up the very backbone of human life and of everything else, and that to ignore them, or to play fast and loose with them, is simply to court failure and loss.

The true *fact* corresponds with the true *idea;* and the man of facts is therefore a man of ideas. He constantly seeks to see the relations of things, and only when he discerns relations does he feel himself to be in the presence of facts. To have an appetite for unrelated facts is as unwholesome as to have an appetite for slate-pencils. "Gradgrind" is not the type of the man of facts: he is rather the type of a man who does not know what a fact is, who is all unconscious that our knowledge in regard to anything has to round itself to some completeness and symmetry before we can claim to possess facts. A true fact is a living, not a dead, thing; and it proves that it is alive by bearing fruit: it produces something, and, like wisdom, it is justified of its children.

What we have in view, however, on the present occasion is, not to pronounce a eulogium on facts—after all, they can take pretty good care of themselves—but to draw attention to the extent to which, in spite of all that has been done for "education," an inability to discern and do justice to facts still prevails in the world. Ask any intelligent business man what the chief trouble is that he encounters among his employés, or what it is that impairs the usefulness of most of them; and he will tell you, not in so many words, but in substance, that it is their imperfect apprehension of facts, and consequent inability to draw conclusions that common sense itself dictates. He will say, perhaps, "Out of a score of men I can only find one or two who can be trusted to put that and that together." Well, "putting that and that together" simply means mentally recognizing a fact and perceiving its significance. It is not the science of logic that is required in every-day affairs; it is the faculty or habit of seizing main points and holding them as long as may be necessary. The truly superior man, the man who counts, is he who is thus able to take a grip of *things*, of that which is substantial, vital, pertinent, organic.

Self-interest is supposed to be a great sharpener of the mental faculties; but nothing is commoner than to find people ignoring the very facts on which their happiness chiefly depends. They live according to the impulse and humor of the moment, in a kind of disjointed, inconsequent fashion. They do not know the great facts of life; and the truth that their life, as a whole, should present a certain organic unity, and should then itself become a great *fact*, has never been revealed to them. Here is a man who is "all out of sorts." He wants change, he says; the desperate monotony of his existence is killing him. He can not understand how it is that he should have to be always running to the doctor and dosing himself with tonics and alteratives. He likes to throw the blame on circumstances; he likes to think there is something mysterious or at least altogether special in his case; the last thing he wants to hear is that probably his condition is due to the neglect of certain important facts of his physical, perchance, also, of his moral, nature. He willingly lends himself to the nostrums of the quack; but a simple account of the general principles upon which Nature works is nowise to his taste. He does not like to think that certain penalties are irrevocable, or that the only course by which partial relief can be obtained is one of careful submission to law for the future.

We see substantially the same condition of mind in many a man whose business career has been one of failure. He likes to think that success in this world is mainly a matter of accident, and that "luck" was against him. That one word, "luck," is the whole philosophy of some men: it does not explain anything, but it does what is more pleasing to persons of their disposition, enables them to dispense with explanations. We may say in general that there is a fatal disposition in most men not to recognize facts, not to perceive that things are woven together in the iron bands of law, and that nothing stands wholly out of relation to any other thing. This is the tendency which it should be the chief object of education to combat. What we require to do is to build up in the mind, little by little, but with undeviating purpose, the belief that things hang together, and that the business of the intellect is to discover the laws or principles of their association. We should teach that there is order in the universe, which should and must—unless our lives are to be marred by failure—be responded to by a certain order in our thoughts. We should teach on every occasion, and with every possible variety of illustration, that nothing can be done wisely or well that is not done upon system; that random words are vain; that random thoughts are vain; that no mental effort is worth anything that is not dominated by some clear purpose, and that does not connect itself with previously acquired knowledge.

We find ourselves here face to face with the principle of evolution. If evolution means anything, it means the unity of the universe; it means the construction of a path along which thought can travel from the infinitely small to the infinitely great, from forms of the last degree of simplicity to forms of the highest degree of complexity; it means, finally, the blending of subject and object in one all-embracing synthesis. Well, this, according to the measure of our opportunities, is what we have to teach to the young. It will be acknowledged that intelligence is only stimulated by the perception of general truths, or, in other words, of laws, which again are the great *facts* of the universe; but the object in education should distinctly be to show that things only exist in relation to one another, and that things out of relation are virtually *out of existence.* Let a man—to take an illustration—introduce irrelevant matter into his argument: that matter relatively to the object of the argument has no existence. The case is even worse; for, in the place where it is found, such matter is a burden and a nuisance; we must put a minus-sign before it. Now, a teacher who is thoroughly imbued with these ideas, and who neither regards nor accepts anything as *work* that does not show progress in the comprehension of them, will, with an inferior subject, accomplish better results than another man will who, with a superior subject, contents himself with more perfunctory methods. The reason why the teaching of science has so often been comparatively barren is that it has not been broadly taught, and has not, therefore, awakened the true scientific spirit. The reason why language-studies have sometimes appeared to produce superior intellectual results is that they have, in these cases, been taught by earnest men who, by dint of their own extensive culture, have connected these studies with wide areas of literature and history, and so obtained a sufficient field for the illustration of law; in other words, for the presentation of their subject in a scientific manner. *Science*, in the true sense, is vindicated as much by success in the one case as by failure in the other.

This is a matter, it is needless to say, to which too much attention can not be given. The whole progress of society depends upon the intelligence of its members. But intelligence is formed in the earlier years of life; the habit of taking rational views, and of being alive to the teachings of experience, is one which, if not acquired while the intellect is fresh, will probably never be acquired at all. We would therefore urge upon all who are interested in the education of the young to see to it, as far as they possibly can, that by education is understood the development of the habit of seeking the true relations of things, and of conceiving of human life as a network of relations. Let us banish from education the unrelated word, the unrelated thought; let us proceed according to the principle of evolution, linking step with step, while tending always to a higher unity; and the intellectual progress of the race will proceed with all the rapidity that is desirable or possible.

LITERARY NOTICES.

Scientific Culture and other Essays. By Josiah Parsons Cooke, LL. D., Professor of Chemistry and Mineralogy in Harvard College. Second edition, with additions. New York: D. Appleton & Co. Pp. 293. Price, $1.

We had carefully read the first edition of this volume of essays, and have now reread it in its expanded form with renewed pleasure. There are but few scientific writers so trained in the skillful use of English as Professor Cooke. Aside from the value and instructiveness of their contents, his essays are a treat to all who appreciate clearness, vigor, and precision in style, while yet the admirable expression is kept subordinate to intense and weighty thought. The work, however, is to be mainly prized as a contribution to the great educational movement of our time, which aims to give larger recognition to science in our higher schemes of study. This new edition must be taken as representing with a high degree of authority the broad and solid claims of scientific education. It does not deal with the subject technically, or formally, or even systematically, but is simply a collection of essays "written for special occasions without reference to each other," but all having a bearing upon one subject, with which the author has been long occupied both as a philosophic thinker and a practical teacher. The first essay, "Scientific Culture," and the eleventh, "Scientific Culture; its Spirit, its Aims, and its Methods," present directly the predominant idea of the book; but the various other papers present the view taken in an instructive and impressive manner. The several biographical articles are of extreme interest in illustrating the mental training and development of scientific men; while the papers on the Greek question are designed to meet immediate issues in relation to collegiate reform. The article on "The Elementary Teaching of Physical Science" is of especial value, for, although Professor Cooke has not devoted himself practically to this field of work, his statement of the scientific principles it involves is forcible and timely.

But, while the volume is full of sound suggestions on the general subject of science-teaching, yet its leading title, "Scientific Culture," embodies the fundamental conception which it is designed to bring out; and this is nothing less than an unqualified avowal of the extremest claim put forth in behalf of science as a new educational basis. The adherents of the old traditional system of scholarship are ready enough to admit that there is a certain usefulness and importance in scientific studies, which entitle them to a place in the collegiate curriculum; but they strenuously resist the idea that science is to give rise to a new "culture." Here they make a stand, and here the battle of progressive education is to be fought, with heavy odds, it must be confessed, against the reformers. For "culture" has come to be a very potent word, representing, as it does, all that is most excellent, dignified, and revered in a system of education that has prevailed for centuries in the leading civilized countries. In fact, the chief capital of the classical party to-day, in their struggle against the new education, is the powerful spell of a single term, which has come mainly to imply a critical knowledge of the dead languages, because, by all our scholastic traditions, no man can lay claim to "culture" who is not familiar with Latin and Greek. The term has no doubt become widened in recent times, so as to embrace other languages and the general subject of literature, but the party of tradition is sharply jealous of any extension of it that will make the term "culture" applicable to proficiency in distinctively modern studies.

Professor Cooke takes no narrow view of his subject. He concedes the value of that genuine mental culture, whatever the instruments employed to attain it, which confers intellectual power by the vigorous and systematic exercise of the intellectual faculties; and he recognizes that this may be secured by the thorough study of languages, and the literatures they contain. He draws a distinction between erudition and scholarship, the former implying the simple accumulation of stores of learning, and the latter a discipline of the intellect and an enlargement of mental power through the process of independent inquiry. The same thing holds in science. The cramming of books—the erudition of science—is of but little worth; while the independent exercise of the mind upon the problems of science—the assimilation of acquisitions into a real knowledge—is the true scholarship of science, and the highest form of mental cultivation. Professor Cooke shows conclusively that the "culture" of science is a broader conception, and involves a more varied and a completer mental training, than can be obtained from the exclusive study of language and of literature, because science has for its object the study of nature, and the whole scheme of phenomena and law in the midst of which human life is carried on.

The Religious Aspect of Philosophy: A Critique of the Bases of Conduct and of Faith. By Josiah Royce, Ph. D., Instructor in Philosophy in Harvard College. Boston: Houghton, Mifflin & Co. Pp. 484. Price, $2.

If the test of a system of philosophy is, as Ferrier says, that it must be "reasoned," then is Dr. Royce's work entitled to this rank, for it is undoubtedly an ably "reasoned" system. He has written an independent and suggestive book, lively and vigorous in style, and which is certain to be appreciated by those who have a taste for metaphysical inquiries.

In his preface the author describes the work better than we can: "This book sketches the basis of a system of philosophy, while applying the principles of this system to religious problems. The form and order of the treatment depend upon the nature of these latter problems themselves, and are not such as a system of philosophy, expounded solely for its own sake, would be free to take. The religious problems have been chosen for the present study because they first drove the author to philosophy, and because they, of all human interests, deserve our best efforts and our utmost loyalty."

It seems, therefore, that our author was driven to philosophy by some sort of religious disquiet or perplexity. We gather from what follows that he had lost his faith, or was fearful of losing it, and went to philosophy for relief. What he found it is the office of the book to tell, but it is evidently something very different from that which had left him at first. He says: "As he has no present connection with any visible religious body, and no sort of desire for any such connection, he can not be expected to write an apology for a popular creed. This confession is made frankly, but not for the sake of provoking a quarrel, and with all due reverence for the faith of other men. If the fox who had lost his tail was foolish to be proud of his loss, he would have been yet more foolish to hide it by wearing a false tail, stolen mayhap from a dead fox. The full application of the moral of the fable to the present case is, moreover, willingly accepted. Not as the fox invited his friends to imitate his loss, would the present writer aim to make other men lose their faiths. Rather is it his aim not to arouse fruitless quarrels, but to come to some peaceful understanding with his fellows touching the ultimate meaning and value and foundation of this noteworthy custom, so widely prevalent among us, the custom of having a religion."

Nevertheless, the philosophy he sought seems to have answered the author's purpose, as it showed him that the skepticism he dreaded was not so bad a thing after all. Again he says: "As to the relation of this book to what is called modern doubt, it is a relation neither to blind obedience nor of unsympathetic rejection. The doctrine of philosophic idealism here propounded is not what in these days is popularly called agnosticism. Yet doubting everything is once for all a necessary element in the organism of philosophic reflection. What is here dwelt upon ever and over again is, however, the consideration that the doubts of our time are not to be apologetically 'refuted,' in the old-fashioned sense, but that, taken just as they are, fully and cordially received, they are upon analysis found to contain and imply a positive and important religious creed, bearing both upon conduct and upon reality. Not to have once thoroughly accepted as necessary the great philosophic doubts and problems of our day, is simply not to have philosophized as a man of this age. But to have accepted these doubts without in time coming to accept the positive truth that is concealed in them, is to treat them as the innocent favorite of fortune in a fairy tale always at first treats his magic gift. It is something common and dingy, and he lays it carelessly away in his empty house, feeling poorer than ever. But see: handle it rightly, and the fairy gift fills your transfigured home with a wealth of gems and gold, and spreads for you a wondrous banquet. To the author has come the fancy that modern doubt may be some such fairy gift as this, and he would like to suggest to some reader what may possibly prove the right fashion of using the talisman."

More light is thrown upon the author's position by a passage from his introductory chapter, where he remarks: "The short and easy agnostic method is not enough—you must supplement skepticism by philosophy; and when you do so, you will find yourself forced to accept, not indeed the old theology of your childhood, but something that satisfies oddly enough certain religious longings that, as skeptic, you had carefully tried to forget. Then you'll find yourself with what you may have to call a religious doctrine; and then you may have to state it as we are here going to do, not in an easy or fascinating way, such as the pure skeptic can so well follow, but at all events with some approach to a serious and sustained effort to consider hard questions from many sides. The skeptical method is not only a good but also a necessary beginning of religious philosophy. But we are bound to go deeper than mere superficial agnosticism."

From these quotations the reader will be able to form some tolerable conception of the scope and purpose of Dr. Royce's work. Of its value as a contribution to speculative thought we are not qualified to speak. But, turning to Chapter I, in which the author puts the grave question, "What, then, is religion?" we do not find the answer so clear and satisfactory as seems required in stating the fundamental idea of a religio-philosophical system. Religion, according to our author, is something important, vaguely associated with ethics. He says: "So much, at all events, seems sure about religion. It has to do with action. It is impossible without some appearance of moral purpose." Again: "A religion adds something to the moral code, and what it adds is, first, enthusiasm." And again: "But in fact religion always adds another element. Not only does religion teach devotion to a moral code, but the means that it uses to this end include a more or less complex theory of things. Religion says not merely, *do* and *feel*, but also *believe*. . . . These three elements then go to constitute any religion." On this basis, which is at any rate sufficiently comprehensive, and by the help of the great lights of German philosophy—Kant, Hegel, Schopenhauer, Lotze, and others—Dr. Royce builds his system, and in the opinion of able critics he has built to excellent purpose.

The French Revolution. By Hippolyte Adolphe Taine. Translated by John Durand. Vol. III. New York: Henry Holt & Co. Pp. 509. Price, $2.50.

The present volume gives the history of the revolutionary government, including the Reign of Terror. The author expresses himself in his preface as regarding the leaders in the movements of the time in the same light as he would the crocodiles of the ancient Egyptian temples—dangerous animals, brutes rolling about on a purple carpet, but worshiped in their day. Of his own kinds of "crocodiles" he has studied the details of the structure, the play of the organs, their habits, their modes of living, their faculties, and their appetites. Of the thousands of specimens he had at hand, he has selected a few for special treatment, of which the three largest seem, "of their kind, truly remarkable, and those in which the divinity of the day might well incarnate himself. The bills of butchers, as well as housekeeping accounts, authentic and regularly kept, throw sufficient light on the cost of this cult. We can estimate how much the sacred crocodiles consumed in ten years, we know their bills of fare daily, their favorite morsels. Naturally, the god selected the fattest victims, but his voracity was so great that he likewise bolted down, and blindly, the lean ones, and in much greater number than the fattest. Moreover, by virtue of his instincts, and an unfailing effect of the situation, he ate his equals once or twice a year, except when they succeeded in eating him. This cult certainly is instructive, at least to historians and men of pure science." We are told also that "this volume, like the others that have gone before it, is written solely for amateurs of moral zoölogy, for naturalists of the understanding, for seekers of texts and of proofs—for these and not for the public, whose mind is made up, and which has its own opinion on the Revolution."

The Morals of Christ. By Austin Bierbower. Chicago; Colegrove Book Company. Pp. 200. Price, 50 cents.

"In announcing his morality," says the author, "Christ took three departures from other systems—one from the Mosaic, one from the Pharisaic, and one from the Græco-Roman. . . . In departing from the Mosaic morality, he sought to develop morality from its primitive rudeness and simplicity; in departing from the Pharisaic morality, he sought to recall it from a ritualistic divergence to the proper subjects of morality; and, in departing from the Græco-Roman morality, he sought to substitute the tender for the heroic virtues." The author's purpose in this essay is declared to be to set forth the morality of Christ as a departure from these three representative types, "it being this triple departure, more than anything absolute, on which he put his chief emphasis, and which, more than anything original, characterized his system."

The History of the Present Tariff. 1860–1883. By F. W. Taussig. New York: G. P. Putnam's Sons, Pp. 111. Price, 75 cents.

This volume is intended to give a narrative of the growth of the protective system which now exists in the United States. It endeavors to state the circumstances under which the various tariff acts were passed, the causes which made their enactment possible, and the changes of duty which they brought about—facts which may be familiar enough to old citizens who have not shut their eyes to them, but which can hardly be known to the younger Americans who have been taught that the protective policy is an essential part of our institutions and prosperity. The author has opinions of his own on the subject, which he has not concealed, but which he has tried not to allow to distort his statements of facts.

The History of the Surplus Revenue of 1837. By Edward G. Bourne. New York and London: G. P. Putnam's Sons. Pp. 161. Price, $1.25.

The proposition has been made within the past two years, instead of reducing our revenue, now too large for the legitimate needs of the Government, to continue collecting the surplus to form a fund for distribution among the States. A similar experiment was tried once before in the history of our country, with disastrous results; but men's memories are short in political and financial history, and the story has been forgotten except by students. Mr. Bourne's book appears opportunely to bring the lesson back to mind, and warn such persons as need the warning and would heed it. In the main it is a relation of facts, showing how the surplus was disposed of in the several States which shared in the distribution, and what came of the dispositions.

Proceedings of the Colorado Scientific Society. Vol. I, 1883 and 1884. Denver: Published by the Society, Whitman Cross, Secretary. Pp. 147, with Plate.

The Colorado Scientific Society was formed in December, 1882, "for the promotion of scientific intercourse, observation, and record in the State of Colorado." From the twelve original members it increased during the first year to a body of thirty-one members. The contents of the present volume of its proceedings are well described by Mr. S. F. Emmons, its first year's president, in his retiring address, as "interesting and instructive papers upon new methods in the chemical investigation of metals; on the geology and manner of occurrence of ores in Colorado mining districts, and the discovery of minerals not only new in this part of the world, but some new to science; upon glacial phenomena in Colorado; upon the geology and volcanic phenomena of the far-distant Dutch possessions in the East Indies; and suggestions with regard to the home question of the supply of water from artesian wells to be expected in Denver."

The Museum, Vol. I, Nos. 1 and 2, May and June, 1885. Philadelphia: William F. Fell & Co. Pp. 16 each number. Price, 15 cents; $1.50 a year.

The "Museum" is an illustrated monthly journal for collectors of all classes and young naturalists. The numbers before us bear the marks of good editing and efforts to secure original contributions from men whose names carry authority in their respective departments of research.

Symbolism and Science. By Lloyd P. Smith. Philadelphia: Privately printed. Pp. 28.

This essay was originally read as a paper before the Germantown Science and Art Club. The author's purpose was to call attention, "rather by way of suggestion than otherwise," to the subject of the esoteric or symbolical method of teaching pursued originally in the East, and the pernicious effects it has had on the progress of true knowledge even down to our own time.

Lessons in Hygiene. By John C. Cutter, M. D. Philadelphia: J. B. Lippincott Company. Pp. 180. Price, 50 cents.

This is an elementary text-book, adapted for common schools, on the maintenance of health, with the rudiments of anatomy and physiology, and the treatment of emergent cases, and lessons on the action of stimulants and sedatives on the brain and nervous system. It presents the essential facts concerning bathing, clothing, air, water, food, cooking, home-construction, mental work, physical exercise, eye-work, contagious disease, filth-disease, disinfection, tea, tobacco, chloral, alcoholics, etc., as bearing upon the maintenance of health and the prevention of disease. The practical is prominent throughout.

Christian Thought. Second Series. Edited by Charles F. Deems, LL. D., President of the American Institute of Christian Philosophy. New York: Phillips & Sons, 80 Fourth Avenue. Pp. 476.

The "Institute of Christian Philosophy" is a society which holds stated meetings for the discussion of questions bearing upon the relations of science and the Christian religion, together with annual assemblies on the Chautauqua plan at some place of summer resort, where the same questions are formally considered with carefully prepared addresses before as large audiences as will attend. The present volume represents the sum of the year's work of the institution as embodied in the more important lectures and papers on philosophy, Christian evidence, and biblical elucidation, spoken at the monthly and annual meetings. These, as they appeared in the monthly numbers of the periodical "Christian Thought," were varied with editorial remarks, briefer articles, paragraphs, and squibs, all having some bearing on the main question, which are also incorporated in the volume.

An Account of the Progress in Zoölogy in the Year 1883. By Theodore Gill. Washington: Government Printing-Office. Pp. 53.

Though no startling discoveries in zoology were recorded during 1883, the progress of the science was real. The two important events deemed worthy of special notice were the International Fisheries Exhibition in London, and the publication of Jordan and Gilbert's "Synopsis of the Fishes of North America." Mr. Gill's "account" is composed of synopses of the several papers and reports of the investigations of naturalists in the various countries in which science is systematically pursued.

Archæological Institute of America. Sixth Annual Report, 1884–'85. Cambridge, Mass.: John Wilson & Son. Pp. 48.

A new departure has been taken by the institute, in order to give it wider national scope and interest, in the division into affiliated societies, of which there are now three, those of Boston, Baltimore, and New York, each with its own roll of members and set of officers. Progress is reported in the exploration of New Mexico and Arizona by M. Bandelier, in the collation of the results of the excavations at Assos, Asia Minor, and in the publication of papers. An expedition was sent out last fall to Babylonia, under the charge of Dr. W. Hayes Ward, for the purpose of looking over the field and finding a favorable site for future thorough investigation. It has not yet made a report for publication. The institute collected and expended $46,150 between May, 1879, and May, 1885.

Proceedings of the Modern Language Association of America, 1884, Professor A. M. Elliott, Baltimore, Md., Secretary. Pp. 100.

The "Modern Language Association" was organized in the city of New York in December, 1883. Its object is the "advancement of the study of the modern languages and their literatures." The second meeting, of which this pamphlet contains the report, was held at Columbia College, New York, on the 29th and 30th of December last. A considerable number of papers, abstracts of which are here given, all instructive and suggestive, were read, bearing on the value of modern languages, the desirability of giving more attention to them and of putting them on an equal footing with the ancient languages, and the best methods of teaching them. A resolution was adopted expressing the opinion of the convention that the establishment of a classical course in modern languages, with special view to disciplinary methods, alongside the ancient classical course in our colleges is not only desirable but practicable.

Notes on the Literature of Explosives. By Professor Charles E. Munroe, U. S. N. A., Annapolis, Md. Pp. 32.

The title well describes the scope of the book. It is a collection of "notes," derived from various sources, covering the chief points of interest concerning explosives, their manufacture, the preparation and application of new ones, their use, and the precautions observed in their manufacture and transportation. It is a continuous publication, appearing in installments from time to time, as new information is brought to light and collected by the compiler.

Elephant Pipes in the Museum of the Academy of Natural Sciences, Davenport, Iowa. By Charles E. Putnam. Pp. 40.

The Academy of Natural Sciences of Davenport has two pipes in the shape of elephants, and three inscribed tablets, which are claimed to have been found among aboriginal relics. Their genuineness has been doubted by some, and has been attacked by Mr. Henry W. Henshaw, in the report of the Bureau of Ethnology. This essay is a vindication of their authenticity by a member of the academy. Behind the question immediately at issue lies the controversy respecting the origin of the mound-builders, on which archæologists are dividing.

Mushrooms of America, Edible and Poisonous. Edited by Julius A. Palmer, Sr. Boston: L. Prang & Co. Pp. 4 of Text, with Twelve Chromo-lithographic Plates.

Regarding the edible mushrooms as supplying most valuable and delicious food, the author seeks to furnish a guide in the selection of species that shall admit of no mistake being made. The letterpress pages furnish general directions for recognizing and gathering the useful species and avoiding the dangerous ones; and the plates give exact portraits of both kinds, in their natural sizes and colors, with botanical descriptions, and directions for preparing them for the table. The same information is given in a cheaper form in two charts, one containing the useful, the other the dangerous kinds. Mr. Palmer's qualifications for the description of these plants are attested by the fact that he has for more than ten years directed his attention and experiments to ascertaining the edible or noxious qualities of the various species of mushrooms abounding in our fields and woods.

A Course of Practical Instruction in Botany. By F. O. Bower and Sidney H. Vines. London: Macmillan & Co. Pp. 226. Price, $1.50.

This work has grown out of the course of botanical instruction which was begun in 1873 by Mr. W. Thistleton Dyer in the Normal School of Science at South Kensington, in which the same plan was adopted as Professor Huxley had found convenient for the animal side of morphology. Mr. Dyer's purpose, to put the results of his experience in teaching methods in the form of a hand-book, which he has not been able personally to carry out, has been fulfilled by his successor, Mr. Bower, in the matter of laboratory instruction for the types selected, and by Dr. Vines in the matter of method and the morphology of the cells. The plan of the teaching is—typical specimens having been selected of well-known or easily identified plants—to give the pupil directions for making careful and minute examinations of all their parts, their structure, and their visible qualities. This volume, which is designated as Part I, is devoted to the phanerogams and the pteridophyta.

The Basic Pathology and Specific Treatment of Diphtheria, Typhoid, Zymotic, Septic, Scorbutic, and Putrescent Diseases generally. By George J. Ziegler, M. D. Philadelphia: George J. Ziegler, M. D. Pp. 225. Price, $2.

The author's treatise is based upon and unfolds the theory that the diseases in question are "dependent upon, or complicated with, one common basic, alkaline, pathogenic factor, mostly the volatile alkali ammonia, incidental to all forms of life, and differing only in quantity and the constitutional and local manifestations and complications arising from diverse etiological and pathological conditions, yet underlying and intensifying them all."

A Manual of the Theory and Practice of Topographical Surveying by Means of the Transit and Stadia. By J. B. Johnson, C. E. New York: John Wiley & Sons. Pp. 113. Price, $1.25.

The author is Professor of Civil Engineering in Washington University, and was formerly Engineer of the United States Lake and Mississippi River Surveys. The system which he explains is well adapted to preliminary railroad and canal surveys; surveys of drainage-basins, reservoir, dam, and bridge sites; the location of ditches and pipe-lines; and, in fact, to surveys of any kind demanding a knowledge of the topographical features or of the contours of the ground. He has had, as objects in view in preparing the work, to make a manual useful to students and in the work in the field; to explain the methods of field-work so clearly and minutely that an engineer in practice could, without other instruction, prepare his instruments, and do the work in good shape; and to furnish means of reducing the field-notes and methods of plotting, the results of many years' experience of many engineers.

The Lineal Measures of the Semi-civilized Nations of Mexico and Central America. By Daniel G. Brinton, M. D. Philadelphia. Pp. 14.

Dr. Brinton is devoted to the study of the history and civilization of the aborigines of the Americas, and pursues it with industry in all its branches. In the present monograph he gives the results of his analyses of the words for weights and measures in the Maya, Cakchiquel, and Nahuatl or Aztec languages, instituted to ascertain, if possible, what units, if any, were employed by the peoples who spoke them. The measures of these nations seem to have been derived from the body, and some of them were curious. A unit of land-measure among the Cakchiquels was the circumference of the human figure. A man stood erect, his feet together, and both arms extended. The end of a rope was placed under his feet and its slack placed over one hand, then on top of his head, then over the other hand, and was finally brought to touch the beginning. This gave somewhat less than three times the height. The Aztecs had four measures from the point of the elbow: one to the wrist of the same arm, a second to the wrist of the opposite arm, a third to the ends of the fingers of the same arm, and the fourth to the ends of the fingers of the opposite arm. Neither of the three nations was acquainted with a system of estimation by weight, or with the use of the plumb-line, nor with an accurate measure of long distances.

The Magnetism of Iron and Steel Ships. An Explanation of the Various Ways in which it affects the Compass. By T. A. Lyons. Washington: Government Printing-Office. Pp. 124, with Plates.

This volume is the seventeenth of the series of "Naval Professional Papers." Its purpose is to exhibit in a concise form the principal phenomena of the deviations of the compass on iron ships. First are described the characteristics of a steel magnet, the method of determining those characteristics for any particular one, and the reciprocal action of two magnets. Next, the similitude of the magnetism in an iron or steel ship to that of an ordinary bar magnet is established, and the inquiry is made applicable to the ship, whereby we may become acquainted with her magnetic peculiarities. These observations are complemented by a number of experiments, all helping to complete the investigation, and to bring out a more satisfactory elucidation of the subject.

The Religion of Philosophy; or, The Unification of Knowledge. A Comparison of the Chief Philosophical and Religious Systems of the World, made with a View to reducing the Categories of Thought, or the most General Terms of Existence, to a Single Principle, thereby establishing a True Conception of God. By Raymond S. Perrin. New York: G. P. Putnam's Sons. Pp. 566. Price, $4.

The purpose and character of this elaborate volume are admirably summed up in its comprehensive title-page. The author has taken to metaphysics from the most modern point of view, and labored with great assiduity, much learning, and no little analytic and constructive skill, to work out the grand conception of unity in the world of philosophical thought. Firmly accepting that important principle of science, that the fewer assumptions we make in the explanation of things the better, he has labored to reduce the number of principles hitherto postulated as the primary elements of existence, and to show that there is but one final and universal principle, of which all others are but derivative expressions. Part I, consisting of eight chapters, is an epitome of the history of philosophy from the dawn of speculation among the Greeks down to the eclecticism and positive philosophy of France and the Scotch school. The contributions of the most illustrious philosophers embraced in that long period are sifted and estimated with a view to their bearings upon the fundamental proposition which the author finds himself called upon to establish. Part II consists of eight chapters, devoted to "The Nature of Perception," four of which are given to Herbert Spencer and four to G. H.

Lewes. In Part III we reach the subject indicated by the title of the book, "The Religion of Philosophy." We have here eight further chapters, six of which are devoted to an account of the leading religious systems of the world, with reference to the fundamental thesis of the author's book. The seventh of these considers "The Science of Morality," and the last is an "Appeal to the Women of America in Behalf of the Religion of Philosophy."

We can do no more than give this brief outline of a portly book which has cost the author immense labor, and will, no doubt, prove helpful to students interested in the various questions it discusses. Of the validity of the work as an original contribution to philosophic thought we can not speak, as we have not had time to give it critical attention. Appealing to the scholarship of the time, it must abide its verdict on the claims of the performance to live in the future.

Proceedings of the Biological Society of Washington. Vol. II, July 1, 1882, to July 1, 1884. Washington: Smithsonian Institution. Pp. 127.

The volume contains, with lists of members, etc., abstracts of the proceedings of the stated meetings of the society, and mention by name of the papers read at each, two presidential addresses, and sixteen special papers. The presidential address of Mr. Theodore Gill, January 19, 1883, was on "Zoögeography," and gave an elaborate review of the faunal regions or "realms" into which naturalists have divided the earth. The presidential address of Mr. Charles A. White, January 25, 1884, was on "Certain Phases in the Geological History of the North American Continent, biologically considered."

Sanitary Suggestions on how to Disinfect our Homes. By B. W. Palmer, M. D. Detroit, Mich.: George S. Davis. Pp. 58. Price, 25 cents.

This is a handbook for popular perusal, containing the latest and best information on the household use of disinfectants, deodorants, and antiseptics, and practical precautions for the prevention of cholera, diphtheria, scarlet fever, and other infectious diseases.

The Filth Power. By J. B. Olcott. Pp. 41.

This is a paper from the report of the Secretary of the Connecticut Board of Agriculture, having been made originally, apparently, in the form of an address at one of the meetings of the board. Its purpose is to present the system of removal of sewage by water as the great evil that now threatens the health and morals of our communities. Sewage irrigation is also condemned as an evil hardly, if any, less dangerous. Making allowance for the speaker's great intensity of statement, there can be no doubt that a truth is here held up to view. Pollution of streams and the ground by turning the nastiness of towns upon them is a dire evil, which, threatening to become almost universal, can not be combated and remedied too soon. For a remedy, the author proposes systematic treatment of all refuse matter with earth.

Mind in Nature. Vol. I, Nos. 1 and 3-March and May, 1885. Chicago: Cosmic Publishing Company. Monthly. Pp. 16 each number. Price, 10 cents a number, $1 a year.

This is a popular journal of "Psychical, Medical, and Scientific Information," and gives especial attention to what has come to be called "Psychical Research." It has a large list of special contributors, among whom clergymen and students of the nervous system are well represented.

Remarks upon Chipped Stone Implements. By F. W. Putnam. Salem, Mass.: Salem Press. Pp. 8, with Nine Plates.

The "remarks" were made at a meeting of the Essex Institute, and relate to the method of manufacture, the character, and use of the implements in question. The plates represent various implements, with and without handles, from Trenton, New Jersey, Mexican localities, the Navajo and Pah-Ute Indians, and Tierra del Fuego.

Facts serving to prove the Contagiousness of Tuberculosis. By W. H. Webb, M. D. Philadelphia. Pp. 28.

The author cites a number of cases that occurred in his own practice where a wife appeared to contract consumption from her husband, and husbands from their wives, and refers to many other cases of which he has notes which prove, he says, "conclusively," the contagiousness of phthisis. He also publishes a note from Surgeon-General von Lauer, of the Royal Prussian War Department, supporting the same view, and describes his apparatus for catching tubercle-bacilli in the air near victims of tuberculosis, and some of the results of using it.

Foul Brood: Its Management and Cure. By D. A. Jones. Beeton, Ont.: "Canadian Bee Journal." Pp. 24.

"Foul brood" is a disease of bees, which, in order that the treatment may not be misapplied, the author carefully distinguishes from "chilled," "neglected," "overheated," "drowned," and "dead" brood. It is a germ-disease, and lurks in the honey, whence the bees contract it. The author's remedy is to cause the bees to fast till all the diseased honey is eliminated from their systems. The process has to be very carefully performed, and the cautions to be observed are particularly insisted upon in the directions.

Bulletins of the United States Geological Survey. No. 2, pp. 8; No. 3, pp. 36; No. 4, pp. 34, with Nine Plates; No. 5, pp. 325; No. 6, pp. 43; No. 11, pp. 66, with Six Plates. Washington: Government Printing-Office.

The bulletins are numbered in a continuous series, and will be bound in volumes of convenient size. The first six numbers constitute Vol. I, which will contain 493 pages, with eleven plates. Of the present list, No. 2 consists of "Gold and Silver Conversion Tables," which give the coining values of troy ounces of fine metal, and the weights of fine metal represented by given sums of United States money. In No. 3 are described the fossil faunas of the Upper Devonian along the meridian of 76° 30′, from Tompkins County, New York, to Bradford County, Pennsylvania. Number 4 gives accounts by Charles A. White of mesozoic fossils, including descriptions of certain aberrant forms of the *Chamidæ* from the cretaceous rocks of Texas; of a small collection gathered in Alaska by Mr. W. H. Dall; and of the Nautiloid genus *Enclimatoceras Hyatt*. No. 5 is a "Dictionary of Altitudes" in the United States, arranged by States and alphabetically by places, compiled by Mr. Henry Gannett. The data are derived from special, railroad, State, and municipal surveys, and generally from barometric or trigonometrical determinations. No. 6 is a list of elevations in the Dominion of Canada, derived generally from railroad and canal surveys. No. 11 is a paper on the quaternary and recent mollusca of the Great Basin, with descriptions of new forms, by R. Ellsworth Call, for which an introductory sketch of the quaternary lakes of the Great Basin is furnished by Mr. G. K. Gilbert.

Ethical Culture. Four Lectures. By Samuel Burns Weston. Philadelphia. Pp. 70. Price, 20 cents.

The Society for Ethical Culture, whose views are partly set forth in these lectures, regards the moral reason as the soul's sovereign authority, and holds that in yielding obedience to that authority, in living true to the dictates of our moral and rational nature, we are on the path that leads to the heights of religion. The present lectures were delivered to the society in Philadelphia. The special subjects are: "The Need of an Ethical Religion"; "Why Christianity does not satisfy us"; "The Success and Failure of Liberalism"; and "The Meaning of a Society for Ethical Culture."

The Sanitary Monitor. A Monthly Journal. Vol. I, Nos. 1 and 2, May and June, 1885. J. F. Winn, M. D., Editor and Proprietor. Pp. 14 each number. Price, 10 cents; $1 a year.

The "Monitor" is devoted to "Individual, Family, and Public Health," and gives contributions, addresses, editorial articles, reports, and items bearing upon these important subjects. It is not a medical journal, but is designed especially for the instruction of the laity in matters pertaining to the preservation of health.

Architectural Studies. Part I. Twelve Designs for Low-Cost Houses. New York: William T. Comstock, 6 Astor Place. Price, $1.

The designs are shown on a large scale, with full details, and include prize designs from "building competition," with specifications, bills of materials, and estimates of cost. The costs of the buildings are estimated at $2,600 and less.

The Abdominal Brain. By Leila G. Bedell, M. D. Chicago: Gross & Delbridge. Pp. 45.

The name of the book is taken from Bichat, who first used the term. The purpose is to maintain that not the brain and spinal cord alone, but the whole nervous system, particularly that part of it called the sympathetic, is concerned in the operations of mind. The author refers, in her introduction, to a paper by Dr. W. A. Hammond, which was published in "The Popular Science Monthly" after her essay was read in her society, the "Woman's Physiological Institute of Chicago," as bearing on her subject, and indicating that there is a place in science for her views.

A New Philological Theory. By Professor A. J. Mogyorosi. Alleghany, N. Y. Pp. 11.

Professor Mogyorosi believes that those writers on languages are wrong who regard the Aryan and Shemitic families as presenting the most perfect types of structure, and ignore the Turanian family, which is, he suggests, to the others as the center to the right and left wings. He illustrates his position by several examples of word-roots as they appear in the several families, in which the Magyar serves as the type of the Turanian.

PUBLICATIONS RECEIVED.

The Iroquois Sacrifice of the White Dog. Pp. 8. On Some Doubtful or Intermediate Articulations: an Experiment in Phonetics. Pp. 12. By Horatio Hale.

Notes on the Literature of Explosives. No. VIII. By Professor Charles E. Munroe, U. S. Naval Academy, Annapolis, Md. Pp. 18.

The Soaring Birds. A Mechanical Problem. By I. Lancaster. Chicago. Pp. 22.

Woman, a Poem. By Logan E. Bleckley. Clarksville, Ga. Pp. 23.

A Study of Thermometers, etc. By O. T. Sherman. Pp. 4.

A Plea for the Medicinal Use of Pure Alcohol, etc. By Henry Leffmann, M. D. Philadelphia. Pp. 10.

The Spirit of Scientific Progress. By Harvey W. Wiley, Ph. D. Pp. 20.

Quarterly Report of the Chief of the Bureau of Statistics, to March 31, 1885. Washington: Government Printing-Office. Pp. 144.

Crop Report (Georgia) for July, 1885. J. T. Henderson, Commissioner of Agriculture, Atlanta. Pp. 28.

International Electrical Exhibition (Philadelphia) Reports. Carbons for Arc Lamps. Pp. 16. Steam-Boilers. Pp. 39. General Report of the Chairman of the Committee on Exhibitions. Pp. 54.

The Western Society for Psychical Research. Chicago. Constitution and Rules. Pp. 8.

The Terraces of Rotomahana, a Poem. By Frank Cowan. To which is prefixed a Paper on Geyser Eruptions and Terrace Formations. By Josiah Martin, F. G. S. Auckland, N. Z. Pp. 61.

Marginal Kames. By H. Carvill Lewis. Philadelphia. Pp. 25.

Report of Proceedings of the Illinois State Board of Health, July Meeting. 1885. Pp. 26.

Teachers' Institutes (Bureau of Education Circular). Washington: Government Printing-Office. Pp. 206.

The Missouri Coteau and its Moraines. By Professor J. E. Todd, Tabor, Iowa. Salem, Mass. Salem Press. Pp. 12, with Plate.

Cocaine Hydrochloride. New York: Druggists' Circular Press. Pp. 97.

"Dio Lewis's Nuggets." Dio Lewis, Editor. Monthly. August, 1885. New York: Dio Lewis Publishing Company. Pp. 38. 10 cents a number, $1 a year.

Minnesota. Its Resources and Possibilities. By Professor C. W. Hall, Mr. D. C. Bell, and Rev. J. H. Morley. Minneapolis. Pp. 32.

A New Physical Truth. By E. J. Goodwin, M. D., Solitude, Ind. Pp. 32.

Hydatid Tumors in the Brain. By R. Harvey Reed, M. D. Mansfield, Ohio. Pp. 16.

Account of the Progress of Chemistry in 1884. by H. Carrington Bolton. Washington: Government Printing-Office. Pp. 52.

Observations of Comets. By J. G. Porter and H. C. Wilson. Cincinnati. Pp. 29, with 13 Plates.

The Latest Systems of Medicine. By J. G. Reeve, M. D. Dayton, Ohio. Pp. 33.

"Man. A Semi-Monthly Journal." Ottawa, Canada. Pp. 8. 5 cents a number, $1 a year.

Cholera, etc. By J. B. McConnell, M. D. Montreal: Robert Miller, Son & Co. Pp. 40.

Sidney Gilchrist Thomas. Biographical Notice. By George W. Maynard. New York. Pp. 7.

Trichina Spiralis. Including an Examination of Indiana Hogs. By Thomas B. Redding, F. R. M. S. Newcastle, Ind. Pp. 44.

Universal or Cosmic Time. By Sanford Fleming. Toronto, Ont.: Copp, Clark & Co.

Fodder Analyses. Blue-Joint Grass Hay. Massachusetts Agricultural Experiment Station, Amherst.

"The Massachusetts Magazine." Conducted by John N. McClintock. Boston: J. A. Cline & Co. Monthly, August, 1885. Pp. 64. 25 cents a number, $2.50 a year.

United States Hay-Fever Association. 1885. Portland, Me.: Hoyt, Fogg & Dunham. Pp. 39.

State Board of Health of Wisconsin. Eighth Report. Madison, Wis. Pp. 160.

Truth, a Poem. By Edwin N. Kingsley. Pp. 57. 25 cents.

Bible Fabrications refuted. By O. B. Whitford. Pp. 47. 15 cents. And St. Matthew before the Court. Pp. 38. New York: Truth-seeker Company. 10 cents.

Smithsonian Institution. Report of Professor Spencer F. Baird, Secretary. Washington: Government Printing-Office. Pp. 98.

Accounts of Progress. 1884. Geography. By Commander F. M. Green, U. S. Navy. Pp. 19. North American Paleontology. By J. B. Marcou. Pp. 20. Meteorology. By Professor Cleveland Abbe. Pp. 176. Physics. By Professor G. F. Barker. Pp. 57. Chemistry. By B. H. Carrington Bolton. Pp. 52. Mineralogy. By Professor E. S. Dana. Pp. 19. Anthropology. By Professor O. T. Mason. Pp. 41. All Smithsonian Reports. Washington: Government Printing-Office.

Lectures on Teaching. By J. G. Fitch, M. A. New edition, with a Preface. By an American Normal Teacher. New York: Macmillan & Co. 1885. Pp. 393. $1.

Students' Songs. Compiled and edited by W. N. Hills. Cambridge, Mass.: Moses King. Pp. 60. 50 cents.

Tornado Studies for 1884. By John P. Finley. (Signal-Service Paper.) Washington: Government Printing-Office. Text and Plates.

Catalogue of Scientific and Technical Periodicals. 1665 to 1882. By H. Carrington Bolton. Washington: Smithsonian Institution. Pp. 773.

Theory and Practice of Teaching. By Rev. Edward Thring, M. A. New and revised edition. Cambridge: University Press. 1885. Pp. 262. $1.

The Manual of Phonography. By Benn Pitman and Jerome B. Howard. Cincinnati: Phonographic Institute. 1885. Pp. 144.

The Devil's Portrait. By Anton Giulio Barrili. From the Italian. By Evelyn Wodehouse. New York: W. S. Gottsberger. 1885. Pp. 312. 75 cents.

On Teaching: Its Ends and Means. By Henry Calderwood, LL. D., F. R. S. E. Third edition. New York: Macmillan & Co. 1885. Pp. 126. 50 cents.

The Treatment of Opium Addiction. By J. B. Mattison, M. D. New York: G. P. Putnam's Sons. 1885. Pp. 49. 50 cents.

Cholera. Its Origin, History, Causation, Symptoms, Lesions, Prevention, and Treatment. By Alfred Stillé, M. D. Philadelphia: Lea, Brothers & Co. 1885. Pp. 164.

Magneto- and Dyamo-Electric Machines. From the German of Glaser De Cew. By F. Krohn; and specially edited, with many Additions, by Paget Higgs, LL. D. London: Symons & Co. 1884. New York: D. Van Nostrand. Pp. 301.

The Windmill as a Prime Mover. By Alfred R. Wolff, M. E. New York: John Wiley & Sons. 1885. Pp. 159. $3.

Life of Frank Buckland. By George C. Bompas. With a Portrait. London: Smith, Elder & Co. Philadelphia: J. B. Lippincott Company. 1885. Pp. 433. $2.

Annual Report of the Operations of the Life-Saving Service for the Fiscal Year ending June 30, 1884. Washington: Government Printing-Office. 1885. Pp. 476.

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POPULAR MISCELLANY.

Industrial Education in Common Schools.—Mr. B. B. Huntoon recently read a paper before the "Conversation Club" of Louisville, Kentucky, on "Industrial Education," in which he advocated the introduction of the Russian system into the public schools. This system does not aim to teach the practical exercise of particular arts, but only so to train the eye and hand to the execution of designs and the use of tools that the pupil may be qualified to take up readily whatever art he may afterward choose to follow. The system, in its most essential features, has already been tried successfully in the Massachusetts Institute of Technology; Washington University, at St. Louis; Purdue University; Illinois University; Tulane University, New Orleans; and in industrial schools in Chicago, Baltimore, Philadelphia, and New York city; and in Boston and Gloucester, Massachusetts, and Montclair, New Jersey, the experiment has been tried of incorporating a course of industrial training upon the city schools. Mr. Huntoon believes that the people are ready to be taxed for such a purpose; that there will be no difficulty in finding teachers; and that the scheme is entirely practicable.

The Pittsburg Natural Gas-Wells.—According to the account recently given by Mr. Andrew Carnegie to the Iron and Steel Institute, the principal district in which the natural gas-wells near Pittsburg are found, the Murraysville field, lies to the northeast of that city, running southward from it toward the Pennsylvania Railroad. Nine wells had been sunk there last fall, and were yielding gas in large quantities. Gas has been found in a belt averaging about half a mile in width for a distance of between four and five miles. Beyond this a point is reached where salt-water flows into the wells and drowns the gas. The gas-fields of Washington County are about twenty miles from the city, swinging round toward the southwest. Four wells are now yielding gas in this district, but are not, perhaps, so strongly charged as those of the Murraysville district, and others are being drilled. Still farther to the west is another gas territory, from which manufacturing works in Beaver Falls and Rochester receive their supply. Next is the Butler gas-field, as far from Pittsburg on the northwest as are the Washington County wells on the southwest. Next, on the Allegheny River, is the Tarentum district, still about twenty miles from Pittsburg, which is supplying a considerable portion of the gas used. Thus, within a circle around Pittsburg having a radius of fifteen or twenty miles, there are four distinct gas-producing districts. Several wells have been bored within the city; but, though they all yielded gas, it has been drowned out by the rush of salt-water. While the largest well known yields about 30,000,000 cubic feet of gas in twenty-four hours, the average product of a good well may be set at about half of this. The pressure of the gas as it issues at the mouth of the well is nearly or quite two hundred pounds per square inch. Even at the works of the company represented by Mr. Carnegie, nine miles from the well, the pressure is seventy-five pounds per square inch. Eleven lines of pipe are conveying gas from the various wells to the manufacturing establishments in and around Pittsburg. Although it is only two years since gas has been used in Pittsburg, it has already displaced 40,000 bushels of coal per day in the mills that have used it, and about an equal amount has been displaced in the works beyond the city limits. Contracts are now made to supply houses with gas at a cost equal to that of the coal bill for the preceding year. In many houses, no other fuel than this gas is used; and everybody who has applied it to domestic purposes is delighted with the change from the smoky and dirty bituminous coal. It is, therefore, Mr. Carnegie suggests, quite within the region of probability that the city, now so black, may become so revolutionized as to be the cleanest manufacturing city in the world.

English Board-School Science.—Dr. Andrew Wilson's "Health" has been struck with some of the answers in the school-children's examination-papers in popular science, and gives a few specimens of them. Among them are—"the humerus (or upper arm-bone) is known as the 'humerous,' and is often called 'the funny-bone.'" "The sweet-bread is otherwise called the pancras (for pancreas), which is so named from the Midland Railway Station in London." "A thermometer is an instrument used to let out the heat when it is going to be cold." "When roasting a piece of beef, put it in front of a brisk fire, so as to congratulate the outside." "Sugar is an amyloid. If you were to eat much sugar and nothing else, you would not live, because sugar has not got no carbon, hydrogen, oxygen, nitrogen. Potatoes is another amyloids." Very interesting is the description of digestion given by one of the pupils: "Food is digested by the action of the lungs; digestion is brought on by the lungs having something the matter with them. The food then passes through your windpipe into the pores, and thus passes off you by evaporation, through a lot of little holes in your skin called capillaries. The food is nourished in the stomach. If you were to eat anything hard you would not be able to digest it, and the consequence would be you would have indigestion. The gall-bladder throws off juice from the food which passes through it. We call the kidneys the bread-basket, because it is where all the bread goes to. They lay concealed up by the heart."

A Story of Two Rats.—A correspondent of "Land and Water" tells a story of two white rats which he had adopted as pets. The male was a quiet, commonplace sort of rat, acquaintance with whom afforded few incidents of particular interest. The female was a great coquette, and a regular domestic tyrant, exercising absolute control of her spouse and household. Always pleased with the gift of some dainty, she was "rapturously delighted" if allowed to think she had stolen it. If the master would have a piece of sugar on the table, she would creep up and take it, retreating behind a book to devour it, as she hoped, unobserved. She was a relentless enemy to mice; and, when one of these animals was put into her cage, "she flew at it and slew it with a single bite, leaving it instantly, as a well-trained terrier does the rat it has killed." The first occasion of Anna Maria having little ones was quite an event. "When I went to the box, as usual, to give my little rodents a scrap of whatever I might have had, I found Augustus (the male) sitting out in the cold and looking terribly sheepish. On opening the sleeping compartment, there was Anna Maria, with something like a smile upon her shrewish little countenance, keeping watch and ward over nine ridiculously naked little offspring. On these occasions Augustus was completely effaced. He shirked the slightest responsibility; and I always had to make him up a separate bed, for sleep with his children he would not. If by chance he was forced to walk among them, he did so with an anxiety that would have done credit to an elephant stepping between eggs. As they grew up, assumed hair, and began to run about, he would allow them to take liberties with him, and even rob him of tidbits." The master thought the hay the naked little fellows were lying upon too rough for their tender skins, and put wadding in its place. "But, with a sneer of contempt for the stupidity of men in such matters, Anna Maria promptly cast out the wadding and bumped her progeny upon the hay again." In washing them, "she would roll them over and over with her paws, and lick them till the sparks flew, and they would utter plaintive little squeaks." But they throve splendidly. "Every night this graceful couple gamboled about my table while I read or wrote. It was a delight to me to watch them at their toilet or eating the food which they held in their delicate little paws. . . . When tired of play, they would clamber up to my shoulder and slumber, huddled together like two love-birds." Anna Maria at last died of a cold, and her place was supplied by a new female, whose chief peculiarity was that as soon as she had a family she would bite off her babies' heads."

Cannibalism among Rats.—Mr. W. Mattieu Williams believes that rats are, upon occasion, voracious cannibals, devouring one another by wholesale and without mercy. Being troubled beyond endurance by these pests, and getting no relief from dogs, ferrets, and cats, and fearing poison, he tried the effects of stuffing the holes with broken glass. "This was successful, and some curious results accompanied the clearance. At first, there were streaks of blood on the kitchen-floor in considerable quantity, and distributed all over it. These appeared on several mornings. At about the same time, and subsequently, much scampering and screaming was heard beneath. This was followed by a rapid reduction of the number of the enemy. My theory," says Mr. Williams, "is, that when any one rat was wounded by the glass, the scent of blood excited the voracity of the others, and a cannibal struggle occurred; that this continued till extirpation followed—the more fighting, the more bloodshed and the more cannibalism." Mr. F. W. Halfpenny partly confirms this view in "Science Gossip," where he says that the black rat is still to be met with at most of the London docks; that the Norway or sewer rat not only kills its victim, but devours it. He describes skins of freshly killed black rats turned inside out, and found in various drawers, boxes, etc., and states that this treatment of their victims is usual with rats. As an experiment, Mr. Halfpenny gave the carcass of a white rat to one of the black and white variety. It was eaten, only a few bones of the head remaining attached to the everted skin.

Coal-Dust in Fire-Damp Explosions.—The Royal Prussian Fire-damp Commission has carried out a series of experiments in the Royal Coal-Mine near Neunkirchen, the results of which go far to confirm Mr. W. Galloway's theory of the agency of coal-dust alone, and in conjunction with fire-damp, in propagating explosions in mines. At the mine in question is a blower of fire-damp at a depth of 131 yards below the surface, which gives off 0·9 cubic foot of gas a minute. For the experiments cannon were planted at the closed end of a horizontal gallery 167 feet long, having a branch 33 feet long, starting at a distance of 93 feet from its closed end. The branch gallery was closed at both ends with two-inch planking. One gun was fired when the gallery was free from fire-damp and from coal-dust; the flame of the shot was a little over 13 feet long. In a second experiment the floor of the gallery was strewed with coal-dust 1·17 inch thick for a length of 65 feet. The shot gave rise to a loud detonation, and the resulting flame filled the gallery to a distance of 88½ feet. The inner planking of the branch gallery was broken. In the third experiment the gallery-floor was strewed with coal-dust for a length of 130 feet. The flame traversed the whole length of the gallery with great velocity, and came out at the open end to a distance of 16 feet, or 183 feet in all. It also emerged from the branch gallery to a distance of several yards. The outer partition of this gallery was broken into small fragments. For the fourth experiment, the partitions in the branch gallery were replaced, coal-dust was strewed on the floor for a distance of 65 feet, and a volume of 35¼ cubic feet of fire-damp was introduced and completely diffused. The firing of the shot produced a flame 190 feet long, accompanied by a report like a thunder-clap. The inner brettice of the branch gallery was broken and drawn several yards into the main gallery, but the outer one remained intact. The incidental effects of the last two shots also indicated how tremendous a force had been let loose when coal-dust formed one of the elements of the explosion. These experiments were typical of two hundred similar ones that had been made with from one to seven guns, all marked by results sustaining the coal-dust theory.

Medical Virtues of Dog's Tongues.—M. Reimach having called attention to the mention, in the recently discovered inscriptions at the Temple of Esculapius, in Epidaurus, of children having been cured of blindness at that sanctuary by having their eyes licked by the sacred dogs, M. Henri Gaïdoz states that he has discovered the faith and practices of the dog-cure among several peoples and in a number of religions. The Hindoos believe that the English kill dogs to obtain possession of a sovereign remedy which is found in their tongues. In a Venetian legend, St. Roch was cured by a balsam distilled from the tongue of his dog. Dogs' tongues are considered to have medical virtue by many people in Portugal, France, and Scotland. In Bohemia they let dogs lick the faces of new-born children for "good luck." A belief in the existence of divinities issuing from dogs, whose office it was to lick the bruises of the wounded, once prevailed in Armenia. In a scene in one of Aristophanes's plays, Plutus recovers his sight in the Temple of Esculapius after being licked by two serpents which the god sent for that purpose in answer to his prayer.

Observations in the Sahara.—Dr. Oscar Lenz, whose account of his journey through Morocco, the Sahara, and the Soudan, to Timbuctoo, has been recently published, is the fourth European traveler who has reached the famous "Queen of the Wilderness," as the desert metropolis is called, during the present century. Having entered the city from the north, and then going from it westward and down the Senegal to the Atlantic coast at St. Louis, he has demonstrated the accessibility of Timbuctoo from both directions. One of the results of the surveys he made on his journey will probably be the death of the theory that the region of the Sahara has ever been a marine basin, at least since the early Tertiary epoch. The whole of the western section of the desert traversed by him was proved not to be a depression, as has been assumed, but an irregular plateau; standing in the north at a mean elevation of from eight hundred to one thousand feet, and even at Taudeni, its lowest level, still maintaining an altitude of four or five hundred feet above the Atlantic. The surface formations have nothing in common with marine sedimentary deposits, but are all evidently the results of weathering. The numerous dried-up water-courses, whose deep channels are distinctly the effect of erosion, also show that this part of the desert has been dry land for many ages. These wadies radiate from the central highland north and northeast to the Mediterranean, east to the Nile, south to Lake Chad and the Niger, and west to the Atlantic, and have been in their day full of water. Hence, it appears that, down to comparatively recent times, the Sahara was a well watered and wooded region, thickly inhabited by agricultural and pastoral communities. What has caused this change in climate? Dr. Lenz attributes it, not as Peschel has supposed, to the dry northeast polar winds (for these in the Sahara yield to the northern and northwestern atmospheric currents), but largely to the reckless destruction of the woodlands which once covered extensive tracts in the region.

Value of Fruit as Food.—The "Lancet" regards the increased use of fruit in ordinary diet as one of the most salutary tendencies of domestic management in our day. The starchy and saccharine components of fruit, while they are not equal in accumulated force to the more solid ingredients of meat and fat, are similarly useful in their own degree, and have the advantage of greater digestibility. Other advantages are the locally stimulant action of many subacid fruits, its control of a too active peptic secretion, and its influence of attraction upon the alkaline and aperient intestinal juice, to which further effects that aid the maintenance of a pure and vigorous circulation are indirectly due. "Thus it follows, on the simplest principles of physiology, that other essential organs, such as the skin and kidneys, are relieved by the transference of part of their excretory function to the bowel and act with greater ease, the general vascular system is lightened by this regulating drain, and its faculty of absorbing the waste products of food and work is encouraged in proportion." Only persons of gouty and rheumatic habit, or of tendencies to diarrhœa, dysentery, or saccharine diabetes, will be likely to find fruit in any moderate quantities to disagree with them, while dyspeptic persons will find it almost wholly beneficial.

Formation of Peat.—For the growth and formation of peat—which is vegetable matter in a semi-decomposed state—is required a climate sufficiently moist to foster the growth of the plants of the remains of which it is composed, and at the same time cool enough to retard, under certain conditions, the decomposition, beyond a certain point, of successive generations of those plants. Accordingly, we find it most abundantly distributed in latitudes above 45° in either hemisphere. In Ireland, the peat-bogs cover about one seventh of the surface. Peat-bogs are classified as those which have ceased to grow and those which are still growing. Some of the former class must be of enormous age. In many bogs in Ireland the deposit is from fifteen to thirty feet deep, and in Scotland this depth is frequently exceeded. Each year's growth, according to Mr. Kinahan, is represented by a layer of lamina, and these lamina are, on an average, in white turf one hundred, in brown turf two to three hundred, in black turf from six to eight hundred to the foot. It is easy with these data to compute approximately the probable age of the bogs; but the result of the calculation is liable to variations according to the manner in which the bog was formed; for the rate of growth is subject to many fluctuations, not only in different bogs, but in different parts of the same bog. When two layers of wood are found in peat, the lower forest usually proves to have consisted of oak, and the upper one of pine. Remains of the great Irish deer are very common in the bogs of Ireland, and human relics are often found. No chronological estimates can, however, be based upon the presence of such relics, for articles having weight will easily sink through the soft mass. In districts where peat is plentiful it is extensively used for fuel, for which purpose the turf is cut from the bogs in narrow rectangular masses a foot or eighteen inches long, and prepared by drying. It is not well adapted for use in manufactures, for its heating power is low. Peat-charcoal has, however, been used with advantage in smelting iron, and it possesses very powerful antiseptic and deodorizing properties. Considerable quantities of peat-land have been reclaimed and brought under cultivation. In its natural state the soil is sour and unfit to promote plant-growth, but when drained and treated with lime it may be brought to a high degree of fertility. When the peat-bog is situated near to limestone, the process of reclaiming the land is cheap and the result is profitable.

A Scientific Commonplace-Book.—The purpose of "The Scientific Roll," a new serial kind of encyclopædia, or commonplace-book, projected and begun by Mr. Alexander Ramsay, is to cull, classify, and embody in a shape conveniently accessible, all the important statements of fact and theory that now lie scattered and substantially out of reach to any one man in the six thousand scientific periodicals of the day. The systematization of notes on this plan results in a most compendious classification of all that is wanted in scientific literature, in such a way that lines of thought are suggested to the reader, and facilities are offered for following them out which books, as a whole, do not afford. No correction is given, or comment upon the views of the several authors, but each one speaks for himself, and the reader is left to choose to what he will hold. The first volume, just published by Swan, Sonnenschein & Co., London, includes the literature of climate, in which a prominent place is given to a very interesting bibliography. One of the oldest works catalogued is said to have been written in the thirteenth century, and was printed by Caxton, under the title of "Image or Mirror of the World." But, as an English journal admits in its review of the publication, "it is not till we reach the year 1789 that we find the germ of the science, in a paper by Benjamin Franklin, under the somewhat timid title, for so bold a meteorologist, of "Meteorological Imaginations and Conjectures." This is followed by contributions from Lamarck, Saussure, Playfair, and Humboldt. The number of references to the year 1800, when Humboldt's name is first mentioned, is only three, while in 1880 the number has increased to eighty-four. America, as the country affording most facilities for systematic observations, has the leading place in the list all the way through.

Enlargement of the Sun and Moon in the Horizon.—Various hypotheses have been proposed to explain the apparent enlargement of the sun and moon in the horizon over the size they seem to present at the zenith. Experiments recently made by M. Stroobant, in Belgium, indicate that the cause of the phenomenon is a physiological one. In a darkened room, M. Stroobant had fixed to the ceiling two electric stars about eight inches apart, and on the level of his eye two similar stars, the distance between which could be varied at pleasure, while the observer's eyes were at an equal distance from either pair. When the pair of stars on the level of his eye were so adjusted as to appear at the same distance as the pair in the ceiling, they were proved on measurement to be only six and a half inches apart. He then transferred his observations to the actual stars, selecting pairs at sensibly equal distances apart in the horizon and in the zenith, and afterward measuring their real angular separation as marked on the celestial globe. The apparent separation of the stars in the horizon was increased in almost precisely the same degree, the ratio of the real distances, which seemed to the eye to be the same, being as 100 in the zenith to from 79·5 to 81·5 in the horizon.

The Vegetation of Gutter-Stones.—Dr. Hugo Winnacker, who devoted eleven full months to the study of the subject, has published a paper on the "Vegetation of Gutter-Stones and its Relation to Infectious Diseases." The subject is one of no little importance, for, if the gutters of our streets really harbor infectious plants or germs, they are capable of being very dangerous agents for the spread of disease. Parts of them are exposed to being dried every day, and when they are in that condition the germs might be taken up by the wind and scattered everywhere, to become active whenever they are supplied with moisture. Dr. Winnacker has found that the vegetation of the gutter-stones consists of green algæ and fungoids. The algæ are harmless and even beneficial, for they grow over the fungoids and at their expense, and help to keep them down. They should therefore be encouraged by not removing them, and by flushing the gutters, so as to supply them with the elements favorable to their nutrition. Most of the fungoids likewise appear to be harmless, but some of them may be dangerous, and, as it is hard to distinguish their qualities, it is well to be on the watch against them. Two of the fungoid forms, quite abundant at Göttingen, are especially described. One, a micrococcus and ferment, grows in a reddish-brown coating from early in the spring till late in the fall. Another, a mold, grows in thick masses all the year round. The character of the vegetation may be different in different cities.

Difficulties of Underground Telephony.—The difficulties in the way of at once laying the telegraph and telephone wires underground in London are succinctly stated in the "Saturday Review." The inductive effects in the telephone wires are already annoying enough, when there is room to spread the wires in the air. They would be greatly multiplied if the conductors were bunched together, as they would have to be, to be put in a tube underground. The retardative effects would also be largely increased, to a serious extent, in fact, in the case of the telephones, for they depend upon abrupt and rapid changes in the strength of the current, and these would be so far nullified as seriously to impair the clearness of the articulation if the line were of any considerable length. The expense of construction would be largely increased by the necessity of coating the wires; while the coating, mainly composed of gutta-percha, is perishable, and constantly giving rise to "faults." A system of sub-ways, like the sewers of Paris, or the underground avenues, that might be made by connecting the sidewalk vaults of New York, seems to be an indispensable prerequisite to any practicable general location of electric telegraphic and other wires under the ground. Nevertheless, the overhead electric-light wires are a nuisance, and fitly entitled to the epithet, "a Damoclctian terror," which the London "Lancet" applies to them.

Food-Value of "Whole-Wheat" Flour.—Dr. Campbell Morfitt, who has been largely instrumental in introducing improved forms of bread and new methods of bread-making, has reported an experiment he has made to ascertain the relative value of common flour and of his "whole-wheat" flour. The objections to the old Graham flour, that its coarse bran was irritating to the digestive organs, were well founded. The "whole-wheat" flour is free from this fault, for the bran is not coarse or sharp-edged. Dr. Morfitt makes three kinds of flour: the crude, representing the entire grain; a standard refined granular meal, representing ninety-three or ninety-four per cent of the cleaned grain; and a pearl-white meal representing all the farina of the grain with some cerealine, about eighty-three per cent of the whole. Given weights of each of these were carefully brushed over a fine wire-cloth till all the farinaceous portions had gone through. That which was left on the sieve—called proximate bran—amounted, in the mean, to 18·28 per cent of the crude, and 12·19 per cent of the standard meal. Therefore, wheat may be said, generally, to consist of 81·72 per cent farina and 18·28 of branny matter. The proximate brans were next inclosed in fine cloths and kneaded under relays of cool water till the latter ceased to become cloudy, and by this treatment were reduced in weight rather more than one half. The residue left from this treatment was called absolute bran. It exists in a fixed ratio to the meal in all the wheats indifferently of 9·65 per cent from the crude, and 5·80 per cent from the standard meal. Thus, the total of actual bran in any wheat does not exceed ten per cent. The proximate bran was then subjected to an artificial digestive process, to discover how much more of its substance it would yield in that way. The quantity of "ultimate" bran left after this experiment was reduced by 18·44 per cent, or to 7·87 per cent for the crude meals, and by 21·38 per cent, or to 4·56 per cent for the standard meals. The more powerful natural digestion of the stomach must certainly extract still more from the meals. "Results could not be more impressive than these," says Dr. Morfitt, "as to the superior nourishing value of whole-wheat meal, for they prove that the separation and rejection of the bran must inevitably impoverish the residual farina of the flour."

Poisonous and Medicinal Herbs in India.—No country is better supplied with medicinal as well as poisonous herbs than India. The waysides and ditches abound in plants that possess some strange, and some the most deadly qualities. One of the most common of these plants is the *datoora*, with its large white flower, and leaves resembling those of the hollyhock. It is well known as a remedy for asthma, and its leaves are used in the shape of cigars or "tobacco," but its seeds are a subtile and powerful poison, in small quantities causing temporary insanity, and in large either permanent injury to the brain or death. The natives believe that it is used by robbers to aid them in their operations. The *madār* grows from two to four feet high in isolated groups along road-sides and in open, sunny places. It is soft and branching, with broad, thick, dark-green leaves covered with down, and large white waxen flowers tinged with pink toward the center. The application of the leaf is a sovereign remedy for sprains, swellings, and pains. The strangest and most powerful property of the *madār* resides in the milk, which exudes abundantly on the slightest scratch of its succulent leaf or stem. The natives profess to use it for any obstinate sore, especially in the nostril, but when swallowed it produces spasms of hilarious intoxication of which the patient recollects nothing after they are over. The natives say that if a probe is formed from a mixture of the *madār*-milk with a pounded *ruttee*-seed, dried and hardened in the sun, and if the skin is pricked with this and the point left, death will follow imperceptibly and painlessly in two or three days, leaving no trace of the cause but the faintest speck like a mosquito-bite where the skin was probed. The wild *ganja*—to which the hasheesh-plant corresponds as a cultivated species—has similar intoxicating effects, except that it is less injurious to the system. The natives chiefly use it spiced for the hookah, or as an infusion for drinking. From long continuance or excess it is a frequent cause of insanity; and this may pass away on discontinuing the use, or result in more or less permanent imbecility. It is used sometimes as a medicine for cattle. The number of herbs considered medicinal by the natives is endless. Hardly a weed grows but they find some virtue in it for some ailment or another. The large leaf of the castor-oil plant, heated and applied externally, is used for allaying local inflammation and pain. The leaf and bark of the *neem*-tree are similarly applied. A small weed like clover, gathered among the grass, is applied to the temples to allay headaches, or otherwise as a counter-irritant, as we use mustard. The *cherita* is a well-known tonic and fever preventive; and the milk of the *chutwan*-tree is used for stuffing what few Hindoo teeth come to be in need of that process.

NOTES.

Professor John S. Newberry has described, in the "Annals" of the New York Academy of Sciences, some peculiar screw-like fossils from the Chemung rocks of Northern Pennsylvania and Southern New York, which at first sight suggest a resemblance that is not real to the fossil fruit Spirangium. Two species are identified, of one of which only one specimen has been found. They consist of a cylindrical or fusiform body traversed by double spiral revolving ridges, which make them look very much like common screws. The generic name of *Spiraxis* has been given to them, with the specific names of *major* and *Randalli*. Professor Newberry regards them as casts of sea-weed stems.

In a paper on "The First Notice of the Pine-Grove or Forest River Shell-heap," Mr. F. W. Putnam reprints the report made by John Lewis Russell in 1840 to the Essex County Natural History Society. Up to this time it had hardly been doubted that these heaps were of natural origin, and Mr. Russell does not appear to have suggested any other view.

Helen C. De S. Abbott has published an analysis of the bark of *Fouquieria splendens*, or the ocotilla-tree, a thorny plant, of the order *Tamariscineæ*, native to the region of the Mexican boundary-line, which grows in the shape of a low fan, from eight to twelve feet high, bearing foot-long scarlet, trumpet-shaped flowers, and which the people find useful for making fences. The bark supplies a wax which differs generally in its properties from known vegetable waxes, and is evidently a new wax peculiar to this plant. The name ocotilla-wax is proposed for it.

Dr. Giles, of the Indian Government's surveying steamer Investigator, has obtained some animals from the Bay of Bengal which appear to be new, and has proved that "the Swatch," at the mouth of the Hoogly, is a deep, submerged valley, forming part of the original depression of the bay.

An interesting new feature of this year's May-day celebrations in London was a procession of cart-horses, similar to those which have been regularly held in some of the towns of the United Kingdom. About a hundred teams participated. No prizes were offered, but each driver received an illuminated card commemorative of the occasion, and acknowledging the evidences afforded of "care, attention, and kindness to animals." A regular observance of this kind might be made the means of greatly encouraging proper treatment of beasts of burden.

M. Witz states, as the result of observations he has been making for some time on atmospheric ozone, that the proportion of ozone in the air of Paris last year was inverse to the mortality from cholera.

According to a Moscow paper, only 21 per cent of the children attending school in Russia are girls. The proportion varies with the religion, being greatest among Protestants, 45·4 per cent; next among Jews, 34·1 per cent; next among Roman Catholics, 14·4 per cent; and lowest among Greek Catholics, 12·3 per cent.

M. Stanislas Meunier has described some silicious pebbles which are quite numerous in the quaternary gravels of the valley of the Loing, France, that are remarkable for being hollow and inclosing, together frequently with a loose stony nucleus, liquid water. They are about forty-five millimetres in diameter, and the water may be heard to strike against the walls of the cavity when the stones are shaken. The only way M. Meunier can account for the water getting into the pebbles is by its seeping through the pores, for not a sign of a crack can be seen with the eye or by the aid of a strong glass.

Several cyclopædias contain the statement, in substance, that no land in Connecticut rises above a thousand feet in height. Professor Asaph Hall writes to "Science" that, according to Mr. G. M. Bradford's surveys, several points in the northwest part of the State are higher than this, and mentions six mountains that exceed 1,600 feet. They are: Ivy Mount, Goshen, 1,642; Haystack Mount, Norfolk, 1,672; Bald Mount, Norfolk, 1,770; Bradford Mount, Canaan, 1,910; Bear Mount, Salisbury, 2,100; and Bruce Mount, Salisbury, 2,300 feet.

Under the promptings of the universal recognition of the truth that, for Japan to take the rank she should hold among civilized nations, her literary and educational work must be freed from the trammels of the Chinese ideographs, a society—the Rōmaji Kai—has been formed to promote the general adoption of the Roman letters. Its committee, composed of native and foreign scholars, has drawn up a scheme of transliteration, and a monthly journal—the "Rōmaji Zasshi," which, besides this subject, will discuss general topics and publish classical and original literary papers—has been begun, to introduce the new system to the people.

Dr. Cornish, a student of cholera, proposes that a certain proportion of the persons who are condemned to death every year in India be used, their own consent having been obtained, as subjects for experiments on the transmission of cholera; further punishment to be remitted if they survive the tests.

A division of economic ornithology has been established in the Entomological Bureau of the Office of Commissioner of Agriculture, and Dr. C. Hart Merriam, Secretary of the American Ornithologists' Union, has been appointed to take charge of it. Its special field of investigation will be the inter-relation of birds and agriculture, and will include the relations of birds and insects, the food and habits of birds, and the collection of data bearing on the migration and geographical distribution of North American birds.

M. J. J. Martinez proposes a universal subscription for the purpose of boring a hole, thirty by one hundred and fifty feet in diameter, down into the earth, at which convenient stations may be fixed for the observation of all kinds of subterranean phenomena.

Lieutenant Van Gêle, of the French Equatorial Station, gives the following list, with the weights, of the various articles of costume of a Congo negro lady: A copper ring on each ankle, $\frac{1}{2}$ kilogramme; brass-wire leglets on each calf, 1 kilogramme each; a petticoat of banana-fiber cloth, twenty inches long and nine inches wide, $\frac{1}{100}$ kilogramme; a bell fastened with a belt, $\frac{1}{5}$ kilogramme; a copper collar around the neck—the most important garment of the dress—27 kilogrammes. The total weight is 29·210 kilogrammes, or nearly 75 pounds—about the load of a European infantry-soldier—of which less than half an ounce is devoted to the purpose of real dress.

The French Association for the Advancement of the Sciences was to meet at Grenoble on the 12th of August, under the presidency of Professor Verneuil. The meetings would continue till the 20th, after which a series of excursions was projected, to last till the 24th. Two conferences were appointed: "On the Alimentary Resources of France," by Dr. Jules Rochard; and "On the New Paleontological Gallery of the Museum," by M. G. Cotteau.

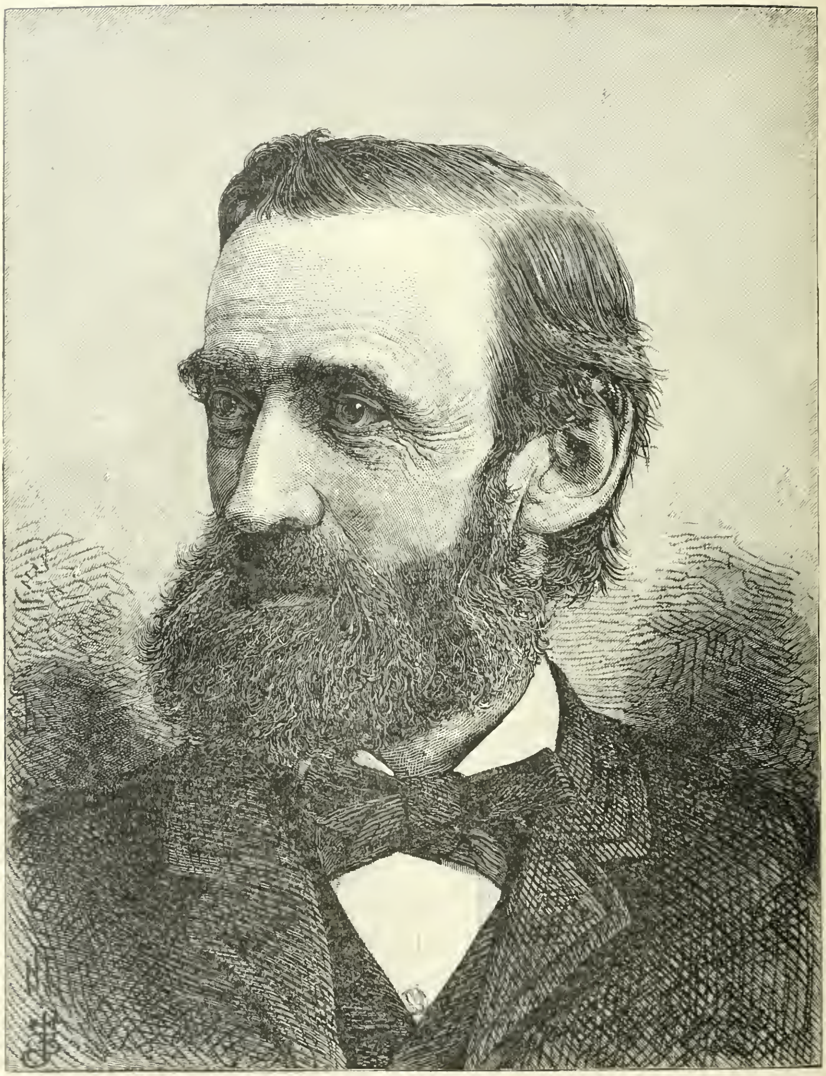
Experiments reported by M. Guignet to the French Academy of Sciences confirm the views of M. Frémy that the behavior of chlorophyl, or the coloring-matter of leaves, is usually like that of an acid. M. Guignet has obtained chlorophyllate of soda, and from it, by double decomposition, salts of lime, baryta, and lead.

MM. Muntz and Marcano have observed that nitrification of the soil is going on in the equatorial regions of South America on an extraordinary scale. At some points the constituents of the mold are cemented together in a kind of paste by enormous proportions—sometimes forty per cent—of nitrate of lime. The origin of these conditions is traced to the numerous mountain-caves, which are inhabited by legions of birds and bats, whence the streams carry the guano over extensive areas.

OBITUARY NOTES.

Dr. Henri Milne-Edwards, the eminent French naturalist, and the successor of Geoffroy St.-Hilaire in the chair of Zoölogy at the Museum of the Academy of Sciences, died in Paris, July 29th, in the eighty-fifth year of his age. A portrait and sketch of his life and works were published in "The Popular Science Monthly" for February, 1883.

Robert von Schlagintweit, Professor of Geography and Ethnology at the University of Giessen, has recently died, at the age of fifty-two. He was the youngest of three brothers who were commissioned by the British East India Company, on the recommendation of Humboldt, to explore India and the mountain-regions of the northwest.



HUBERT ANSON NEWTON.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

By ANDREW DICKSON WHITE,
LATE PRESIDENT OF CORNELL UNIVERSITY.

I. THE DOCTRINE OF COMETS.

IN all the development of astronomy few things are more interesting than the growth of a true doctrine of comets. Hardly anything throws a more vivid light upon the danger of using isolated texts of Scripture to preserve beliefs which observation and thought have superseded, and upon the folly of arraying ecclesiastical power against scientific discovery.

Out of the ancient world had come a mass of beliefs regarding comets, meteors, and eclipses; these were universally held to be portents sent directly from heaven for the warning of mankind. As to stars and meteors, they were generally thought to presage happy events, especially births of gods, heroes, and great men. So firmly rooted was this idea that we constantly find among the ancient nations notices of lights in the heavens heralding the birth of persons of note. The sacred books of India show that the births of Crishna * and of Buddha † were announced by such heavenly lights. The sacred books of China reveal similar appearances at the births of Yu, the founder of the first dynasty, and of the inspired sage Lao-tse.‡ In the Jew-

* For stars at the birth of Crishna, see Maurice's "History of Hindostan," vol. ii, p. 336; also Cox's "Aryan Mythology" (London, 1870), vol. ii, p. 133; also "Vishnu Purana," Wilson's translation, b. v, chap. iii.

† For lights at the birth, or rather conception, of Buddha, see Bunsen's "Angel Messiah," pp. 22, 23–33; also, Alabaster, "Wheel of the Law," illustrations of Buddhism (London, 1871), p. 102; also, Edwin Arnold's "Light of Asia" (London, 1881), p. 3; also, "Life of Gaudama, the Burmese Buddha," by Bishop Bigandet (London, 1880), p. 30; also, Oldenberg's "Buddha," English translation, part i, chap. i.

‡ For Chinese legends regarding stars at the births of Lao-tse and Yu, see Horton's "History of China," i, 137.

ish legends a star appeared at the birth of Moses,* and was seen by the Magi of Egypt,† who informed the king; and when Abraham was born an unusual star appeared in the east. The Greeks and Romans held similar traditions.‡ A heavenly light accompanied the birth of Æsculapius, and the births of various Cæsars were heralded in like manner.

As to the nature of these heavenly bodies, the fathers of the Christian Church were divided. Origen thought them living creatures possessed of souls, and the belief was thought warranted by the beautiful Song of the Three Children which the Anglican communion has so wisely retained in its liturgy. Other fathers of the Church thought the stars abiding-places of the angels, and that shooting-stars were moved by angelic hands. Philo Judæus believed the stars beneficent spirits, and this belief was widely held by Jews, Greeks, and Christians. Among the Mohammedans we have curious examples of the same tendency toward a kindly interpretation of stars and meteors, in the belief of certain Mohammedan teachers that meteoric showers are caused by good angels hurling missiles to drive evil angels out of the sky.#

As to eclipses, they were regarded in a very different light, and were supposed to express the distress of Nature at earthly calamities. The Greeks believed that darkness overshadowed the earth at the

* As to traditions regarding stars at the births of Moses and Abraham, see Calmet's "Fragments," part viii; also, the Rev. Baring-Gould's "Legends of Old Testament Characters" (London, 1871), chap. xxiv; also, Farrar's "Life of Christ" (American edition), chap. iii.

† For the general subject, see Higgins's "Anacalypsis"; also, Hooykaas, Ort and Kuehnen (the Bible for learners), vol. iii.

‡ For similar appearances in Greece and Rome, see Bell's "Pantheon," article "Æsculapius"; also, Luc. i, 529; Suet. Cæs., 88; Seneca, "Nat. Quæst.," i, 1; Virgil's "Eclogues," 9, 47.

\# As to movement of stars by angels, see Leopardi, "Errori Popolari."

As to the feeling of the fathers, see Origen's "De Principiis," vol. i, p. 129; also Philo Judæus.

As to meteoric showers caused by struggles between good and bad angels, see Watson and Guillemin on Comets.

For Atreus, *et al.*, see Cox's "Tales of Ancient Greece," pp. 41, 61, 62; Higgins's "Anacalypsis," vol. i, p. 322; Bell's "Pantheon," article "Atreus."

For the legend regarding darkness at the death of Romulus, see Higgins, vol. i, pp. 616, 617.

For legends regarding portents at the birth, death, and downfall of the Cæsars, see Suetonius, Vit. xii Cæs., cap. xxxvi; also, Josephus, book xiv, chap. xii, and note.

Also, for these and similar cases, see Virgil, Ovid, Pliny, and other Roman historians and poets; also, Higgins, as above; Gibbon's "Rome," vol. i, pp. 159, 590; Farrar's "Life of Christ," p. 52.

On Nero, see Tacitus's "Annals," book xiv, chap. xxii.

For portents at the death of Charles I, see sermon preached before Charles II, cited in Lecky's "History of England in the Eighteenth Century," vol. i, p. 65.

For the belief in general, see Leopardi, "Errori Popolari," cap. xi.

For eclipses, Phra Rahu, *et al.*, see Alabaster, "Wheel of the Law," p. 11.

deaths of Prometheus, Atreus, Hercules, Æsculapius, and Alexander the Great. The Roman legends held that, at the death of Romulus, there was darkness for six hours. The lives of the Cæsars give portents of all three kinds; for, at the death of Julius, the earth was shrouded in darkness, the birth of Augustus was heralded by a star, and the downfall of Nero by a comet. Nor has this mode of thinking ceased in modern times. A similar claim was made at the execution of Charles I, and Increase Mather thought an eclipse in Massachusetts an evidence of the grief of Nature at the death of President Chauncey, of Harvard College.* Traces of this feeling have come down to our own times. The beautiful story of the sturdy Connecticut statesman who, when his associates in the General Assembly were alarmed by a general eclipse, and thought it the beginning of the day of judgment, ordered in candles, purposing in any case to be found doing his duty, marks probably the last noteworthy effect of the old belief in the civilized world.

In these beliefs regarding meteors and eclipses there was little calculated to do harm by arousing that superstitious terror which is the worst breeding-bed of cruelty. Far otherwise was it with the beliefs regarding comets. During many centuries they brought terrors which developed the direst superstition and fanaticism; the ancient records of every continent are full of these. One great man, indeed, in the Roman Empire had the scientific instinct and prophetic inspiration to foresee that at some future time the course of comets would be found in accordance with natural law.† But this thought of Seneca was soon forgotten; such an isolated utterance could not stand against the mass of superstition which upheld the doctrine that comets are "signs and wonders." The belief that every comet is a ball of fire, flung from the right hand of an angry God to warn the groveling dwellers of earth, was received into the early Church, transmitted through the middle ages to the Reformation period,‡ and in its transmission and reception was made all the more precious by supposed textual proofs from Scripture. The great fathers of the Church committed themselves unreservedly to this doctrine. Tertullian # declared that "comets portend revolutions of kingdoms, pestilence, war, winds, or heat." Origen ‖ insisted that they indicate "catastrophes and the downfall of empires and worlds." The Venerable Bede,^ so justly dear to the English Church, made in the ninth

* He thought, too, that it might have something to do with the deaths of sundry civil functionaries of the colony. See his discourse concerning comets, 1682.

† See Watson "On Comets," p. 46, with Glaisher's translation of Seneca's prediction.

‡ For this feeling in antiquity see Guillemin, "The World of Comets," translated by Glaisher, chaps. i and ii; also Watson "On Comets," preliminary chapters.

For Tertullian, see "Ad Scapul," 3.

‖ For Origen, see "De Principiis," i, 754; also Maury, "Legendes pieuses du Moyen Age," p. 203, and note.

^ For Bede, see his "De Natura Rerum," chap. xxiv.

century a similar declaration. St. Thomas Aquinas,* the great light of the universal Church in the thirteenth century, whose works the Pope now reigning commends as the center of all university instruction, accepted and handed down the same opinion. The sainted Albert the Great,† the most noted genius of the mediæval Church in natural science, received and developed this theory.

By these men a science was developed out of scriptural texts and the principles of morals, and so firmly rooted in Scripture and theology that it flourished for seventeen centuries.

The main evils thence arising were two: First, the paralysis of self-help, and the arousing of fanaticism; and, secondly, the strengthening of ecclesiastical and political tyranny.

As to the first of these evils—the paralysis of self-help—instead of wise statesmanship striving to avert war, instead of scientific observation and reason striving to avert pestilence, instead of social science taking proper measures against famine, we constantly see, at the appearance of a comet, all Christendom, from pope to peasant, whining before various fetiches, trying to bribe them to remove these signs of God's wrath, and planning to wreak this supposed wrath of God upon misbelievers.

As to the second of these evils—the strengthening of ecclesiastical and civil despotism—examples appear on every side. It was natural that hierarchs and monarchs whose births were announced by stars, or whose deaths were announced by comets, should regard themselves as far above the common herd, and be so regarded by mankind; that passive obedience should thus be strengthened, and that the most monstrous assumptions of authority by such men should be considered simply as manifestations of the divine will. Shakespeare makes Calphurnia say to Cæsar:

> "When beggars die, there are no comets seen;
> The heavens themselves blaze forth the death of princes." ‡

Galeazzo, tyrant of Milan, expressing satisfaction on his death-bed that his approaching end was of such importance as to be heralded by a comet, is a type of many thus encouraged to prey upon mankind.#

But, for the retention of this belief, there was a moral cause. No doubt myriads of good men in the Christian Church, down to a recent period, saw in the appearance of comets not merely an exhibition of "signs in the heavens" foretold in Scripture, but also divine warnings to repentance and improvement of life of vast value to humanity—warnings, indeed, so precious that they could not be dispensed with

* For St. Thomas Aquinas, see Maury, "La Magie et l'Astronomie," p. 181.

† For Albert the Great, see "Alb. Mag.," lib. i, tract. iii, chaps. x and xi; also ibid., "Super sex principiis Gilberti Porretani"; also "Tractatus primus de causis impressionum," etc. The copy I have used is in the Cornell University Library.

‡ "Julius Cæsar," act ii, scene ii.

For Galeazzo, see Guillemin "On Comets."

without danger to the moral government of the world. Reasons, then, partly scriptural, partly theological, led men to cherish the belief in the portentous character of comets as absolutely essential, religiously and morally. To say nothing of the many examples in the earlier mediæval period, comets in the tenth century strengthened the belief in the approaching end of the world, and increased the distress and terror of all Europe. The charters of that age constantly refer to this. In the middle of the eleventh century a comet was thought to accompany the death of Edward the Confessor, and to presage the Norman Conquest; the traveler in France to-day may see this belief as it was then wrought in the Bayeux tapestry.*

Nearly every decade of years saw Europe plunged into alarm by appearances of this sort; but the culmination was reached in 1456. At that time, the Turks, after ages of effort, had made good their footing in Europe. A large statesmanship or generalship might have kept them out; but, while different religious factions were disputing over petty shades of dogma, the Turks had advanced, had taken Constantinople, and were pressing on to secure their foothold in Europe. Now came the full bloom of this superstition. A comet appeared. The Pope of that period, Calixtus III, was a man of more than ordinary ability, but saturated with the ideas of his time. By virtue of his position as the infallible head of Christendom, he publicly and solemnly anathematized both the Turks and the comet, bidding all the faithful beseech the Almighty to turn the monster in the heavens away from the Christians and against the Turks. In the litany was incorporated the prayer, "From the Turk and the comet, good Lord deliver us." Thence, it is generally supposed, dates the midday *Angelus*, the bell calling the faithful to prayer against the powers of evil.

Never was the object of a papal fulmination more unfortunately chosen; for the Turk has held Constantinople from that day to this, and the comet, being that now known under the name of Halley, so far from heeding the infallible anathema, has returned imperturbably at short periods ever since.†

* For effects of comets in the eleventh and following centuries, see "Chronicles" of Raoul Glaber, William of Nangis, and others *passim*.

For the Bayeux tapestry, see Bruce, "Bayeux Tapestry elucidated" (London, 1856), Plate VII, and text, p. 86; also Guillemin, p. 24; also Champion, p. 89. This tapestry, wrought by the wife of William the Conqueror and her ladies, is now preserved in the town museum of Bayeux.

† The usual statement is that Calixtus excommunicated the comet by a papal bull. A statement to this effect is made by such authorities as Arago, Guillemin, Watson, and many others; and this suggested the shrewd parallel made on a noted occasion by President Lincoln. An examination of various *Bullaria* has as yet failed to discover any formal bull; and, though this by no means proves that such a bull was not issued, it is most likely that the utterance of the Pope was in the nature of a general anathema, an appeal to Christian peoples against the comet, as stated in the "Historia B. Platinæ de vitis Pontificum, Coloniæ, MDC.," p. 317, for which I am indebted to Dr. Gilette, Librarian of the Union Theological Seminary, New York.

But this superstition went still further. It became more and more incorporated into what was considered "scriptural science" and "sound learning." The encyclopedic statements exhibiting the science of the middle ages and the Reformation period furnish abundant proofs of this.*

Yet scientific truth was slowly undermining the structure: the inspired prophecy of Seneca had not been forgotten: even as far back as the ninth century, in the midst of the "sacred learning" so abundant at the court of Charlemagne and his successors, we find a scholar protesting against the doctrine.†

So, too, in the sixteenth century we have Paracelsus writing to Zwingle against it; and, in the century following, men like De Gamon and Pierre Petit taking similar ground.‡

At first this skepticism only aroused the horror of theologians and increased the vigor of ecclesiastics; both asserted all the more strenuously what they conceived to be scriptural truth. During the sixteenth century France felt the influence of one of her greatest men on the side of this superstition. Jean Bodin, so far before his time in political theories, was as far behind it in religious theories: the same reverence for the mere letter of Scripture which made him so fatally powerful in supporting the witchcraft delusion led him to support this theological theory of comets; but with a difference—he thought them the souls of men wandering in space, bringing famine, pestilence, and war.#

In England, too, during the sixteenth and seventeenth centuries, there was at least literary acquiescence in this received doctrine of comets. Both Shakespeare and Milton recognize it, whether they fully accept it or not. Shakespeare makes the Duke of Bedford, lamenting at the bier of Henry V, say:

> "Comets, importing change of times and states,
> Brandish your crystal tresses in the sky;
> And with them scourge the bad revolting stars,
> That have consented unto Henry's death."

Milton, speaking of Satan preparing for combat, says:

> ". . . On the other side,
> "Incensed with indignation, Satan stood
> Unterrified, and like a comet burned,
> That fires the length of Ophiuchus huge
> In the Arctic sky, and from its horrid hair
> Shakes pestilence and war."

* See Vincent de Beauvais, and the various editions of Reisch's "Margarita Philosophica."

† See Champion, p. 156; also Leopardi, "Errori Popolari," p. 165.

‡ For these exhibitions of skepticism, see Champion, pp. 155, 156.

See Champion, p. 89; also a vague citation in Baudrillart, "Vie de Bodin," p. 360.

Even as late as the end of the seventeenth century (1688) we have English authors of much power battling for this supposed scriptural view.

But it was in Germany that this superstition took its strongest hold. The same depth of feeling which produced in that country the most terrible growth of the witchcraft persecution brought superstition to its highest development regarding comets. In one of his Advent sermons, Luther had declared strongly in favor of it. A little later Arietus declared, "The heavens are not merely given us for our pleasure, but also as a warning for the correction of our lives, and of the wrath of God." * Lavather showed that comets are signs of death or calamity, and cited proofs from Scripture. Catholic and Protestant strove together for the glory of asserting the doctrine, and in the same seventeenth century Fromundus, the eminent Professor and Doctor of Theology at the University of Louvain, who so strongly opposed the rotundity of the earth, supported no less vigorously the prophetic character of comets. So, too, as late as 1680, we have Voigt declaring that the comet of that year clearly presages the downfall of the Turkish Empire, and stigmatizing as "atheists and epicureans" all who do not believe comets to be God's warnings.†

But the great efforts in behalf of this doctrine throughout Europe were made in the pulpits, and especially in the Protestant pulpits. Out of the mass of such sermons which were widely circulated, I will select just one as typical, and it is worthy of careful study, as showing the dangers of applying theological methods to scientific fact. Conrad Dieterich was during the first half of the seventeenth century a Lutheran ecclesiastic of the highest authority. His ability as a theologian had made him Archdeacon of Marburg, Professor of Philosophy and director of studies at the University of Giessen, and finally "Superintendent," exercising functions of an episcopal character in the Lutheran regions of Southwestern Germany. In the year 1620, on the second Sunday in Advent, in the great Cathedral of Ulm, he developed the orthodox doctrine of comets in a sermon, taking up the questions: 1. What are comets? 2. What do they indicate? 3. What have we to do with their significance? This sermon marks an epoch. Delivered in that center of Protestant Germany, and by a prelate of the highest standing, it was immediately printed, prefaced by three laudatory poems from different men of note, and sent forth to drive back the scientific, or, as it was supposed, the "godless," view of comets. The preface shows that Dieterich was sincerely alarmed by the tendency to regard comets as natural appearances. His text was taken from the twenty-fifth verse of the twenty-first chapter of St. Luke: "And there shall be signs in the sun, and in the moon, and in

* See Mädler, "Geschichte der Astronomie," vol. ii.

† For Fromundus and Voigt, see Mädler, p. 399; also Lecky, "Rationalism in Europe," vol. i, p. 28.

the stars; and upon the earth distress of nations, with perplexity; the sea and the waves roaring." As to what comets are, he cites a multitude of ancient philosophers, and, finding that they differ among themselves, he uses a form of argument very common from that day to this, declaring that this difference of opinion proves that there is no solution of the problem save in revelation, and insisting that they are "signs especially sent by the Almighty to warn the earth." An additional proof of this he finds in the forms of comets. One, he says, took the form of a trumpet; another, of a spear; another, of a goat; another, of a torch; another, of a sword; another, of an arrow; another, of a saber; still another, of a bare arm; and so on. From these forms of comets he infers that we may divine their purpose. As to their creation, he quotes John of Damascus and other great church authorities in behalf of the idea that each comet is a star newly created at the divine command out of nothing, and that it indicates the wrath and punishment of God. As to their purpose, having quoted largely from the Bible and from Luther, he winds up by insisting that, as God can make nothing in vain, comets must have some distinct object: then from Isaiah and Joel among the prophets, from Matthew, Mark, and Luke among the Evangelists, from Origen and St. John Chrysostom among the fathers, from Luther and Melanchthon among the Reformers, he draws various texts more or less conclusive to prove that comets indicate evil and only evil, and he cites Luther's Advent sermon, to the effect that, though comets may arise in the course of nature, they are still signs of evil to mankind.

In answer to the theory of certain naturalists, that comets are made up of "a certain fiery, warm, sulphurous, saltpetery, sticky fog," he declares, "Our sins, our sins! they are the fiery heated vapors, the thick, sticky, sulphurous clouds which rise from the earth toward heaven before God."

Throughout the sermon contempt was poured over all men who simply investigated comets as natural objects, and special attention was called to the fact that a comet then in the heavens resembled a long broom or bundle of rods; and Dieterich declared that he and his hearers would only consider it rightly "when we see standing before us our Lord God in heaven as an angry father with a rod for his children."

In answer to the question, what comets signify, he commits himself entirely to the idea that they indicate the wrath of God, and therefore calamities of every sort. Page after page is filled with the record of evils following comets. Beginning with the creation of the world, he insists that the first comet brought on the deluge of Noah. He cites a mass of authorities ranging from Moses and Isaiah to Albert the Great and Melanchthon, in support of the view that comets precede earthquakes, famines, wars, pestilences, and every form of evil. Page after page is filled with this sort of historical proof. He makes some parade of astronomical knowledge as to the greatness of the sun and moon, but relapses soon into his old line of argument. Conjuring his audience not to be led away from the well-established belief of Christendom and the principles of their fathers, he comes back to his old figure of speech, insists that "our sins are the inflammable material of which comets are made," and winds up with a most earnest appeal to the Almighty to spare his people.*

It can be easily understood that such an authoritative utterance as this must have produced a great effect throughout Protestant Christendom, and in due time we see its working in New England. That same tendency to provincialism which, save at rare intervals, has been the bane of Massachusetts thought from that day to this, appeared; and in 1664 we have Samuel Danforth arguing from the Bible that comets are "portentous signals of great and notable changes," and arguing from history that they "have been many times heralds of wrath to a secure and impenitent world." He cites especially the comet of 1652, which appeared just before Mr. Cotton's sickness, and disappeared after his death.† Morton also, in his memorial, recording the death of John Putnam, alludes to the comet of 1652 as "a very signal testimony that God had then removed a bright star and a shining light out of the heaven of his church here into celestial glory above."‡ Again he speaks of another comet, insisting that "it was no fiery meteor caused by exhalation, but it was sent immediately by God to awaken the secure world," and goes on to show how in that year "it pleased God to smite the fruits of the earth, namely, the wheat in special, with blasting and mildew, whereby much of it was spoiled and became profitable for nothing, and much of it worth little, being light and empty. This was looked upon by the judicious and conscientious of the land as a speaking providence against the unthankfulness of many . . . as also against voluptuousness and abuse of the good creatures of God by licentiousness in drinking and fashions in apparel, for the obtaining whereof a great part of the principal grain was oftentimes unnecessarily expended." #

But in 1680 a stronger man than either of these seized upon the doctrine and wielded it with power. Increase Mather, so open always to ideas from Europe, and always so powerful for good or evil in the

* See "Ulmische Cometen Predigt, von dem Cometen, so nechst abgewischenen 1618 Jahrs im Wintermonat erstenmahls in Schwabensen lassen, Dannach folgende Gehalten zu Ulm," etc. Durch Conrad Dieterich, Ulm, 1620.

For a life of the author of the book, see article, "Dieterich," in the "Allgemeine Deutsche Biographie."

† See S. Danforth (1664), "An Astronomical Description of the late Comet or Blazing Star, together with a Brief Theological Application thereof." (Collections in the Massachusetts Historical Society Library.)

‡ See Morton's "Memorial," pp. 251, 252.

Ibid., pp. 309, 310.

colonies, preached his sermon on "Heaven's Alarm to the World, . . . wherein is shown that fearful sights and signs in the heavens are the presages of great calamities at hand." The texts were taken from the book of Revelation: "And the third angel sounded, and there fell a great star from heaven, burning as it were a lamp"; also, "Behold, the third woe cometh quickly." *

In this as in various other sermons he supported the theological cometary theory, fully. He insists that "we are fallen into the dregs of time," and that the day of judgment is evidently approaching. He explains away the words of Jeremiah, "Be not dismayed at signs in the heavens," and shows that comets have been forerunners of nearly every form of evil. Having done full justice to evils thus presaged in scriptural times, he begins a similar display in modern history by citing blazing stars which foretold the invasions of Goths, Huns, Saracens, and Turks, and warns gainsayers by citing the example of Vespasian, who, after ridiculing a comet, soon died. The general shape and appearance of comets, he thinks, betoken their purpose, and cites Tertullian to prove them "God's sharp razors on mankind whereby he doth poll, and his scythe whereby he doth shear down multitudes of sinful creatures." At last, rising to a fearful height, he declares: "For the Lord hath fired his beacon in the heavens among the stars of God there; the fearful sight is not yet out of sight. The warning piece of heaven is going off. Now then if the Lord discharge his murdering pieces from on high, and men be found in their sins unfit for death, their blood shall be upon them." And again, in an agony of supplication, he cries out: "Do we see the sword blazing over us? Let it put us upon crying to God, that that judgment be diverted and not return upon us again so speedily. . . . Doth God threaten our very heavens? O pray unto Him, that He would not take away stars and send comets to succeed them." †

But even in the midst of all his arguments appears an evident misgiving. The thoughts of Newton in science and Bayle in philosophy were evidently tending to accomplish the prophecy of Seneca. Mather's alarm at this is clear. His natural tendency is to uphold the idea that a comet is simply a fire-ball flung from the hand of an avenging God at a guilty world, but he evidently feels obliged to yield something to the scientific spirit; hence, in the discourse concerning comets, published in 1682, he declares: "There are those who think that, inasmuch as comets may be supposed to proceed from natural causes, there is no speaking voice of heaven in them beyond what is to be said of all other works of God. But certain it is that many things which may happen according to the course of nature are portentous signs of divine anger and prognostics of great evils hastening upon the world."

* Rev. viii, 10, and xi, 14.

† See "Heaven's Alarm to the World," Boston, 1682. (In President Sparks's collection, Cornell University Library.)

He then notices the eclipse of August, 1672, and adds: "That year the college was eclipsed by the death of the learned president there, worthy Mr. Chauncey; and two colonies, namely, Massachusetts and Plymouth, by the death of two governors, who died within a twelvemonth after. . . . Shall, then, such mighty works of God as comets are be insignificant things?"

Vigorous as his argument is, we see skepticism regarding "signs" continuing to invade the public mind; and, in spite of his threatenings, about twenty years after, we find a remarkable evidence of this progress in the fact that this skepticism has seized upon no less a personage than that colossus of orthodoxy, his thrice illustrious son, Cotton Mather himself; and him we find, in 1726, despite the arguments of his father, declaring in his "Manuductio": "Perhaps there may be some need for me to caution you against being dismayed at the signs of the heavens, or having any superstitious fancies upon eclipses and the like. . . . I am willing that you be apprehensive of nothing portentous in blazing stars. For my part, I know not whether all our worlds, and even the sun itself, may not fare the better for them."*

Curiously enough, for this scientific skepticism in Cotton Mather, there was a cause identical with that which had developed superstition in the mind of his father. The same provincial tendency to receive implicitly any new idea from abroad wrought upon both, plunging one into superstition and drawing the other out of it. First among the more important reasonings against the prevailing superstition were those of Gassendi. Early in the seventeenth century, by strictly scientific process, he arrived at the conclusion that comets are outside the earth's atmosphere, and then made a strong argument from common sense that there is nothing to prove them hostile to the happiness of mankind.†

But, toward the end of the same century, the subject was taken up by Pierre Bayle. He attacked the old theory from the side of philosophy. While professor at the University of Sedan he had observed the alarm caused by the comet of 1680, and he now brought all his reasoning powers to bear upon it. Thoughts deep and witty he poured out in volume after volume; Catholics and Protestants were alike scandalized: Catholic France spurned him, and Jurieu, the great reformed divine, tried hard to have Protestant Holland do likewise. Though Bayle did not touch immediately the mass of mankind, he wrought with power upon men who gave themselves the trouble of thinking. It was indeed unfortunate for the Church that theologians, instead of taking the initiative in this matter, left it to Bayle; for, in tearing down the pretended scriptural doctrine of comets, he tore down much else: of all men in his time, no one so thoroughly prepared the way for Voltaire.

* See "Manuductio," pp. 54, 55.

† For Gassendi, see Mädler, ii, 397, and Champion, 93–95.

The whole argument of Bayle is rooted in the prophecy of Seneca. He declares, "Comets are bodies subject to the ordinary law of nature, and not prodigies amenable to no law." He shows historically that there is no reason to regard comets as portents of earthly evils. As to the fact that such evils occur after the passage of comets across the sky, he compares the person believing that comets cause these evils to a woman looking out of a window into a Paris street, and believing that the carriages pass because she looks out. As to the accomplishment of some predictions, he cites the shrewd saying of Henry IV, to the effect that "the public will remember one prediction that comes true better than all the rest that have proved false"; finally, he sums up by saying: "The more we study man, the more does it appear that pride is his ruling passion, and that he affects grandeur even in his misery. Mean and perishable creature that he is, he has been able to persuade men that he can not die without disturbing the whole of nature and obliging the heavens to put themselves to fresh expense in order to light his funeral pomp. Foolish and ridiculous vanity! If we had a just idea of the universe, we should soon comprehend that the death or birth of a prince is too insignificant a matter to stir the heavens." *

This great philosophic champion of right reason was followed by a literary champion hardly less famous; for Fontenelle now gave to the French theatre his play of "The Comet," and a point of capital importance in France was made by rendering the army of ignorance ridiculous.†

But the heart of the position held by the so-called "religious" party was not really touched until about the beginning of the eighteenth century. Then it was that the announcement of Doerfel as to the parabolic paths of certain comets, and the publication of Halley's "Synopsis" and "Tables" foreshadowed a final victory, and the complete accomplishment of the prophecy of Seneca. This victory was fully gained when Halley, observing the times of the comet which now bears his name, made his calculations, predicted the period of its return, and the prediction was fulfilled.

Still more evident was this victory when Clairaut, in France, foretold the exact time when the coming comet would reach its perihelion, and his prediction also proved true. Then it was that a Roman heathen philosopher was proved more infallible and more directly under divine inspiration than a Roman Christian pontiff; for the very comet which the traveler finds to-day depicted on the Bayeux tapestry as portending destruction to Harold and the Saxons at the Norman inva-

* For special points of interest in Bayle's argument, see Bayle, "Pensées Diverses," Amsterdam, 1749, pp. 79, 102, 134, 206.

For the response to Jurieu, see "Continuation des Pensées Diverses," Rotterdam, 1705; also Champion, p. 164; also Lecky, as above; also Guillemin, pp. 29, 30.

† See Fontenelle, cited in Champion, p. 167.

sion of England, and which was anathematized by Pope Calixtus as portending evil to Christendom four centuries later, was found to be, as Seneca had prophesied, a heavenly body obeying the great laws of the universe, and coming at regular periods. Thenceforth the whole ponderous enginery of superstition, with its citations of proof-texts regarding "signs in the heavens," its theological reasoning to show the moral necessity of cometary warnings, and its ecclesiastical fulminations against the "atheism, godlessness, and infidelity" of scientific investigation, was seen by all thinking men to be as weak against the scientific method as Indian arrows against needle-guns. Copernicus, Galileo, Newton, Cassini, Doerfel, Halley, and Clairaut had gained the victory.*

And still even good men looked longingly back to the old belief. It was so hard for them to give up the doctrine of "signs in the heavens," seemingly based upon Scripture, and exercising such a healthful moral tendency! As is always the case under such circumstances, votaries of "sacred science" appeared, and these exerted the greatest ingenuity in averting the new doctrine; but their voices gradually died into silence, though far within our own century Joseph de Maistre echoed them in declaring his belief that comets are special warnings of evil.

There did, indeed, still linger one little cloud-patch of superstition, arising from the supposed fact that comets had really been followed by a marked rise in temperature. Even this poor basis for the belief that comets might, after all, affect earthly affairs was swept away. Science won here another victory, for Arago, by thermometric records carefully kept at Paris from 1735 to 1781, proved that comets had produced no effect upon temperature. Among multitudes of similar examples he showed that, in some years when several comets appeared, the temperature was lower than in other years when few or none appeared. In 1737 there were two comets, and the weather was cool; in 1765 there was no comet, and the weather was hot; through the whole fifty years it was shown that comets were sometimes followed by hot weather, sometimes by cool, and that no rule was deducible. The victory of science was complete at every point.†

But in this whole history there was one little exhibition so curious as to be worthy of notice, though its permanent effect upon thought was small. Whiston and Burnet, so devoted to what they considered sacred science, had determined that in some way comets must be instruments of divine wrath. One of them maintained that the deluge was caused by the tail of a comet striking the earth; the other

* See Mädler, as above; also, Guillemin, Watson, and Grant's "History of Astronomy"; also, Delambre, Proctor, article "Astronomy" in "Encyclopædia Britannica," and others.

† For the writings of several on both sides, and especially those who sought to save, as far as possible, the sacred theory of comets, see Mädler, ii, p. 384, *et seq.*

put forth the theory that comets are places of punishment for the damned—in fact, "flying hells." Both these theories were soon discredited.

Perhaps this theory can best be met by another which, if not fully established, appears much the better based of the two; namely, that in 1868 the earth passed directly through the tail of a comet, with no deluge, no sound of any wailings of the damned, with slight appearances here and there, only to be detected by the keen sight of the meteorological or astronomical observer.* In our own country superstitious ideas regarding comets continued to have some little currency; † but their life was short. The tendency shown by Cotton Mather, at the beginning of the eighteenth century, toward acknowledging the victory of science was completed by the utterances of Winthrop, professor at Harvard. In 1759 he published two lectures on comets, and in these he simply and clearly revealed the truth, never scoffing, but reasoning quietly and reverently. In one passage he says, "To be thrown into a panic whenever a comet appears, on account of the ill effects which some few of them might possibly produce, if they were not under proper direction, betrays a weakness unbecoming a reasonable being." ‡

The victory was, indeed, complete. Happily, none of the fears expressed by Conrad Dieterich or Increase Mather were realized. No catastrophe has ensued either to religion or morals. In the realm of religion, the Psalms of David remain no less beautiful, the great utterances of the Hebrew prophets no less powerful; the Sermon on the Mount, "the first commandment and the second which is like unto it," the definition of "pure religion and undefiled," by St. James, appeal no less to the deepest things in the human heart. In the realm of morals, too, serviceable as the idea of fire-brands thrown by the right hand of an avenging God to scare a naughty world might seem, any competent historian must find that the destruction of the old theological cometary theory was followed by moral improvement rather than by deterioration. We have but to compare the general moral tone of society to-day, wretchedly imperfect as it is, with that existing in the time when this superstition had its strongest hold, to make ourselves sure of this. We have only to compare the court of Henry VIII with the court of Victoria, the reign of the late Valois and earlier Bourbon princes with the present French Republic, the period of the Medici and Sforzas and Borgias with the period of Leo XIII and Humbert, the monstrous wickedness of the Thirty Years' War with the ennobling patriotism of the Franco-Prussian struggle, and the

* See Guillemin and Watson.

† See sermon of Israel Loring, of Sudbury, published in 1722 (Professor M. C. Tyler's manuscript notes).

‡ See Professor J. Winthrop on comets (Professor Tyler's manuscript notes, pp. 15 and 16).

despotism of the miserable German princelings of the sixteenth and seventeenth centuries with the reign of the Emperor William.

The gain is not simply that mankind has arrived at a clearer conception of law in the universe; not merely that thinking men see more clearly that we are part of a system not requiring constant patching and arbitrary interference; but perhaps best of all is the fact that science has cleared away one more series of dogmas which tend to debase rather than to develop man's whole moral and religious nature. In this emancipation from terror and fanaticism, as in so many other results of scientific thinking, we have a proof of the inspiration of those great words, "THE TRUTH SHALL MAKE YOU FREE."

THE WHITE ANT: A THEORY.

BY PROFESSOR HENRY DRUMMOND, F. R. S. E., F. G. S.,
AUTHOR OF "NATURAL LAW IN THE SPIRITUAL WORLD," ETC.

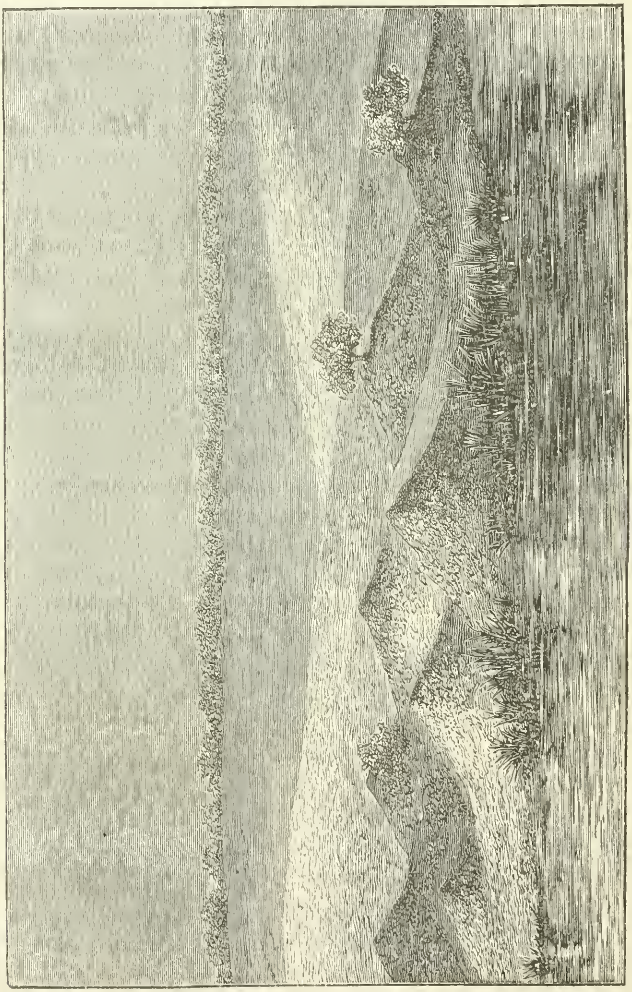
A FEW years ago, under the distinguished patronage of Mr. Darwin, the animal in vogue with scientific society was the worm. At present the fashionable animal is the ant. I am sorry, therefore, to have to begin by confessing that the insect whose praises I propose to sing, although bearing the honored name, is not entitled to consideration on account of its fashionable connections, since the white ant, as an ant, is an impostor. It is, in fact, not an ant at all, but belongs to a much humbler family—that of the *Termitidæ*—and, so far from ever having been the vogue, this clever but artful creature is hated and despised by all civilized peoples. Nevertheless, if I mistake not, there is neither among the true ants, nor among the worms, an insect which plays a more wonderful or important part in nature.

Fully to appreciate the beauty of this function, a glance at an apparently distant aspect of nature will be necessary as a preliminary.

When we watch the farmer at work, and think how he has to plow, harrow, manure, and humor the soil before even one good crop can be coaxed out of it, we are apt to wonder how Nature manages to secure her crops and yet dispense with all these accessories. The world is one vast garden, bringing forth crops of the most luxuriant and varied kind century after century, and millennium after millennium. Yet the face of Nature is nowhere furrowed by the plow, no harrow disintegrates the clods, no lime and phosphates are strewed upon its fields, no visible tillage of the soil improves the work on the great world's farm.

Now, in reality there can not be crops, or successions of crops, without the most thorough agriculture; and when we look more closely into nature we discover a system of husbandry of the most surprising kind. Nature does all things unobtrusively ; and it is only now that we are beginning to see the magnitude of these secret agricultural operations by which she does already all that man would wish to imitate, and to which his most scientific methods are but clumsy approximations.

In this great system of natural husbandry Nature uses agencies, implements, and tools of many kinds. There is the disintegrating



"THE MOUNDS OF THE WHITE ANT."

frost, that great natural harrow, which bursts asunder the clods by the expansion during freezing of the moisture imprisoned in their pores. There is the communistic wind which scatters broadcast over the fields the finer soil in clouds of summer dust. There is the rain which washes the humus into the hollows, and scrapes bare the rocks for further denudation. There is the air which, with its carbonic acid and oxygen, dissolves and decomposes the stubborn hills, and manufactures out of them the softest soils of the valley. And there are the humic acids, generated through decay, which filter through the ground and manure and enrich the new-made soils.

But this is not all, nor is this enough; to prepare a surface film, however rich, and to manure the soil beneath, will secure one crop, but not a succession of crops. There must be a mixture and transference of these layers, and a continued mixture and transference kept up from age to age. The lower layer of soil, exhausted with bringing forth, must be transferred to the top for change of air, and there it must lie for a long time, increasing its substance, and recruiting its strength among the invigorating elements. The upper film, restored, disintegrated, saturated with fertility and strength, must next be slowly lowered down again to where the rootlets are lying in wait for it, deep in the under soil.

Now, how is this last change brought about? Man turns up the crust with the plow, throwing up the exhausted earth, down the refreshed soil, with infinite toil and patience. And Nature does it by natural plowmen who, with equal industry, are busy all over the world reversing the earth's crust, turning it over and over from year to year, only much more slowly and much more thoroughly spadeful by spadeful, foot by foot, and even grain by grain. Before Adam delved the garden of Eden these natural agriculturists were at work, millions and millions of them in every part of the globe, at different seasons and in different ways, tilling the world's fields.

"STANDING OUT AGAINST THE SKY LIKE OBELISKS."

According to Mr. Darwin, the animal which performs this most important function in nature is the earth-worm. The marvelous series of observations by which the great naturalist substantiated his conclusion are too well known for repetition. Mr. Darwin calculates that on every acre of land in England more than ten tons of dry earth are passed through the bodies of worms and brought to the surface every year: and he assures us that the whole soil of the country must pass and repass through their bodies every few years. Some of this earth is brought up from a considerable depth beneath the soil, for in order to make its subterranean burrow the animal is compelled to swallow a certain quantity of earth. It eats its way, in fact, to the surface, and there voids the material in a little heap. Although the proper diet of worms is decaying vegetable matter, dragged down from the surface in the form of leaves and tissues of plants, there are many occasions on which this source of aliment fails, and the animal has then to nourish itself by swallowing quantities of earth, for the sake of the organic substances it contains. In this way the worm has a twofold inducement to throw up earth: First, to dispose of the material excavated from its burrow; and, second, to obtain adequate nourishment in times of famine. "When we behold a wide, turf-covered expanse," says Mr. Darwin, "we should remember that its smoothness, on which so much of its beauty depends, is mainly due to all the inequalities having been slowly leveled by worms. It is a marvelous reflection that the whole of the superficial mold over any such expanse has passed, and will again pass, every few years, through the bodies of worms. The plow is one of the most ancient and most valuable of man's inventions; but long before he existed the land was, in fact, regularly plowed by earth-worms. It may be doubted whether there are many other animals which have played so important a part in the history of the world as have these lowly organized creatures." *

Now, without denying the very important contribution of the earth-worm in this respect, a truth sufficiently indorsed by the fact

"SINGLY OR IN CLUSTERS."

that the most circumstantial of naturalists has devoted a whole book to this one animal, I would humbly bring forward another claimant to the honor of being, along with the worm, the agriculturist of na-

* "Vegetable Mold and Earth-worms," p. 313.

ture. While admitting to the fullest extent the influence of worms in countries which enjoy a temperate and humid climate, it can scarcely be allowed that the same influence is exerted, or can possibly be exerted, in tropical lands. No man was less in danger of taking a provincial view of nature than Mr. Darwin, and in discussing the earthworm he has certainly collected evidence from different parts of the globe. He refers, although sparingly, and with less than his usual wealth of authorities, to worms being found in Iceland, in Madagascar, in the United States, Brazil, New South Wales, India, and Ceylon. But his facts, with regard especially to the influence on the large scale of the worm in warm countries, are few or wholly wanting. Africa, for instance, the most tropical country in the world, is not referred to at all; and, where the activities of worms in the tropics are described, the force of the fact is modified by the statement that these are only exerted during the limited number of weeks of the rainy season.

The fact is, for the greater portion of the year in the tropics the worm can not operate at all. The soil, baked into a brick by the burning sun, absolutely refuses a passage to this soft and delicate animal. All the members of the earth-worm tribe, it is true, are natural skewers, and, though boring is their supreme function, the substance of these skewers is not hardened iron, and the pavement of a tropical forest is quite as intractable for nine months in the year as are the frost-bound fields to the farmer's plowshare. During the brief period of the rainy season worms undoubtedly carry on their function in some of the moister tropical districts; and in the sub-tropical regions of South America and India worms, small and large, appear with the rains in endless numbers. But on the whole the tropics proper seem to be poorly supplied with worms. In Central Africa, though I looked for them often, I never saw a single worm. Even when the rainy season set in, the closest search failed to reveal any trace either of them or of their casts. Nevertheless, so wide is the distribution of this animal that in the moister regions even of the equatorial belt one should certainly expect to find it. But the general fact remains. Whether we consider the comparative poorness of their development, or the limited period during which they can operate, the sustained performance of the agricultural function by worms, over large areas in tropical countries, is impossible.

Now, as this agricultural function can never be dispensed with, it is more than probable that Nature will have there commissioned some other animal to undertake the task. And there are several other animals to whom this difficult and laborious duty might be intrusted. There is the mole, for instance, with its wonderful spade-like feet, that natural navvy who shovels the soil about so vigorously at home; but against the burned crust of the tropics even this most determined of burrowers would surely turn the edge of his nails. The same remark applies to those curious little geologists, the marmots and chipmunks, which one sees throwing up their tiny heaps of sand and gravel on the American prairies. And, though the torrid zone boasts of a strong-limbed and almost steel-shod creature, the ant-bear, his ravages are limited to the destruction of the nests of ants ; and, however much this somewhat scarce animal contributes to the result, we must look in another direction for the true tropical analogue of the worm.

The animal we are in search of, and which I venture to think equal to all the necessities of the case, is the termite or white ant. It is a small insect (Fig. 1), with a bloated yellowish-white body and a somewhat large thorax, oblong-shaped, and colored a disagreeable oily brown. The flabby, tallow-like body makes this insect sufficiently repulsive, but it is for quite another reason that the white ant is the worst abused of all living vermin in warm countries. The termite lives almost exclusively upon wood ; and, the moment a tree is cut or a log sawed for any economical purpose, this insect is upon its track. One may never see the insect, possibly, in the flesh, for it lives under-ground ; but its ravages confront one at every turn. You build your house, perhaps, and for a few months fancy you have pitched upon the one solitary site in the country where there are no white ants. But one day suddenly the door-post totters, and lintel and rafters come down together with a crash. You look at a section of the wrecked timbers and discover that the whole inside is eaten clean away. The apparently solid logs of which the rest of the house is built are now mere cylinders of bark, and through the thickest of them you could push your little finger. Furniture, tables, chairs, chests of drawers, everything made of wood is inevitably attacked, and in a single night a strong trunk is often riddled through and through, and turned into match-wood. There is no limit, in fact, to the depredation by these insects, and they will eat books, or leather, or cloth, or anything, and in many parts of Africa I believe if a man lay down to sleep with a wooden leg it would be a heap of sawdust in the morning. So much feared is this insect now, that no one in certain parts of India and Africa ever attempts to travel with such a thing as a wooden trunk. On the Tanganyika plateau I have camped on ground which was as hard as adamant, and as innocent of white ants apparently as the pavement of St. Paul's, and wakened next morning to find a stout wooden box almost gnawed to pieces. Leather portmanteaus share the same fate, and the only substances which seem to defy the marauders are iron and tin.

Fig. 1.—Worker White Ant (natural size and magnified).

But what has this to do with earth or with agriculture? The most important point in the work of the white ant remains to be noted. I have already said that the white ant is never seen. Why he should have such a repugnance to being looked at is at first sight a mystery, seeing that he himself is stone-blind. But his coyness is really due to the desire for self-protection, for the moment his juicy body shows itself above-ground there are a dozen enemies waiting to devour it. And yet the white ant can never procure any food until it comes above-ground. Nor will it meet the case for the insect to come to the surface under the shadow of night. Night in the tropics, so far as animal life is concerned, is as the day. It is the great feeding-time, the great fighting-time, the carnival of the carnivores, and of all beasts, birds, and insects of prey from the least to the greatest. It is clear, then, that darkness is no protection to the white ant; and yet without coming out of the ground it can not live. How does it solve the difficulty? It takes the ground out along with it. I have seen white ants working on the top of a high tree, and yet they were underground. They took up some of the ground with them to the tree-top; just as the Esquimaux heap up snow, building it into the low tunnel huts in which they live, so the white ants collect earth, only in this case not

"ALL SORTS OF FANTASTIC SHAPES."

from the surface but from some depth underneath the ground, and plaster it into tunneled ways. Occasionally these run along the ground, but more often mount in endless ramifications to the top of trees, meandering along every branch and twig, and here and there debouching into large covered chambers which occupy half the girth of the trunk. Millions of trees in some districts are thus fantastically plastered over with tubes, galleries, and chambers of earth, and many pounds weight of subsoil must be brought up for the mining of even a single tree. The building material is conveyed by the insects up a central pipe with which all the galleries communicate, and which at the downward end connects with a series of subterranean passages leading deep into the earth. The method of building the tunnels and covered ways is as follows: At the foot of a tree the tiniest hole cautiously opens in the ground close to the bark. A small head appears with a grain of earth clasped in its jaws. Against the tree trunk this earth-grain is deposited, and the head is withdrawn. Presently it reappears with another grain of earth, this is laid beside the first, rammed tight against it, and again the builder descends underground for more. The third grain is not placed against the tree, but against the former grain; a fourth, a fifth, and a sixth follow, and the plan of the foundation begins to suggest itself as soon as these are in position. The stones or grains, or pellets of earth, are arranged in a semicircular wall, the termite, now assisted by three or four others, standing in the middle between the sheltering wall and the tree and working briskly with head and mandible to strengthen the position. The wall in fact forms a small moon-rampart, and as it grows higher and higher it soon becomes evident that it is going to grow from a low battlement into a long perpendicular tunnel running up the side of the tree. The workers, safely ensconced inside, are now carrying up the structure with great rapidity, disappearing in turn as soon as they have laid their stone and rushing off to bring up another. The way in which the building is done is extremely curious, and one could watch the movements of these wonderful little masons by the hour. Each stone as it is brought to the top is first of all covered with mortar. Of course, without this the whole tunnel would crumble into dust before reaching the height of half an inch; but the termite pours over the stone a moist, sticky secretion, turning the grain round and round with its mandibles until the whole is covered with slime. Then it places the stone with great care upon the top of the wall, works it about vigorously for a moment or two till it is well jammed into its place, and then starts off instantly for another load.

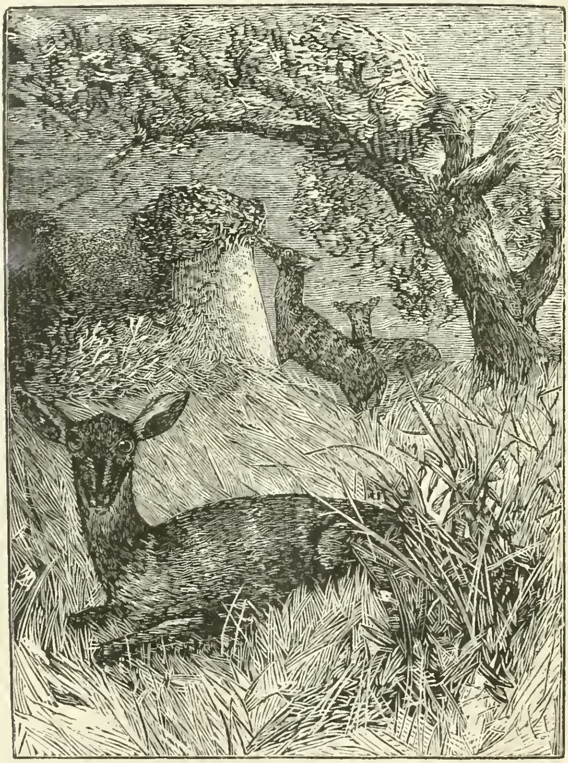
Peering over the growing wall one soon discovers one, two, or more termites of a somewhat larger build, considerably longer, and with a very different arrangement of the parts of the head and especially of the mandibles (Fig. 2). These important-looking individuals saunter about the rampart in the most leisurely way, but yet with a certain air of business as if perhaps the one was the master of the works and the other the architect, but close observation suggests that they are in no wise superintending operations, nor in any immediate way contributing to the structure, for they take not the slightest notice either of the workers or the works. They are posted there, in fact, as sentries, and there

Fig. 2.—Soldier White Ant.

they stand, or promenade about, at the mouth of every tunnel, like Sister Ann, to see if anybody is coming. Sometimes somebody does come in the shape of another ant—the real ant this time, not the defenseless *Neuropteron*, but some valiant and belted knight from the warlike *Formicidæ.* Singly or in troops, this rapacious little insect, fearless in its chitinous coat-of-mail, charges down the tree-trunk, its antennæ waving defiance to the enemy and its cruel mandibles thirsting for termite blood. The worker white ant is a poor defenseless creature, and, blind and unarmed, would fall an immediate prey to these well-drilled banditti, who forage about in every tropical forest in unnumbered legion. But at the critical moment, like Goliah from the Philistines, the soldier termite advances to the fight. With a few sweeps of its scythe-like jaws it clears the ground, and, while the attacking party is carrying off its dead, the builders, unconscious of the fray, quietly continue their work. To every hundred workers in a white ant colony, which numbers many thousands of individuals, there are perhaps two of these fighting-men. The division of labor here is very wonderful, and the fact that besides these two specialized forms there are in every nest two other kinds of the same insect, the kings and queens, shows the remarkable height to which civilization in these communities has attained.

But where is this tunnel going to, and what object have the insects in view in ascending this lofty tree? Thirty feet from the ground, across innumerable forks, at the end of a long branch are a few feet of dead wood. How the ants know it is there, how they know its sap has dried up, and that it is now fit for the termites' food, is a mystery. Possibly they do not know, and are only prospecting on the chance. The fact that they sometimes make straight for the decaying limb argues in these instances a kind of definite instinct; but, on the other hand, the fact that in most cases the whole tree, in every branch and limb, is covered with termite-tunnels, would show perhaps that they work most commonly on speculation, while the number of abandoned tunnels, ending on a sound branch in a *cul-de-sac*, proves how often they must suffer the usual disappointments of all such adventurers. The extent to which these insects carry on their tunneling is quite incredible until one has seen it in nature with his own eyes. The tunnels are perhaps about the thickness of a small-sized gas-pipe, but there are junctions here and there of large dimensions, and occasionally patches of earth-work are found embracing nearly the whole trunk for some feet. The outside of these tunnels, which are never quite straight, but wander irregularly along stem and branch, resembles in texture a coarse sand-paper; and the color, although this naturally varies with the soil, is usually a reddish-brown. The quantity of earth and mud plastered over a single tree is often enormous; and when one thinks that it is not only an isolated specimen here and there that is frescoed in this way, but often the whole of the trees of a forest, some idea will be formed of the magnitude of the operations of these insects and the extent of their influence upon the soil which they are thus ceaselessly transporting from underneath the ground.

In traveling through the great forests of the Rocky Mountains or of the Western States, the broken branches and fallen trunks strewing the ground breast-high with all sorts of decaying litter frequently make locomotion impossible. To attempt to ride through these Western forests, with their mesh-work of interlocked branches and decaying trunks, is often out of the question, and one has to dismount and drag



"USEFUL TO THE SPORTSMAN."

his horse after him as if he were clambering through a wood-yard. But in an African forest not a fallen branch is seen. One is struck at first by a certain clean look about the great forests of the interior, a novel and unaccountable cleanness, as if the forest-bed was carefully swept and dusted daily by unseen elves. And so, indeed, it is. Scavengers of a hundred kinds remove decaying animal matter—from the carcass of the fallen elephant to the broken wing of a gnat—eating it, or carrying it out of sight, and burying it in the deodorizing earth. And these countless millions of termites perform a similar function for the vegetable world, making away with all plants and trees, all stems, twigs, and tissues, the moment the finger of decay strikes the signal. Constantly in these woods one comes across what appear to be sticks and branches and bundles of fagots, but when closely examined they are seen to be mere casts in mud. From these hollow tubes, which preserve the original form of the branch down to the minutest knot or fork, the ligneous tissue is often entirely removed, while others are met with in all stages of demolition. There is the section (Fig. 3) of an actual specimen which is not yet completely destroyed, and from which the mode of attack may be easily seen. The insects start apparently from two centers. One company attacks the inner bark, which is the favorite morsel, leaving the coarse outer bark untouched, or more usually replacing it with grains of earth atom by atom as they eat it away. The inner bark is gnawed off likewise as they go along, but the woody tissue beneath is allowed to remain to form a protective sheath for the second company who begin work at the center. This second contingent eats its way outward and onward, leaving a thin tube of the outer wood to the last as props to the mine till they have finished the main excavation. When a fallen trunk lying upon the ground is the object of attack, the outer cylinder is frequently left quite intact, and it is only when one tries to drag it off to his camp-fire that he finds to his disgust that he is dealing with a mere hollow tube a few lines in thickness filled up with mud.

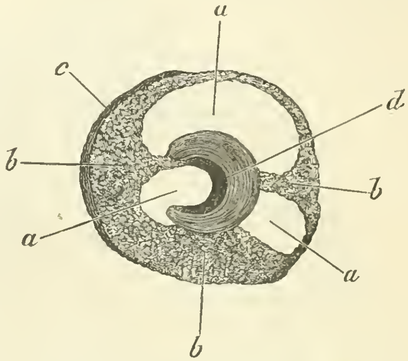


Fig. 3.—*a*, tunnel; *b*, earth; *c*, shreds of outer bark; *d*, remains of branch.

But the works above ground represent only a part of the labors of these slow-moving but most industrious of creatures. The arboreal tubes are only the prolongation of a much more elaborate system of subterranean tunnels (Fig. 4) which extend over large areas and mine the earth sometimes to a depth of many feet or even yards.

The material excavated from these underground galleries and from the succession of domed chambers—used as nurseries and granaries—to which they lead, has to be thrown out upon the surface. And it is from these materials that the huge ant-hills are reared which form so distinctive a feature of the African landscape. These heaps and mounds are so conspicuous that they may be seen for miles, and so numerous are they and so useful as cover to the sportsman, that without them in certain districts hunting would be impossible. The first things, indeed, to strike the traveler in entering the interior are the mounds of the white ant, now dotting the plain in groups like a small cemetery, now rising into mounds singly or in clusters, each thirty or forty feet in diameter, and ten or fifteen in height, or again standing out against the sky like obelisks, their bare sides carved and fluted into all sorts of fantastic shapes. In India these ant-heaps seldom attain a height of more than a couple of feet, but in Central Africa they form veritable hills, and contain many tons of

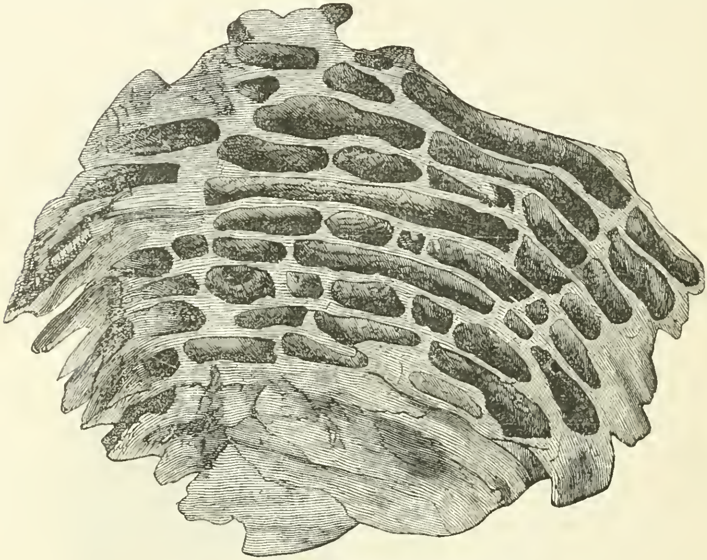


Fig. 4.—Galleries in White Ants' Nest.

earth. The brick houses of the Scotch mission-station on Lake Nyassa have all been built out of a single ants' nest, and the quarry from which the material has been derived forms a pit beside the settlement some dozen feet in depth. A supply of bricks as large again could probably still be taken from this convenient depot, and the missionaries on Lake Tanganyika and onward to Victoria Nyanza have been similarly indebted to the labors of the termites. In South Africa the Zooloos and Caffres pave all their huts with white-ant earth ; and during the Boer war our troops in Praetoria, by scooping out the interior from the smaller beehive-shaped ant-heaps, and covering the top with clay, constantly used them as ovens. These ant-heaps may be said to abound over the whole interior of Africa, and there are three or four distinct varieties. The most peculiar, as well as the most ornate, is a small variety from one to two feet in height, which occurs in myriads along the shores of Lake Tanganyika. It is built in symmetrical tiers, and resembles a pile of small rounded hats, one above another, the rims depending like eaves, and sheltering the body of the hill from rain. To estimate the amount of earth per acre raised from the water-line of the subsoil by white ants would not in some districts be an impossible task, and it would be found probably that the quantity at least equaled that manipulated annually in temperate regions by the earthworm.

These mounds, however, are more than mere waste-heaps. Like the corresponding region underground they are built into a mesh-work of tunnels, galleries, and chambers, where the social interests of the community are attended to. The most spacious of these chambers, usually far underground, is very properly allocated to the head of the society, the queen. The queen-termite (Fig. 5) is a very rare insect,

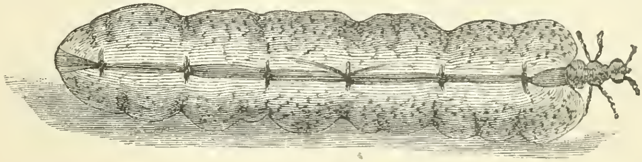


Fig. 5.—The Queen White Ant.

and as there are seldom more than one, or at most two, to a colony, and as the royal apartments are hidden far in the earth, few persons have ever seen a queen, and indeed most, if they did happen to come across it, from its very singular appearance would refuse to believe that it had any connection with white ants. It possesses, indeed, the true termite head (Figs. 6, 7), but there the resemblance to the other members of the family stops, for the size of the head bears about the same proportion to the rest of the body as does the tuft on his Glengarry bonnet to a six-foot Highlander. The phenomenal corpulence of the royal body in the case of the queen-termite is possibly due in part to want of exercise, for once seated upon her throne she never stirs to the end of her days. She lies there, a large, loathsome cylindrical package, two or three inches long, in shape like a sausage, and as

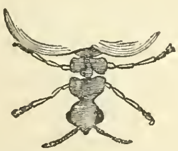


Fig. 6.—Head of Queen (magnified).

Fig. 7.—Undeveloped Winged Female.

Fig. 8.—Eggs.

white as a bolster. Her one duty in life is to lay eggs (Fig. 8), and it must be confessed she discharges her function with complete success, for in a single day her progeny often amounts to many thousands, and for months this enormous fecundity never slackens. The body increases slowly in size, and through the transparent skin the long-folded ovary may be seen, with the eggs, impelled by a peristaltic motion, passing onward for delivery to the workers who are waiting to carry them to the nurseries where they are hatched. Assiduous attention meantime is paid to the queen by other workers, who feed her diligently, with much self-denial stuffing her with morsel after morsel from their own jaws. A guard of honor in the shape of a few of the larger soldier-ants is also in attendance as a last and almost unnecessary precaution. In addition, finally, to the soldiers, workers, and queen, the royal chamber has also one other inmate—the king. He is a very ordinary-looking insect (Fig. 9), about the same size as the soldiers, but the arrangement of the parts of the head and body is widely different, and like the queen he is furnished with eyes.

Fig. 9.—King White Ant.

Let me now attempt to show the way in which the work of the termites bears upon the natural agriculture and geology of the tropics. Looking at the question from the large point of view, the general fact to be noted is, that the soil of the tropics is in a state of perpetual motion. Instead of an upper crust, moistened to a paste by the autumn rains, and then baked hard as adamant in the sun, and an under soil, hermetically sealed from the air and light, and inaccessible to all the natural manures derived from the decomposition of organic matters—these two layers being eternally fixed in their relation to one another—we have a slow and continued transference of the layers always taking place. Not only to cover their depredations, but to dispose of the earth excavated from the underground galleries, the termites are constantly transporting the deeper and exhausted soils to the surface. Thus there is, so to speak, a constant circulation of earth in the tropics, a plowing and harrowing, not furrow by furrow and clod by clod, but pellet by pellet and grain by grain.

Some idea of the extent to which the underlying earth of the tropical forests is thus brought to the surface will have been gathered from the facts already described; but no one who has not seen it with his own eyes can appreciate the gigantic magnitude of the process. Occasionally one sees a whole trunk or branch, and sometimes almost an entire tree, so swathed in red mud that the bark is almost completely concealed, the tree looking as if it had been taken out bodily and dipped in some crystallizing solution. It is not only one tree here and there that exhibits the work of the white ant, but in many places the whole forest is so colored with dull-red tunnels and patches as to give a distinct tone to the landscape—an effect which, at a little distance, reminds one of the *abend-roth* in a pine-forest among the Alps. Some regions are naturally more favorable than others to the operations of the termites, and to those who have only seen them at work in India or in the lower districts of Africa this statement may seem an exaggeration. But on one range of forest-clad hills on the great plateau between Lake Nyassa and Tanganyika I have walked for miles through trees, every one of which, without exception, was ramified, more or less, with tunnels. The elevation of this locality was about five thousand feet above the sea, and the distance from the equator some 9°; but nowhere else have I seen a spot where the termites were so completely masters of the situation as here. If it is the case that in these, the most elevated regions of Central Africa, the termite colonies attain their maximum development, the fact is of much interest in connection with the geological and agricultural function which they seem to serve; for it is here precisely, before the rivers have gathered volume, that alluvium is most wanting; it is here that the tiny head-waters of these same rivers collect the earth for subsequent distribution over the distant plains and coasts; and, though the white ant may itself have no power, in the first instance, of creating soil, as a denuding and transporting agent its ministry can scarcely be exaggerated. If this is its function in the economy of Nature, it is certainly clear that the insect to which this task is assigned is planted where, of all places, it can most effectively fulfill the end.

The direct relation of the termites' work to denudation will still further appear, if we try to imagine the effect upon these accumulations of earth-pellets and grains of an ordinary rainy season. For two or three months in the tropics, though intermittently, the rains lash the forests and soils with a fury such as we, fortunately, have little idea of. And though the earth-works, and especially the larger ant-hills, have marvelous resisting properties, they are not invulnerable, and must ultimately succumb to denuding agents. The tunnels, being only required for a temporary purpose, are made substantial enough only to last the occasion. And, in spite of the natural glue which cements the pellets of earth together, the structure, as a whole, after a little exposure, becomes extremely friable, and crumbles to pieces at a touch. When the earth-tubes crumble into dust in the summer season, the *débris* is scattered over the country by the wind, and in this way tends to increase and refresh the soil. During the rains, again, it is washed into the rivulets and borne away to fertilize with new alluvium the distant valleys or carried downward to the ocean, where along the coast-line it "sows the dust of continents to be." Herodotus, with equal poetic and scientific truth, describes Egypt as "the gift of the Nile." Possibly had he lived to-day he might have carried his vision farther back still, and referred some of it to the labors of the humble termites in the forest slopes about Victoria Nyanza.—*Good Words.*

THE EARLY STUDY OF PLANTS.

By ELIZA A. YOUMANS.

IN the interesting articles, in previous numbers of "The Popular Science Monthly," entitled "An Experiment in Primary Education," by Dr. Mary Putnam-Jacobi, she makes courteous reference to my "First Book of Botany," while dissenting from certain points of its method. The objections, I think, indicate a partial misunderstanding of this method, and, as some of them have been made before and as I have just reissued the plan of study as a volume of "Descriptive Botany," in which the matters criticised remain unchanged, it seems desirable that the erroneous impressions should be corrected. This is the more needful, because of the weight of Mrs. Jacobi's authority in what may be called human science, and because her objections, though briefly stated, come as results of fresh study tested by careful and prolonged experiment. The chief points she makes are contained in the following passage, which is quoted from pages 618 and 619 of the September "Monthly":

"I suppose that most persons seriously interested in education are acquainted with Miss Youmans's admirable little 'First Lessons in Botany,' and the plea she makes for this science as a typical means of training the observing powers of children. According to her plan, the first object studied is the leaf—and the pupil is brought at once, not only to draw the leaf, but to fill out a schedule of description of it. Much may be said in favor of this method, which proceeds from the simple to the complex form, but it is by no means the only possible one; the writing part of the scheme is, moreover, impossible for a child who has not yet learned how to write. There is another method which consists in seizing at once upon the most striking aspect of the subject, and which shall make the most vivid impression upon the imagination. For this purpose the leaf is the least useful, the flower the most. The earliest botanical classifications are based upon the corolla, and, in accordance with a principle already enunciated, a child may often best approach a science through the series of ideas that attended its genesis. The conditions are different for an adult, who requires to get the latest results; the child's mind is always remote from these, but often singularly near to the conceptions entertained by the first observers. Again, it is unnatural to enter upon the beautiful world of plants by the study of forms and outlines—which is much better pursued when abstracted from all other circumstances, as in models of pure mathematical figures. But with plants comes a new idea—that of life, of change, of evolution. It is fitting that this tremendous idea make a profound impression on the child's mind; and this impression may be best secured by watching the continuous growth of a plant from the seed. The study of life is a study of events, of dynamics, of catastrophes. The earliest observation perceives the extraordinary influence of the surrounding medium upon the destinies of the living organism. It is not difficult to surround these destinies with such a halo of imagination as shall impress on the mind a sense of the mystery, sanctity—I may add, the necessary calamities of life—before it has become absorbed in the consideration of living personalities."

The first statement here made contains an error, which, though apparently trivial, involves a serious misunderstanding of the plan of study adopted in my book. Mrs. Jacobi says that, according to the method, "the first object studied is the leaf, and the pupil is brought at once, not only to draw the leaf," etc. This is a mistake. I have not included drawing as a part of the exercise in the study of leaves, have purposely avoided it, and have always insisted that it is a waste of time and a hindrance to the object I had in view. Instead of facilitating, it impedes the work of observation. The aim is, by the observation of real objects, to form the habit of intelligent discrimination, and such a *habit* can only be formed by numerous and repeated and continued mental exercises, which, with the young beginner, should be as simple and uncomplicated as possible. The method is one of self-instruction, in which the pupil is put upon a *search* to find out things for himself, and he has to inspect a great number of objects to identify, compare, and describe their special characters. Plants were chosen because of the almost endless detail of varying structure which their parts present, and which can only be made familiar by the examination, comparison, and contrast of a great many of them. This forbids the delay entailed by the drawing of specimens, and to insist upon the practice would defeat the method. The pupil could not draw one specimen in a hundred of those with which it is necessary that he should become familiar.

The idea that the parts of plants must be drawn has been the stumbling-block of teachers in using my books from the outset. It is a mode of evading out-of-door work, the collection of multitudes of plants, and their direct and constant observation and comparison. Mere book-science is now condemned, at least nominally, even in the schools; but in place of it we have what is no better, blackboard-science and teacher's talk. My books were made simply for the learner's immediate use as a guide in the direct study of plants, and they have not the slightest value when used in any other way. Yet some teachers have set children to copy their illustrations with chalk upon the blackboard, while others have themselves copied them for their classes, the books being withheld from the pupils. One eminent superintendent of education gravely assured me that my "First Book of Botany" was a book for teachers and not for pupils; and, in exemplification of this idea, I know an instance of a large school for which one hundred copies were purchased, but in which the contents of the book were doled out by the teacher from the blackboard to a room full of pupils, while ninety-nine copies of the purchased volume remained unopened in the cellar! The most inveterate obstacle to the method is the pervasiveness of the teacher with her drawing, oral instruction, and other school-room processes. They make impossible that training in self-instruction which it was the prime object of the book to secure.

In the plan of the book, leaves were chosen to begin study with, in order to make the first steps easy and effective. Of all the organs of plants, leaves are the simplest and most varied in structure, and are most readily obtained throughout the longest period of the year. With these we are able to begin early the work of self-education, which may be continued along a course of inquiry and discovery that increases in difficulty as by exercise the mind increases in ability. Mrs. Jacobi objects to this. She says, "For the purposes of the beginner the leaf is the least useful, the flower the most." She thinks it better "to seize at once the most striking aspect of the subject, and make the most vivid impression upon the imagination"—adding that "the earliest classifications were based upon the corolla, and a person may often best approach a science through the series of ideas that attended its genesis." Is it the flower or is it only the corolla that Mrs. Jacobi thinks most useful? If the latter, I can only say that, while the corolla is the simplest element of the flower, it is less simple than the leaf, compared with which its forms are few, and not readily classifiable by beginners. If she means the entire flower, we are met by the fact that all its other parts are complex, and often so small as to require the use of a glass in studying their forms. It frequently happens that much strength of judgment is needed in fixing their boundaries and interpreting the appearances they present. Yet, if we are to begin with the flower, it is this complex portion of the plant that Mrs. Jacobi would offer first for the uncultivated attention of the child. The flower was early used in artificial classification, and it is true that the education of the individual must have a general correspondence with the evolution of the race, but this principle can have only a very partial application in primary education, and in this instance its application violates an important law of mental development. It is a fundamental principle of mental growth that the relatively simple and easy shall come before and lead on to the relatively complex and difficult, and to contravene this law is certainly bad education. Nor can I see how the showiness of flowers can in any degree compensate for this total inversion of mental processes. The sensuous interest in flowers is trivial in comparison with the deeper intellectual interest of the child, when discovering for himself the features of plants, and the resemblances of various parts by which relations and affinities are determined. I have found in a long experience with children that the curiosity, the pleasure, and even the excitement that come from a connected course of observations upon simple leaves are all-sufficient as a stimulus to continued effort, and the concurrent testimony of able teachers who have practiced the method abundantly justifies my own results.

This objection, that I begin with leaves in the study of plants, has been often made before. Of course, there may be various points of approach to the subject; but I had to adopt one, and I chose that which is unquestionably most favorable for beginning the work of self-instruction. None of the objections that I have seen have any force against the proved advantage of the plan pursued.

In further criticism of the method Mrs. Jacobi says, "Again, it is unnatural to enter upon the beautiful world of plants by the study of forms and outlines—which is much better pursued when abstracted from all other circumstances, as in models of pure mathematical figures." I am at a loss to understand this. Does Mrs. Jacobi regard me as attempting to teach geometry by the forms and outlines of leaves? I certainly have made no other use of forms and outlines than results from the inevitable relations of the mind to its environment. Forms and outlines are properties by which objects are known. The properties of bodies revealed to us through sensation are used by the child in the study of plants in exactly the same way that they are earlier used in the study of household and all familiar objects. The only difference is that, in descriptive botany, these observations are made with more precision, have a logical unity, and a conscious purpose. I am the more puzzled to understand in what the unnaturalness of the study of forms and outlines of leaves consists, because Mrs. Jacobi tells us (p. 472) that, "before the child has a clearly intellectual life on any other subjects, it attains a very definite power to distinguish the square, the oval, the spiral." If this be true, how can the study of forms of any objects be considered unnatural? If, as she relates, a child may describe bits of cake as squares and cubes, "make pentagons and octagons with knife and fork," characterize onions as "oblates," without being unnatural, why does she become so when she describes leaves as round, oval, oblong, etc., as the case may be?

But perhaps Mrs. Jacobi means that "it is unnatural to enter upon the beautiful world of plants by the study of forms and outlines," because the most beautiful and attractive parts should receive attention first. This might accord with the dictates of æsthetic feeling, but there is no reason why it should be regarded as especially the *natural* way. The truth is, this point has been settled by the history of botanical method. The flower, the most conspicuous and beautiful part, was for a long time taken alone as the basis of a classification which depended upon the number and mode of arrangement of its essential organs, to the neglect of the remaining plant-characters; but that is now recognized as the *artificial* system. Afterward the flower was deposed from its supremacy, and all the characters of plants, of which forms and outlines are leading ones, were taken into account in grouping them, and this is named the *natural* system. I should rather say that to make a fanciful idea predominant in a method of study is unnatural, while the truly natural method is that which conforms to the requirements of the mind and the progress of the science to be studied, and which will therefore lead to the best acquaintance with the truth of nature.

Again, after objecting to the early study of plants in their most simplified forms by children, Mrs. Jacobi says: "But with plants comes a new idea—that of life, of change, of evolution. It is fitting that these tremendous ideas make a profound impression on the child's mind; and this impression may be best secured by watching the continuous growth of a plant from the seed." I confess to having read this passage with no little surprise. It may be well at times to strike out from the beaten track, and take independent views, but some things are, nevertheless, established. Mrs. Jacobi here ignores the latest progress in the methods of botanical study for minds of all grades. The plan of beginning the study of the vegetable kingdom by inquiries concerning life-processes is now discredited and abandoned by the best botanical authors and teachers. It is the old method of studying physiological botany before descriptive botany, or the inner mysteries of plant organization before the external characters and relations of plant-structures by which they are known and classified. In his botanical text-book, published more than forty years ago, Professor Gray began with the idea of life and growth, but, in the series of botanical text-books he is now preparing, the first volume is devoted to the study of the external aspects of plants. He recognizes that this should come first, saying, "It will furnish the needful preparation to those who proceed to the study of vegetable physiology and anatomy." The reasons for adopting this order are conclusive, but they are strongest in the case of beginners; and yet Mrs. Jacobi adopts the old plan condemned by experience, in the case of a child five years old. If there is any truth in mental science, or any value in the experience of practical teachers, there is in childhood a special intellectual fitness for acquiring a knowledge of the external characters of organisms, and an unfitness for grasping and comprehending the obscure and difficult operations of life as manifested by these organisms. Nor can the reason which Mrs. Jacobi offers for the course taken be for a moment accepted as sound. She would introduce a little child to the study of plants through the grand gateway of evolution, to impress it at the start with the tremendous conception of unfolding life. It is proper, and I have recommended it in my little book for beginners, to make the germination of seeds an experimental exercise in observation ; and this is as far as the juvenile capacity can go. It is neither fitting nor possible that tremendous ideas should make a profound impression upon a child's mind. It has no capability either to appreciate or to receive them. Savages are incapable of wonder; they do not know enough to wonder. Said Professor Grove, in his address before the British Association at Nottingham, "If the primitive inhabitants of Britain could emerge and behold the wonderful triumphs of art and science in our civilization, it is doubtful if they would know enough to be astonished." And so with children. We may teach them to say of the stars, "How I wonder what you are!" but they do not *wonder* in the least. Only minds highly cultivated and widely informed are capable of appreciating the tremendous idea of evolution so as to be deeply impressed by it. We are not to suppose, because the young readily acquire terms and phrases, and seem in a way to understand them, that they are therefore in possession of their real and full meanings. There are stages in the process of assimilating ideas which the pupil reaches one after another in the slow course of mental unfolding. Before the period of its formal education, in the natural development of mind, the child never leaps forward into the complex and difficult, but insensibly grows into greater and greater strength through its spontaneous interest in simple things. This is the safest course to follow, because we are here on the solid ground of Nature's own method.

ON THE SOLAR CORONA.*

By WILLIAM HUGGINS, F. R. S.

IF it were usual to prefix a motto to these evening discourses, I might have selected such words as "Seeing the Invisible," for I have to describe a method of investigation by which what is usually unseeable may become revealed. We live at the bottom of a deep ocean of air, and therefore every object outside the earth can be seen by us only as it looks when viewed through this great depth of air. Professor Langley has shown recently that the air mars, colors, distorts, and therefore misleads and cheats us to an extent much greater than was supposed. Langley considers that the light and heat absorbed and scattered by the air and the particles of matter floating in it amount to no less than forty per cent of the light falling upon it. In consequence of this want of transparency and of the presence of finely divided matter always more or less suspended in it, the air, when the sun shines upon it, becomes itself a source of light. This illuminated

* A lecture delivered at the Royal Institution of Great Britain, Friday evening, February 20, 1885.

aërial ocean necessarily conceals from us by overpowering them any sources of light less brilliant than itself which are in the heavens beyond. From this cause the stars are invisible at midday. This illuminated air also conceals from us certain surroundings and appendages of the sun, which become visible on the very rare occasions when the moon coming between us and the sun cuts off the sun's light from the air where the eclipse is total, and so allows the observer to see the surroundings of the sun through the cone of unilluminated air which is in shadow. It is only when the aërial curtain of light is thus withdrawn that we can become spectators of what is taking place on the stage beyond. The magnificent scene never lasts more than a few minutes, for the moon passes and the curtain of light is again before us. On an average, once in two years this curtain of light is lifted for from three to six minutes. I need not say how difficult it is from these glimpses at long intervals even to guess at the plot of the drama which is being played out about the sun.

The purpose of this discourse is to describe a method by which it is possible to overcome the barrier presented to our view by the bright screen of air, and so watch from day to day the changing scenes taking place behind it in the sun's surroundings.

The object of our quest is to be found in the glory of radiant beams and bright streamers intersected by darker rifts which appears about the sun at a total solar eclipse. The corona possesses a structure of great complexity, which is the more puzzling in its intricate arrangement because, though we seem to have a flat surface before us, it exists really in three dimensions. If we were dwellers in Flatland and the corona were a sort of glorified catherine-wheel, the task of interpretation would seem less difficult. But, as we are looking at an object having thickness as well as extension, the forms seen in the corona must appear to us more or less modified by the effect of perspective. This consideration tells us also that the intrinsic brightness of the corona toward the sun's limb is much less than its apparent brightness as seen by us, of which no inconsiderable part must be due to the greater extent of corona in the line of sight as the sun is approached. The corona undergoes great and probably continual change, as the same coronal forms are not present at different eclipses.

The attempts which have been made from time to time to see the corona without an eclipse have been based mainly upon the hope that if the eye were protected from the intense direct light of the sun, and from all light other than that from the sky immediately about the sun, then the eye might become sufficiently sensitive to perceive the corona. These attempts have failed because it was not possible to place the artificial screen where the moon comes, outside our atmosphere, and so keep in shadow the part of the air through which the observer looks. The latest attempts have been made by Professor Langley at Mount Whitney, and Dr. Copeland, assistant to Lord

Crawford, on the Andes. Professor Langley says, "I have tried visual methods under the most favorable circumstances, but with entire non-success." Dr. Copeland observed at Puno, at a height of 12,040 feet. He says, "It ought to be mentioned that the appearances produced by the illuminated atmosphere were often of the most tantalizing description, giving again and again the impression that my efforts were about to be crowned with success."

There are occasions on which the existence of the brighter part of the corona near the sun's limb can be detected without an eclipse. The brightness of the sky near the sun's limb is due to two distinct factors, the air-glare and the corona behind it, which M. Janssen considers to be brighter than the full moon. When Venus comes between us and the sun, it is obvious that the planet, as it approaches the sun, comes in before the corona, and shuts off the light which is due to it. To the observer the sky at the place where the planet is appears darker than the adjoining parts, that is to say, the withdrawal of the coronal light from behind has made a sensible diminution in the brightness of the sky. It follows that the part of the sky behind which the corona is situated must be brighter in a small degree than the adjoining parts, and it would perhaps not be too much to say that the corona would always be visible when the sky is clear, if our eyes were more sensitive to small differences of illumination of adjacent areas. My friend Mr. John Brett, A. R. A., tells me that he is able to see the corona in a telescope of low power.

The spectroscopic method by which the prominences can be seen fails because a part only of the coronal light is resolved by the prism into bright lines, and of these lines no one is sufficiently bright and co-extensive with the corona to enable us to see the corona by its light, as the prominences may be seen by the red, the blue, or the green line of hydrogen.

The corona sends to us light of three kinds: 1. Light which the prism resolves into bright lines, which has been emitted by luminous gas. 2. Light which gives a continuous spectrum, which has come from incandescent liquid or solid matter. 3. Reflected sunlight, which M. Janssen considers to form the fundamental part of the coronal light.

The problem to be solved was how to disentangle the coronal light from the air-glare mixed up with it, or in other words how to give such an advantage to the coronal light that it might hold its own sufficiently for our eyes to distinguish the corona from the bright sky.

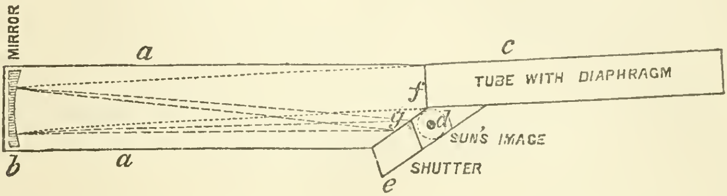
When the report reached this country in the summer of 1882 that photographs of the spectrum of the corona taken during the eclipse in Egypt showed that the coronal light seen from the earth as a whole is strong in the violet region, it seemed to me probable that if by some method of selective absorption this kind of light were isolated, then when viewed by this kind of light alone the corona might be at a sufficient advantage relatively to the air-glare to become visible. Though this light falls within the range of vision, the eye is less sensitive to small differences of illumination near this limit of its power. This consideration and some others led me to look to photography for aid, for it is possible by certain technical methods to accentuate the extreme sensitiveness of a photographic plate for minute differences of illumination. [A cardboard, on which a corona had been painted by so thin a wash of Chinese white that it was invisible to the audience, had been photographed. The photograph thrown upon the screen showed the corona plainly.] This cardboard represents the state of things in the sky about the sun. The painted corona is brighter than the cardboard, but our eyes are too dull to see it. In like manner the part of the sky near the sun where there is a background of corona is brighter than the adjoining parts where there is no corona behind, but not in a degree sufficiently great for our eyes to detect the difference.

A photographic plate possesses another and enormous advantage over the eye, in that it is able to furnish a permanent record of the most complex forms from an instantaneous exposure.

In my earlier experiments the necessary isolation of violet light was obtained by interposing a screen of colored glass or a cell containing potassic permanganate. The possible coming of false light upon the sensitive plate from the glass sides of the cell, as well as from precipitation due to the decomposition of the potassic permanganate under the sun's light, led me to seek to obtain the necessary light-selection in the film itself. Captain Abney had shown that argentic bromide, iodide, and chloride, differ greatly in the kind of light to which they are most sensitive. The chloride is most strongly affected by violet light from *h* to a little beyond K. It was found possible by making use of this selective action of argentic chloride to do away with an absorptive medium. To prevent reflected light, the back of the plate was covered with asphaltum varnish, and frequently a small metal disk a little larger than the sun's image was interposed in front of the plate to cut off the sun's direct light.

The next consideration was as to the optical means by which an image of the sun, as free as possible from imperfections of any kind, could be formed upon the plate. For several obvious reasons the use of lenses was given up, and I turned to reflection from a mirror of speculum metal. My first experiments were made with a Newtonian telescope by Short. With this instrument, during the summer of 1882, about twenty plates were taken on different days, in all of which coronal forms are to be seen about the sun's image. After a very critical examination of these plates, in which I was greatly helped by the kind assistance of Professor Stokes and Captain Abney, there seemed to be good ground to hope that the corona had really been obtained on the plates. [One of these negatives, obtained in August, 1882, was shown upon the screen.]

In the spring of the following year, 1883, the attack upon the corona was carried on with a more suitable apparatus. The Misses Lassell were kind enough to lend me a seven-foot Newtonian telescope made by Mr. Lassell, which possesses great perfection of figure and retains still its fine polish. For the purpose of avoiding the disadvantage of a second reflection from the small mirror, and also of reducing the aperture to three and a half inches, which gives a more manageable amount of light, I adopted the arrangement of the instrument which is shown in the following woodcut:



The speculum *b* remains in its place at the end of the tube *a, a*, by which the mechanical inconvenience of tilting the speculum within the tube as in the ordinary form of the Herschelian telescope is avoided.

The small plane speculum and the arm carrying it were removed. The open end of the tube is fitted with a mahogany cover. In this cover at one side is a circular hole, *f*, three and a quarter inches diameter, for the light to enter; below is a similar hole over which is fitted a framework to receive the "backs" containing the photographic plates, and also to receive a frame with fine-ground glass for putting the apparatus into position. Immediately below, toward the speculum, is fixed a shutter with an opening of adjustable width, which can be made to pass across more or less rapidly by the use of India-rubber bands of different degrees of strength. In front of the opening *f* is fixed a tube, *c*, six feet long, fitted with diaphragms, to restrict as far as possible the light which enters the telescope to that which comes from the sun and the sky immediately around it. The telescope-tube *a, a*, is also fitted with diaphragms, which are not shown in the diagram, to keep from the plate all light, except that coming directly from the speculum. It is obvious that, when the sun's light entering the tube at *f* falls upon the central part of the speculum, the image of the sun will be formed in the middle of the second opening at *d*, about two inches from the position it would take if the tube were directed axially to the sun. The exquisite definition of the photographic images of the sun shows, as was to be expected, that this small deviation from the axial direction, two inches in seven feet, does not affect sensibly the performance of the mirror. The whole apparatus is firmly strapped on to the refractor of the equatorial in my observatory, and carried with it by the clock-motion.

The performance of the apparatus is very satisfactory. The photographs show the sun's image sharply defined; even small spots are seen. When the sky is free from clouds, but presents a whity appearance from the large amount of scattered light, the sun's image is well defined upon a uniform background of illuminated sky, without any sudden increase of illumination immediately about it. It is only when the sky becomes clear and blue in color that coronal appearances present themselves with more or less distinctness. [Several negatives taken during the summer of 1883 were shown on the screen.] In our climate the increased illumination of the sky where there is a background of coronal light is too small to permit the photographs which show this difference to be otherwise than very faint. A small increase of exposure, or of development, causes it to be lost in the strong photographic action of the air-glare. For this reason, the negatives should be examined under carefully arranged illumination. They are not, therefore, well adapted for projection on a screen. [A negative taken with a whity sky showed a well-defined image of the sun, with a sensibly uniform surrounding of air-glare, but without any indication of the corona. In the case of the other negatives exhibited, which were taken on clearer days, an appearance, very coronal in character, was to be seen about the sun.]

On May 6th the corona was photographed during a total eclipse at Caroline Island by Messrs. Lawrence and Woods. This circumstance furnished a good opportunity of subjecting the new method to a crucial test, namely, by making it possible to compare the photographs taken in England, where there was no eclipse, with those taken at Caroline Island of the undoubtedly true corona during the eclipse. On the day of the eclipse the weather was bad in this country, but plates were taken before the eclipse, and others taken later on. These plates were placed in the hands of Mr. Wesley, who had had great experience in making drawings from the photographs taken during former eclipses. Mr. Wesley drew from the plates before he had any information of the results obtained at Caroline Island, and he was therefore wholly without bias in the drawings which he made from them. [Photographs of Mr. Wesley's drawings were projected on the screen, and then a copy of the Caroline Island eclipse photograph. The general resemblance was unmistakable, but the identity of the object photographed in England and at Caroline Island was placed beyond doubt by a remarkably formed rift on the east of the north pole of the sun. This rift, slightly modified in form, was to be seen in a plate taken about a solar rotation period before the eclipse, and also on a plate taken about the same time after the eclipse. The general permanence of this great rift certainly extended over some months, but no information is given as to whether the corona rotates with the sun. For from the times at which the plates were taken, one about a rotation period before and the other a rotation period after the eclipse, it is obvious the rift might have gone round with the sun, but there is no positive evidence on this point.*]

As the comparison of the English plates with those taken at Caroline Island possesses great interest, I think it well to put on record here a letter written by Mr. Lawrence to Professor Stokes, dated Sept. 14, 1883 :

"Dr. Huggins called upon Mr. Woods this morning and showed us the drawings Mr. Wesley has made of his coronas. He told us that he particularly did not wish to see our negatives, but that he would like us to compare his results with ours. We did so, and found that some of the strongly marked details could be made out on his drawings, a rift near the north pole being especially noticeable ; this was in a photograph taken on April 3d, in which the detail of the northern hemisphere is best shown, while the detail of our southern hemisphere most resembles the photograph taken on June 6th ; in fact, our negatives seem to hold an intermediate position. Afterward I went with Dr. Huggins and Mr. Woods to Burlington House to see the negatives. The outline and distribution of light in the inner corona of April 3d are very similar to those on our plate which had the shortest exposure ; the outer corona is, however, I think, hidden by atmospheric glare. As a result of the comparison, I should say that Dr. Huggins's coronas are certainly genuine as far as 8′ from the limb."

Though the plates which were obtained during the summer of 1883 appeared to be satisfactory to the extent of showing that there could be little doubt remaining but that the corona had been photographed without an eclipse, and therefore of justifying the hope that a successful method for the continuous investigation of the corona had been placed in the hands of astronomers, yet, as the photographs were taken under the specially unfavorable conditions of our climate, they failed to show the details of the structure of the corona.

The next step was obviously to have the method carried out at some place of high elevation, where the large part of the glare which is due to the lower and denser parts of our atmosphere would no longer be present. I ventured to suggest to the Council of the Royal Society that a grant from the fund placed annually by the Government at the disposal of the Royal Society should be put in the hands of a small committee for this purpose. This suggestion was well received, and a committee was appointed by the Council of the Royal Society. The committee selected the Riffel, near Zermatt in Switzerland, a station which has an elevation of 8,500 feet, and the further advantages of easy access, and of hotel accommodation. The committee was fortunate in securing the services, as photographer, of Mr. Ray Woods, who as assistant to Professor Schuster had photographed the corona during the eclipse of 1882 in Egypt, and who in 1883, in conjunction with Mr. Lawrence, had photographed the eclipse of that year at Caroline Island.

* See Plates XI and XIa, "British Association Report," 1883, p. 348.

Mr. Woods arrived at the Riffel in the beginning of July, 1884, with an apparatus, similar to one shown in the woodcut on a former page, constructed by Mr. Grubb.

Captain Abney, who had made observations on the Riffel in former years, had remarked on the splendid blue-black skies which were seen there whenever the lower air was free from clouds or fog. But unfortunately during the last year or so a veil of finely divided matter of some sort has been put about the earth, of which we have heard so much in the accounts from all parts of the earth of gorgeous sunsets and after-glows. This fine matter was so persistently present in the higher regions of the atmosphere during last summer, that Mr. Woods did not get once a really clear sky. On the contrary, whenever visible cloud was absent, then instead of a blue-black sky there came into view a luminous haze, forming a great aureole about the sun, of a faint red color, which passed into bluish white near the sun. Mr. Woods found the diameter of the aureole to measure about 44°. This appearance about the sun has been seen all over the world during last summer, but with greatest distinctness at places of high elevation.

The relative position of the colors, blue inside and red outside, shows that the aureole is a diffraction phenomenon due to minute particles of matter of some kind. Mr. Ellery, Captain Abney, and some others, consider the matter to be water in the form probably of minute ice-spicules ; others consider it to consist of particles of volcanic dust projected into the air during the eruption at Krakatoa ; but whatever it is, and whencesoever it came, it is most certainly matter in the wrong place so far as astronomical observations are concerned, and in a peculiar degree for success in photographing the corona. We are only beginning to learn that, whether in our persons or in our works, it is by minimized matter chiefly that we are undone. So injurious was the effect of this aureole that it was not possible to obtain any photographs of the corona at my observatory near London. This great diffraction aureole went far to defeat the object for which Mr. Woods had gone to the Riffel, but fortunately the great advantage of being free from the effects of the lower eight thousand feet of denser air told so strongly that, notwithstanding the ever-present aureole, Mr. Woods was able to obtain a number of plates on which the corona shows itself with more or less distinctness. [Three untouched photographic copies of the plates taken at the Riffel were shown upon the screen.] From the presence of the aureole the negatives show less detail than we have every reason to believe would have been the case if the sky had been as blue and clear as in some former years. This circumstance makes great care necessary in the discussion of these plates, and it would be premature to say what information is to be obtained from them.

[As an illustration of the differences of form which the corona has assumed at different eclipses, photographs taken in 1871, 1878, 1882, and 1883 were projected on the screen. Attention was called to the equatorial extension seen in the photograph taken in 1878, and to the suggestion which had been put forward that this peculiar character was connected with the then comparative state of inactivity of the sun's surface, at a period of minimum sun-spot action, especially as an equatorial extension was observed in 1867.]

It is now time that something should be said of the probable nature of the corona.

Six hypotheses have been suggested :

1. That the corona consists of a gaseous atmosphere resting upon the sun's surface and carried round with it.

2. That the corona is made up, wholly or in part, of gaseous and finely divided matter which has been ejected from the sun, and is in motion about the sun from the forces of ejection, of the sun's rotation, and of gravity—and possibly of a repulsion of some kind.

3. That the corona resembles the rings of Saturn, and consists of swarms of meteoric particles revolving with sufficient velocity to prevent their falling into the sun.

4. That the corona is the appearance presented to us by the unceasing falling into the sun of meteoric matter and the *débris* of comets' tails.

5. That the coronal rays and streamers are, at least in part, meteoric streams strongly illuminated by their near approach to the sun, neither revolving about nor falling into the sun, but permanent in position and varying only in richness of meteoric matter, which are parts of eccentric comet orbits. This view has been supported by Mr. Proctor, on the ground that there must be such streams crowding richly together in the sun's neighborhood.

6. The view of the corona suggested by Sir William Siemens in his solar theory.

It has been suggested, even, that the corona is so complex a phenomenon that there may be an element of truth in every one of these hypotheses. Anyway, this enumeration of hypotheses, more or less mutually destructive, shows how great is the difficulty of explaining the appearances which present themselves at a total solar eclipse, and how little we really know about the corona.

An American philosopher, Professor Hastings, has revived a prior and altogether revolutionary question : Has the corona an objective existence ? Is it anything more than an optical appearance depending upon diffraction ? Professor Hastings has based his revival of this long-discarded negative theory upon the behavior of a coronal line which he saw, in his spectroscope, change in length east and west of the sun during the progress of the eclipse at Caroline Island. His view appears to rest on the negative foundation that Fresnel's theory of diffraction may not apply in the case of a total eclipse, and that at such great distances there is a possibility that the interior of the shadow might not be entirely dark, and so to an observer might cause the appearance of a bright fringe around the moon.*

Not to speak of the recent evidence of the reality of the corona from the photographs which have been taken when there is no intervening moon to produce diffraction, there is the adverse evidence afforded by the peculiar spectra of different parts of the corona, and by the complicated and distinctly peculiar structure seen in the photographs taken at eclipses. The crucial test of this theory appears to be that, if it be true, then the corona would be much wider on the side where the sun's limb is least deeply covered, that is to say, the corona would alter in width on the two sides during the progress of the eclipse. Not to refer to former eclipses where photographs taken at different times and even at different places have been found to agree, the photographs taken during the eclipse at Caroline Island show no such changes. M. Janssen says, "Les formes de la couronne ont été absolument fixes pendant toute la durée de la totalité." The photographs taken by Messrs. Lawrence and Woods also go to show that the corona suffered no such alterations in width or form as would be required by Professor Hastings's theory during the passage of the moon.

We have, therefore, I venture to think, a right to believe in an objective reality of some sort about the sun corresponding to the appearance which the corona presents to us. At the same time some very small part of what we see must be due to a scattering of the coronal light itself by our air, but the amount of this scattered light over the corona must be less than what is seen over the dark moon.

That the sun is surrounded by a true gaseous atmosphere of relatively limited extent there can be little doubt, but many considerations forbid us to think of an atmosphere which rises to a height which can afford any explanation of the corona, which streams several hundred thousand miles above the photosphere. For example, a gas at that height, if hundreds or even thousands of times lighter than hydrogen, would have more than metallic density near the sun's surface—a state of things which spectroscopic and other observations show is not the case. The corona does not exhibit the rapid condensation toward the sun's limb which such an atmosphere would present, especially when we take into account the effect of perspective in increasing the apparent brightness of the lower regions of the corona. There is, too, the circumstance that comets have passed through the upper part of the corona without being burned up or even sensibly losing velocity.

There can scarcely be doubt that matter is present about the sun wherever the corona extends, and further that this matter is in the form of a fog. But there are fogs and fogs. The air we breathe,

* Report of the Eclipse Expedition to Caroline Island, May, 1883. Memoir of the National Academy of Sciences, Washington.

when apparently pure, stands revealed as a dense swarming of millions of motes if a sunbeam passes through it. Even such a fog is out of the question. If we conceive of a fog so attenuated that there is only one minute liquid or solid particle in every cubic mile, we should still have matter enough, in all probability, to form a corona. That the coronal matter is of the nature of a fog is shown by the three kinds of light which the corona sends to us—reflected solar light scattered by particles of matter, solid or liquid; and, secondly, light giving a continuous spectrum, which tells us that these solid or liquid particles are incandescent; while the third form of spectrum of bright lines, fainter and varying greatly at different parts of the corona and at different eclipses, shows the presence also of light-emitting gas. This gas existing between the particles need not necessarily form a true solar atmosphere, which the considerations already mentioned make an almost impossible supposition, for we may well regard this thin gas as carried up with the particles, or even to some extent to be furnished by them under the sun's heat.

It will be better to consider first the probable origin of this coronal matter, and by what means it can find itself at such enormous heights above the sun.

There is another celestial phenomenon, very unlike the corona at first sight, which may furnish us possibly with some clew to its true nature. The head of a large comet presents us with luminous streamers and rifts and curved rays, which are not so very unlike, on a small scale, some of the appearances which are peculiarly characteristic of the corona.* We do not know for certain the conditions under which these cometary appearances take place, but the hypothesis which seems on the way to become generally accepted attributes them to electrical disturbances, and especially to a repulsive force acting from the sun, possibly electrical, which varies as the surface, and not, like gravity, as the mass. A force of this nature in the case of highly attenuated matter can easily master the force of gravity, and, as we see in the tails of comets, blow away this thin kind of matter to enormous distances in the very teeth of gravity.

If such a force of repulsion is experienced in comets, it may well be that it is also present in the sun's surroundings. If this force be electrical, it can only come into play when the sun and the matter subjected to it have electric potentials of the same kind, otherwise the attraction on one side of a particle would equal the repulsion on the other. On this theory the coronal matter and the sun's surface must both be in the same electrical state, the repelled matter negative if the sun is negative, positive if the sun is positive.

The grandest terrestrial displays of electrical disturbance, as seen in lightning and the aurora, must be of a small order of magnitude as compared with the electrical changes taking place in connection

* See "Comets," Royal Institution Proceedings, vol. x, p. 1.

with the ceaseless and fearful activity of the sun's surface; but we do not know how far these actions, or the majority of them, may be in the same electrical direction, or what other conditions there may be, so as to cause the sun's surface to maintain a high electrical state, whether positive or negative. A permanence of electric potential of the same kind would seem to be required by the phenomena of comets' tails.

If such a state of high electric potential at the photosphere be granted as is required to give rise to the repulsive force which the phenomena of comets appear to indicate, then, considering the gaseous irruptions and fiery storms of more than Titanic proportions which are going on without ceasing at the solar surface, it does not go beyond what might well be, to suppose that portions of matter ejected to great heights above the photosphere, and often with velocities not far removed from that which would be necessary to set it free from the sun's attraction, and very probably in the same electric state as the photosphere, might so come under this assumed electric repulsion as to be blown upward and to take on forms such as those seen in the corona: the greatest distances to which the coronal streamers have been traced are small as compared with the extent of the tails of comets, but then the force of gravity which the electrical repulsion would have to overcome near the sun would be enormously greater.

It is in harmony with this view of things that the positions of greatest coronal extension usually correspond with the spot-zones where the solar activity is most fervent; and also that a careful examination of the structure of the corona suggests strongly that the forces to which this complex and varying structure is due have their seat in the sun. Matter repelled upward would rise with the smaller rotational velocity of the photosphere, and lagging behind would give rise to curved forms; besides, the forces of irruption and subsequent electrical repulsion might well vary in direction and not be always strictly radial, and under such circumstances a structure of the character which the corona presents might well result. The sub-permanency of any great characteristic coronal forms, as, for example, the great rift seen in the photographs of the Caroline Island eclipse, and also in those taken in England a month before the eclipse and about a month afterward, must probably be explained by the maintenance for some time of the conditions upon which the forms depend, and not by an unaltered identity of the coronal matter; the permanency belonging to the form only, and not to the matter, as in the case of a cloud over a mountain-top or of a flame over the mouth of a volcano. If the forces to which the corona is due have their seat in the sun, the corona would probably rotate with it; but if the corona is produced by conditions external to the sun, then the corona might not be carried round with the sun.

We have seen that the corona consists probably of a sort of incandescent fog, which at the same time scatters to us the photospheric light. Now, we must bear in mind the very different behavior of a gas, and of liquid or solid particles in the near neighborhood of the sun. A gas need not be greatly heated, even when near the sun, by the radiated energy. Heated gas from the photosphere would rapidly lose heat ; but, on the other hand, liquid or solid particles, whether originally carried up as such or subsequently formed by condensation, would absorb the sun's heat, and at coronal distances would soon rise to a temperature not very greatly inferior to that of the photosphere. The gas which the spectroscope shows to exist along with the incandescent particles of the coronal stuff may therefore have been carried up as gas or have been in part distilled from the coronal particles under the enormous radiation to which they are exposed. Such a view would not be out of harmony with the very different heights to which different bright lines may be traced at different parts of the corona and at different eclipses. For obvious reasons, gases of different vapor density would be differently acted upon by a repulsive force which varies as the surface, and would to some extent be winnowed from each other ; the lighter the gas the more completely would it come under the sway of repulsion, and so would be carried to a greater height than the gas more strongly held down by gravity. The relative proportions, at different heights of the corona, of the gases which the spectroscope shows to exist there (and recently Captain Abney and Professor Schuster have shown that in addition to the bright lines already known the spectrum of the corona of 1882 gave the rhythmical group of the ultra-violet lines of hydrogen which are characteristic of the photographic spectra of the white stars, and some other lines also) would vary from time to time, and depend in part upon the varying state of activity of the photosphere, and so probably establish a connection with the spectra of the prominences. This view of the corona would bring it within the charmed circle of interaction which seems to obtain among the phenomena of sun-spots and terrestrial magnetic disturbances and auroræ.

Many questions remain unconsidered ; among others, whether the light emitted by the gaseous part of the corona is due directly to the sun's heat, or to electrical discharges taking place in it of the nature of the aurora. Further, what becomes of the coronal matter on the theory which has been suggested ? Is it permanently carried away from the sun, as the matter of the tails of comets is lost to them? Among other considerations it may be mentioned that electric repulsion can maintain its sway only so long as the repelled particle remains in the same electrical state : if through electric discharges it ceases to maintain the electrical potential it possessed, the repulsion has no more power over it, and gravity will be no longer mastered. If, when this takes place, the particle is not moving away with a velocity sufficiently great to carry it from the sun, the particle will return to the sun.

Of course, if the effect of any electric discharges or other conditions has been to change the potential of the particle from positive to negative, or the reverse, as the case may be, then the repulsion would be changed into an attraction acting in the same direction as gravity. In Mr. Wesley's drawings of the corona, especially in those of the eclipse of 1871, the longer rays or streamers appear not to end, but to be lost in increasing faintness and diffusion, but certain of the shorter rays are seen to turn round and to descend to the sun.*

It is difficult for us living in dense air to conceive of the state of attenuation probably present in the outer parts of the corona. Mr. Johnstone Stoney has calculated that more than twenty figures are needed to express the number of molecules in a cubic centimetre of ordinary air; and Mr. Crookes shows us in his tubes that matter, even when reduced to one-millionth part of the density of ordinary air, can become luminous under electrical excitement. [A glass bulb about four inches in diameter, kindly lent to me by Mr. Crookes, was exhibited, in which a metal ball about half an inch in diameter formed the negative pole. Under a suitable condition of the induction-current, this ball was seen to be surrounded by a corona of bluish-gray light which was sufficiently bright to be seen from all parts of the theatre.] Yet it is probable that these tubes must be looked upon as crowded cities of molecules as compared with the sparse molecular population of the great coronal wastes.

I forbear to speculate further, as we may expect more information as to the state of things in the corona from the daily photographs which will be shortly commenced at the Cape of Good Hope by Mr. Ray Woods under the direction of Dr. Gill.

THE RELATIONS OF RAILWAY MANAGERS AND EMPLOYÉS.

By Dr. W. T. BARNARD.

[*Concluded.*]

IN the United States it has not been an uncommon practice for railroad corporations, looking to their own immediate immunity from prosecution, to aid their servants in securing, in various ways, some protection from or indemnity for the effects of injuries received in the performance of duty; but such efforts, being usually spasmodic, and always conditioned upon releasing the company from all liability, have

* For a history of opinion of the nature of the corona, see papers by Professor Norton, Professor Young, and Professor Langley, in the "American Journal of Science"; also "The Sun," by Professor Young; and "The Sun the Ruler of the Planetary System," and various essays, by Mr. R. A. Proctor.

not generally received the cordial recognition and support of the employés themselves; have been ephemeral, and at best have only partially afforded the contributing companies protection from legal responsibilities. Objection has frequently been made to the writer that the conditions under which railroads are operated in the United States differ so widely from those of other countries as to render the experience of the latter of little practical value to us for purposes of comparison and guidance, and this belief seems to be wide-spread. The best possible answer to such an objection may be obtained from an inquiry into the results of the efforts of those American railroads (and there are several conspicuous examples) which, following English and Continental precedents, have *systematically united* with their employés in establishing societies like those which have proved so prosperous abroad. Reference has been made in a previous paragraph to an association of this character inaugurated five years ago by a prominent Eastern trunk line. From the first publication of its prospectus the Baltimore and Ohio Employés' Relief Association attracted marked attention, not only among railroad managers of advanced thought, but very generally among students of social and industrial science and prominent educators, and that interest has been well sustained by frequent reports in the public press of its growth and work. Having in the five years of its existence a sustained membership exceeding 18,400; having, under its various features, distributed over a wide territory more than $929,940.14, in 42,930 separate payments; and combining within itself, in one harmonious system, provision for the relief of the sick, injured, superannuated, and for their families after death; a savings-bank, a building association, a circulating library, and other features of less importance; being a leader in railroad sanitation; and, in short, representing, on the largest scale in the United States, the most popular foreign friendly and aid societies—this Relief Association will best serve for purposes of restoration.

A general review of its theory and provisions is necessary for a proper understanding of the results it has attained, but any specially interested in the details of its organization and management are referred to the secretary of the association at Baltimore.*

In a circular dated May 1, 1880, the Baltimore and Ohio Railroad Company announced that, on the petition of a number of its employés, after a very thorough examination and study of benevolent railway organizations in Great Britain, France, and Germany, having a full appreciation of the advantages which experience has uniformly shown may be enjoyed by the employers and employés of railroad and other large corporations where benevolent relief societies have

* The writer was induced, some years ago, to publish in the Chicago "Railway Age" an account of the features of this association, then in operation, but to which important additions have since been made. Having but a limited circulation, among railroad people only, that paper has been utilized in the preparation of this article.

been put into operation, it thereby inaugurated an Employés' Relief Association, which was subsequently incorporated by special act of the Legislature of Maryland, June 3, 1882.

The Baltimore and Ohio board of directors, by a resolution guaranteeing the absolute fulfillment of all the promises and provisions of the constitution of the association, made the following announcement:

"To give further force and effect to this plan, and as an earnest of its solicitude for their comfort and welfare, the company has contributed $100,000 as the nucleus of a fund from which its employés can derive pecuniary relief in the event of becoming incapacitated for earning their livelihood, or by means of which, in the event of death, they may leave some provision for their families, upon condition that they will second its endeavor to promote their welfare by making such contributions to the fund as will secure its permanency and effectiveness.

"The company will also, without expense to the fund, give the services of its staff in conducting the clerical and other business necessary to its proper management; office-room for its records, etc.; and, whenever it is necessary or desirable to employ females or children for such work as they are qualified to perform, preference will be given to the widows, wives, sisters, and children of its faithful contributing employés over other applicants in the order above named.

"It will also make arrangements by which the children of those contributing to the fund, under sixteen years of age, shall travel free when going to or returning from school, over all its lines for distances under ten miles, and will give half-fare transportation to contributors, their wives and children traveling over its lines.

"Also, having learned of the pecuniary necessities of persons formerly in its service, and being anxious and solicitous that its present and future employés, although escaping accidents and sickness while in the discharge of duty, shall not find themselves without means of support whenever, through approaching old age or the contraction of infirmities, they become unable to perform the services assigned them or to earn a livelihood in other pursuits, it has added to the indemnity features of the plan its superannuation or annuity provision, which it commends to their consideration and adoption."

Subsequently this superannuation feature was elaborated under a further endowment which nets the association $25,000 per annum, and later on its savings, building, and free circulating library features were guaranteed by and received the liberal support of the company, which is also taking measures to establish a sanitarium and home for its disabled and aged employés and their families, for which a beautifully located and healthy site has already been purchased.

In the preparation of this scheme the selecting and classification of risks were among the earliest and most embarrassing of the questions to be settled. All legitimate life and accident insurance companies, and indeed all the most solvent co-operative associations, select their risks, upon which they place a limit, imposing their own standard of physical qualifications. Railroads, however, can make no such invidious distinctions against, perhaps, their most deserving servants, and hope to succeed in any insurance scheme they inaugurate. Such a plan must embrace all, if any. In considering percentages of railroad accidents the physical condition of employés is a comparatively small factor—entering but little into cause and effect—because in active railroading, as in army campaigning, the weak and diseased are soon eliminated, and the fittest only survive the exposure and physical strain to which they are constantly subjected. In the five years of this association it has been uniformly found that the standard of health and longevity of railroad operatives is remarkably high, far exceeding that which the insurance tables assign as the average for people of equal age but of unselected occupations. On the other hand, age is a potent factor in determining liability for sickness and death from other causes than violence. Besides the statistics of accidents at its command, the Baltimore and Ohio Company were able to ascertain with approximate accuracy the ages of its employés; and it was thereby enabled to estimate with a reasonable degree of certainty the risks to be incurred and provided for. Then, after allowing the employés a reasonable time within which to enter the association without questioning their age or physical condition, it adopted and has since rigidly enforced the policy of employing for its service none over forty-five years of age, and who can not pass a strict medical examination. Among other immediate results of this measure, the average age of many thousands of employés has been reduced to twenty-eight years, and the standard of their physical strength and activity perceptibly advanced, to the company's obvious gain and the lessening of the liabilities of the relief association, which were predicated upon the average age and health of the company's employés when the average of age was much higher and their standard of health lower than now. This has resulted in largely increased benefits without increasing premiums, and has rendered the company's guarantee, as regards the *relief* features, practically a nullity. The premiums and benefits under the relief feature of the association were predicated upon a simple classification of the employés according to hazard of occupation and accustomed compensation. It was recognized that the laboring classes of this country are familiar with larger sums of money than are foreigners, and are therefore apt to regard with indifference the net earnings of premiums that would be deemed considerable abroad; and because adequate protection against the wants of life affords great security against harassing and costly litigation with the employers, it was thought desirable to fix the standard unit sufficiently high to give substantial relief, while yet not allowing such large benefits as would require oppressive taxation of the employés, or as would offer temptations to practice fraud or deceit by pretended disablements. The benefit must also be tangible and fixed, to obviate discontent; for, as a rule, the people engaged in manual labor are suspicious of indefinite insurance, and dread being taxed for unknown quantities—the employés of the company were therefore divided into two classes—the first class containing those engaged in operating trains and rolling-stock, and the second containing all those not so engaged; and the unit of premium was fixed at twenty-five cents per month per rate, for each feature, or seventy-five cents for the three features of the lowest rate, increasing in the ratio as given in the table on page 773.

Members may now secure insurance under this feature to the extent of thirty rates, or six thousand for a premium of twenty-five cents a rate for death under benefit 5 only.

It was provided that, while no employé could take the benefits of a lower class than those to which his salary assigned him, he could take as many more rates (up to the limit) as he chose. Also that such of those employés in the service at the time of the inauguration of the association as did not desire to take the three, could yet, as they elected, enjoy the benefits of one or more features; which brought within the reach of all, on a uniform and simple scale, protection commensurate with what they could spare to secure it.

The manner of collecting premiums next demanded consideration. As no initiation fee could, with propriety, be exacted of those newly seeking employment for a livelihood, so none could properly be collected from those already in the service; and as, for obvious reasons, it was undesirable to ground the plan upon a capital stock company, it became necessary to mainly depend for assets upon the payment of premiums. By the simple expedient of requiring premiums to be paid in advance, there would always be on hand the maximum sum required to pay for the casualties of the following month, and this was also thought to be the least onerous and therefore the best form of subscription.

The liabilities and benefits of members being well known, premiums could be deducted from their wages on the monthly pay-roll, and thus all risk through the handling of funds by irresponsible parties was avoided, and the Baltimore and Ohio Company became responsible for the collection—the association being credited on the company's books with the premiums which remain in its custody until withdrawn by legitimate warrant. No large sums are allowed to accumulate, the surplus not needed for immediate wants being invested by the committee of management from time to time in first-class securities. It was believed, and the result has fully proved, that premiums thus collected, while subject to the scrutiny of every interested person, would be paid with less reluctance than after the money had passed into the actual possession of members, and in many cases they would not be conscious of having made any contribution at all.

SALARIES.	PAYMENTS PER MONTH.	BENEFITS.				
		1.	2.	3.	4.	5.
		In case of temporary disablement by accident, while in the discharge of duty, the monthly payment, for a period not exceeding six months, of Per day.	In case of permanent disablement and incapacity to resume employment, arising from accident while in the discharge of duty, the monthly payment (after the sixth month) during continuance of such disablement, of Per day.*	In case of death, arising from accident while in the discharge of duty, the payment to the legal representative, within sixty days after death, of	In case of injury or sickness, from any cause other than accident while in the discharge of duty, causing total inability to labor, the payment (not longer than one year) of a daily allowance of	In case of death, arising from any cause other than accident while in the discharge of duty, the payment to the legal representative, within sixty days after death, of †
1. Those receiving $35 and under per month should pay...............	1st class $1 00 2d " 0 75	$0 50	$0 25	$500 00	$0 50	$100 00
2. Those receiving $35 and not more than $50 should pay.............	1st " 2 00 2d " 1 50	1 00	0 50	1,000 00	1 00	200 00
3. Those receiving $50 and not more than $75 should pay.............	1st " 3 00 2d " 2 75	1 50	0 75	1,500 00	1 50	300 00
4. Those receiving $75 and not more than $100 should pay............	1st " 4 00 2d " 3 00	2 00	1 00	2,000 00	2 00	400 00
5. Those receiving $100 should pay....	1st " 5 00 2d " 3 75	2 50	1 25	2,500 00	2 50	500 00

* Including free surgical and hospital treatment.

† Subject to increase predicated upon surplus at end of each year, now double this stated allowance.

A much graver matter was that involving the question whether membership should be made compulsory upon employés of the company, and, if at all, to what extent. It is believed to be a fact that neither abroad nor in this country has an accident railway association —although some have carried heavy endowments—been successful for a long term of years except where membership has been made compulsory. Many have been organized, and have lived for longer or shorter periods, but their sphere of usefulness is always very limited, and they gradually become inefficient and fall into disrepute or have to be reorganized at the sacrifice of good faith to old members.

It was urged upon the management that they should use all proper means to induce membership on the part of those already in the service, and that the company should adopt such measures as would at least insure a thoughtful consideration of the benefits offered its employés. It was finally determined to adopt a modified compulsory policy, the ultimate effect of which would be to bring within the association every employé of the company. It is this compulsory feature which makes the association unique, and which guarantees its permanency and continuous success. It is undeniably within the strict bounds of propriety for the management of a railway or any other corporation to specify the conditions upon which it will employ, and to decline the services of those who show no disposition to protect themselves and families against the vicissitudes of the service they seek to enter. But to inaugurate such a policy at that particular time was to trespass upon very delicate ground, and required no little determination, for the railroads of the country were just recovering from the prostrating effects of the strike of 1877, and were cautiously re-establishing the *status quo.* This new departure from preconceived ideas and practices of dealing with labor was watched with great interest by railroad officials and others accustomed to dealing with the grave issues constantly arising from the employment of large bodies of men, and it was amid many predictions of failure that the announcement was made that the company would thereafter require as a condition precedent to employment that those seeking service should enter the insurance organization. It started a very lively discussion as to the merits of the scheme, and forced those to examine its provisions who would otherwise have passed them by with indifference.

Upon careful examination of the foregoing tabulated statement it will be noted that contributions are, in all cases, deducted monthly from the members' wages, so that payments are required of them only when they have earned wages, and the allowance is, in all cases, proportioned to the monthly contributions paid by each person in the several classes into which the contributors have been divided.

In cases of disablement the allowance is paid not less than once every month ; before each payment, whether for temporary or permanent disability, satisfactory evidence of its existence being required.

The notification of disablement, which precedes all applications for temporary or permanent allowance, is made upon and in consonance with forms furnished for that purpose ; when it is the duty of the head of the department, or supervisor of division or section, under whom the member serves, to certify whether the disablement was received in the discharge of duty and in the company's service, and to forward a certificate to that effect to the secretary of the association, accompanied by a similar certificate covering the clinical facts from the society's surgeon called to attend the member.

The managers, from time to time, adopt such measures to secure the proper visitation of contributors on the allowance list as they think proper, and no member refusing to submit to an examination by such visitor is entitled to receive any benefits from the fund during the continuance of such refusal.

To constitute a lawful claim for accident indemnity, there must be :

1. Exterior or patent evidence of injury, and satisfactory testimony that it resulted from accident while in the discharge of duties assigned the contributor by the company, and incapacitates him from earning a livelihood.

2. In case of death, that the injuries sustained by such accident were the sole and direct cause of death ; or—

3. Not resulting from accidents while performing the company's service, that it was not caused by injuries received while engaged in unlawful enterprises or riots. The managers are the exclusive judges as to whether the injuries have been so caused and received, and their decision shall be final and conclusive.

All legitimate claims for death-allowance are paid in full, irrespective of any previous payments which may have been made under the head of temporary disability allowance, but the managers have power to require such information and particulars as they deem necessary to establish the validity of the claim of any person applying for allowance.

In urgent cases the managers have power to pay part of the death-allowance within a shorter period than sixty days, but the whole is always paid within that time.

In the event of a contributor, who has been injured while in the line of duty and in the company's service, resuming work and afterward dying from the effects of such injury, the fund is liable for the payment of the accidental death allowance, according to the scale, should death occur within a period of six months from the date of injury ; but, after that interval no further liability attaches to the fund with regard to the payment of the accidental death allowance. Any contributor, who, by reason of continued sickness from natural causes, or resulting from accidents incurred while not on duty, is unable to work, is entitled to death-allowance according to the scale and provisions relating thereto ; if death occur no later than one month after the time for which payments have been made, and if it can be shown to the satisfaction of the committee of management that such person has not worked elsewhere during any part of the intervening time.

Each contributor is given a certificate setting forth his rate of contribution, and the measure of relief to which he is entitled; which is valid during the period the holder remains employed by the Baltimore and Ohio Railroad Company, or by other companies to whose employés the benefits of the fund may be extended; which certificate is to be exchanged or modified from time to time, so as always to represent the grade or standing of its holder in the fund.

The death-allowance is paid to the person designated by the contributor in his application; but, if there be no such designation, then to the legal representative of the deceased.

The several subscriptions to the fund are deducted monthly, or whenever salaries are paid by the company's paymasters in advance, and are held subject to investment or disbursement as the managers may decide.

In order to secure to the railroad company that immunity from prosecution which its liberal contributions for the protection of its employés' interests entitle it to enjoy, it was further announced that it was not contemplated to give double benefits in those cases of disability or death resulting from accidents; the promised benefits would not be paid when the contributor or any person entitled to damages because of the accident to him, whether resulting in death or not, claimed damages against the company; and requiring the filing with the managers of the association of a release satisfactory to them, signed by all persons in interest, releasing the company from all liability; but it was left optional with the employé to accept the benefits offered by the association, or to institute other measures to secure indemnity for injury sustained.

Every applicant for membership is required to state in his application his age and length of service with the road, or its branches, which is held to be conclusive evidence in respect to any subsequent claim presented by him or his representative.

Before any accident allowance can be paid to any member, the surgeon of the association must certify that he is totally unable to labor; and the supervisor or chief of division or department in which he served before the accident must certify that his injuries were received while in the discharge of duty and in the company's service.

In cases of illness or diability not thus incurred, the allowance is paid only after certificates, satisfactory to the managers, have been received from a duly registered medical practitioner, corroborated by the contributor's superintendent, or the head of department, that sickness or injury had caused total disability for labor for the time specified in the certificate.

The moneys belonging to the funds of the association not required for immediate use are invested by the managers in United States bonds, Maryland State and municipal bonds, Baltimore and Ohio Railroad bonds or obligations, or other first-class securities. All securities and the moneys necessary to meet current expenses are intrusted to the official custody of the Treasurer of the Baltimore and Ohio Railroad Company, to be held subject to requisition of the committee of management.

The managers are chosen partly by the Baltimore and Ohio Railroad Company, on account of its interest in the fund, and partly by the contributors to it ; the company choosing four and the contributors five —the majority of those selected.

Any differences arising between claimants for the benefits set forth in the constitution and the committee of management are submitted to arbitration.

The condition of the fund is annually investigated and reported on by a proper and competent person, to be selected by the managers for that purpose, and any surplus remaining at the end of each year is devoted to the reduction of the rates of contributions of members, or in such other manner disposed of as in the judgment of the committee will best subserve the interests of the association.

The association utilizes, under judicious contracts, those hospitals located, and those physicians and surgeons residing, along the company's lines, and this service has been economical and agreeable to its members. While it is responsible for surgical expenses only in cases of injury arising from the discharge of duty, its members have the advantage of reduced prices obtained under its contracts when they are otherwise disabled or sick. There are besides, as a part of the staff of the society, a corps of salaried physicians designated as medical inspectors, to each of whom is assigned territorial limits, which they are constantly traversing, investigating cases of disability, methods of treatment, the sanitary condition of the lines, etc. It is also their duty to afford prompt relief to sufferers from casualties of travel, whether they be members of the association or other employés, or passengers ; to examine applicants for admission to the company's service as to physical qualifications, and to exercise a rigid censorship over the sanitary conditions of grounds, buildings, coaches, baggage, etc.

The rigid sanitary supervision exercised by the association through its medical inspectors over every portion of the line enables it to check and control many disorders before they have assumed grave proportions. Thus, some years ago, when small-pox was prevalent at many points tapped by the Baltimore and Ohio system, over twelve thousand employés (and in dangerous localities their immediate families) were vaccinated by the medical inspectors at association expense, and, though many employés were greatly exposed to contagion, less than a dozen were affected, and but two died from the disease. It is somewhat remarkable that nearly eighty-five per cent were successful vaccinations or revaccinations. When diarrhœal, dysenteric, and typhoid disorders become prevalent at any point, they are immediately checked by appropriate remedies placed at the disposal of the medical inspectors, master-mechanics, and supervisors, with explicit directions for use. Malarial disorders, especially, have been kept well under control by the distribution of large quantities of approved anti-periodic remedies, which are at the command of every member, and thereby much embarrassment and inconvenience to the service has been prevented.

Another and popular feature recently inaugurated is the free circulating library, which already has nearly five thousand volumes, selected with special reference to the wants and tastes of the employés and their families, and purchased from private subscription of officers of the company.

Many of the employés reside at points remote from towns, and have no opportunities for procuring literature adapted to their tastes, and when thrown out of their accustomed occupation by sickness or accident, without resources for entertainment, the minds of many men brood over their misfortunes to an extent that seriously retards recovery. To such, anything that diverts the mind from care or trouble is unquestionably of therapeutical value. Other employés also are furnished with educational and technical works, especially adapted to the requirements of engineers, mechanics, firemen, road, and all other classes of workmen, and those who wish to improve their leisure hours, by studying such works as will increase their professional business knowledge, are supplied under conditions which do not necessitate their leaving the society and comforts of their homes, and many employés, therefore, avail themselves of this chance for qualifying themselves for promotion and advancement in life, while at the same time their children, wherever located, have at command facilities for study, and instructive reading matter seldom obtainable outside large cities. The library also undertakes to purchase for members stationery, school, text, and other books at cost price, giving them the benefit of discounts on large orders and free transportation. The plan under which this library is operated is very simple, inexpensive, and effective, and could be put into operation on all our roads at nominal expense. Inexpensive but carefully prepared catalogues are printed; also cards on which to make requisitions for books, so distributed that every employé can select, order, receive, and return literature without delay through the company's train-service. Library committees, composed of employés, are organized at divisional and all other large stations, and through them, direct or by the aid of officials of the company, any workman, or any member of his family, however isolated, is readily supplied.

In pursuance of the policy of the company to improve the secular, moral, and intellectual welfare of its forces by every means in its power, well lighted and heated reading-rooms have been provided at several principal stations where employés may assemble for social intercourse, or for reading and writing, and these rooms are well furnished with the principal daily and monthly periodicals, as well as with weightier matter. It is in contemplation to provide them at other divisional stations.

Like the relief features the savings-fund and building features are operated under fixed laws by a board, the majority of whom are contributing members, and are equally fostered and guaranteed by the railroad company.

Among the inducements offered by the savings feature are:

Facilities to members and their wives, no matter how isolated their location, to invest savings or to make temporary deposits in the fund; and they may make deposits in larger sums and with more frequency than allowed by other savings-banks.

Avoidance of loss of time and of trouble in reaching places for depositing and withdrawing money, depositories being located at intervals along the line, averaging less than twenty miles.

Allowance of interest, generally greater than, and always equaling, that given by other savings-banks.

Ability to draw checks against balances, as in other banks, wherever on the line a depositor may be; to obtain, in place of deposits, checks of the Baltimore and Ohio Company negotiable anywhere, and to withdraw deposits, wholly or in part, with accrued interest, with promptness and certainty, under the legally binding promise of the Baltimore and Ohio Company.

Participation in all profits earned by the operations of the fund—every permanent depositor being substantially a stockholder, without liability or any of the legal responsibilities usually attaching thereto—and under the most favorable conditions for the economical, faithful, and wise administration of the fund through the offer of the Baltimore and Ohio Company of the services of its bonded and other officials, and the designation of experienced, able, and conservative directors to invest its moneys, and generally to manage its affairs.

Under the building feature: Opportunity for every member of the association, not only those who can provide collateral for loans, but also those who have no real estate or other security to provide or to improve homes for their families, by borrowing from the savings fund at the uniform rate of six per cent interest, and upon the easiest terms as regards repayment of principal, viz.: in monthly installments of one dollar upon every hundred dollars borrowed, with the option to borrowers of making larger repayments.

Payment of interest, not upon the whole sum borrowed until all the loan is repaid, but only the payment of six per cent per annum upon so much thereof as, at the commencement of each year, remains unpaid—an advantage over most building societies.

Certainty of securing valid titles and conveyancing, searching records, recording deeds, etc., at minimum cost, through the employment of the company's numerous counsel resident in various localities.

Free and complete possession of property purchased with loans from the savings fund during the repayment of the loan ; thus substituting the repayment of loans for the payment of rents, and acquiring ownership of homes at little or no additional monthly payments.

Ability to purchase materials at large reductions upon current rates, through contracts made by the association with wholesale dealers for building and other material in large quantities.

Opportunity to utilize, free of cost, the officers of the association as agents in negotiating real estate and other transactions, such as securing fire and life insurance at reduced rates, prompt payment of taxes, water-rates, etc., etc.

Reduced transportation for all materials entering into the construction or improvement of homesteads.

For those who have nothing to offer as security for loans, a plan for enabling them to secure homes by simply insuring their lives for the ultimate benefit of their families is provided.

Those leaving the company's service can continue their payments as before, or can dispose of their interests to the best advantage, as can also those unable to meet their payments.

Many other minor provisions, all looking to the comfort and welfare of its members, have been added to this association from time to time, but their enumeration is unnecessary here. To summarize briefly the benefits conferred by this institution under its relief features :

It enables employés to avoid selecting insurance organizations unworthy of confidence, and to avoid forfeiture of their moneyed interests, as premiums are only deducted from month to month, and are monthly expended in giving immunity to the well and indemnity to the disabled. The plan of periodical deductions enables them to make payments of premiums with definiteness, certainty, and regularity, in such small installments as not to be felt, and on a scale which the company has obligated itself shall not be increased. They have the company's guarantee that all benefits promised shall be faithfully paid. The premiums are so graduated that the poorest can enjoy membership and advantages proportioned to their contributions. It relieves employés from all necessity of soliciting contributions, prevents restlessness, discontent, and hardship resulting from inability to earn wages under bodily infirmity ; and the knowledge that when in distress they get their dues promptly, and not through charity, and that their families are adequately provided for against immediate want in case of their death or disablement, makes the men more cheerful, efficient, and contented. On the other hand, it does away with all appeals to the personal or official charity of the management, and with claims for indemnity for accident, and relieves the company from nearly all the costs and embarrassments of suits instituted by employés.

The library exerts an elevating and educating influence on the employés of the service, and particularly upon their children, the value of which can only be estimated by those acquainted with the dearth of school facilities, and the ignorance prevailing in the mountain-regions of Maryland and Virginia, and generally throughout West Virginia.

The effect of the savings and building features in inculcating and encouraging prudence and thrift will be readily recognized by us all, who know by experience that there is more need to learn the art of saving money than of earning it. By their means the humblest laborer can provide against seasons of adversity, or if he pleases may provide a home for himself and family and take that rank and independence among his fellows that attach everywhere to freehold and freedom from debt; and all this, under circumstances of convenience, cheapness, and absolute security that none but—and not many of—our metropolitan cities can offer. As illustrating the avidity with which the employés of the Baltimore and Ohio Company are utilizing these new features, it is reported that the savings fund had received in deposits \$273,132.59, of which \$159,440.88 have been loaned under its building feature, and only $26\frac{35}{100}$ per cent of deposits have been withdrawn since the bank was opened.

The benefits accruing to the Baltimore and Ohio Company through the formation of this association were early demonstrated to be material and important. Though at first there was opposition from some employés caused by a misapprehension of its provision, and unjust, harsh, and ignorant criticism from newspapers inimical to the Baltimore and Ohio management, the end of its first year showed a membership excelled by few if any benevolent societies in the United States, and at the end of its fourth fiscal year ninety-five per cent of all the company's employés — other than clerks, telegraphers, and agents, non-hazardously employed—were enrolled.

While before its establishment the Baltimore and Ohio, like all other railroads similarly situated, directly or indirectly, yearly disbursed large sums for damages to its employés, and was subjected to much annoyance and loss by the angry feelings engendered by litigations with its people and their friends, since 1880 it has not had a dozen such suits, and this almost total immunity from vexatious litigation with its employés has of itself been a saving of several times the entire expenditure on the association's behalf.

Through the system of medical examination of applicants, through the improved sanitary condition of its shops, through the consideration and care and compensation paid employés when disablement necessitates cessation from labor, and through the prompt payment of sufficiently large death insurance, the standard of the service has been perceptibly raised, and it is securing a much more efficient and desirable class of labor, skilled and unskilled, and has, in some places, drawn the best material from competitive works, and holds its force with less difficulty and loss. It is the bond of closer friendly relationship between employer and employé, and has fostered a feeling that the interests of both are identical. It has done away with all pretext for joining organizations inimical to labor, as well as with all justification for seeking charitable assistance from the company or from fellow-employés.

It is the almost unanimous testimony of the railroad company's officials that it would now be most difficult, if not impossible, to inaugurate a general strike among the members of this association.

Personal appeals to the managers of the company for pecuniary assistance on behalf of unfortunate employés are now unknown in this service, and this relief from solicitation has reacted favorably upon the *morale* of the force by inducing independence and contentment. Besides the many patent advantages accruing to the company from the savings fund and building features, is the important one of converting a proverbially migratory force into a permanent one, which is gradually locating itself at points where the company's interests will best be subserved and protected.

Under the pension feature the provision made for the support during life of its aged and permanently disabled employés enables the company to dispense at will with many old servants, who. though incapacitated by mental or bodily infirmity, often the effect of injuries received in the service, must, under ordinary conditions, through sheer humanity, be borne on the rolls, though, as all administrative officers know, to the disadvantage and frequently to the endangering of the company's interests.

In brief, the best possible testimony of the good results attained lies in the fact that, as the result of two years' trial of the plan, such a conservative corporation as the Baltimore and Ohio Railroad Company undertook further obligations on its behalf which, if capitalized, would amount to over a half a million dollars, and is contemplating still further donations to the same cause.

Railroading is rapidly advancing beyond the boundaries of a mere business, and into the dignity of a profession requiring extensive knowledge of many branches of science, technical training of a high order, and already requires a devotion to corporate interests from its staff-officers and many subordinates that necessitates the sacrifice of their independence, and all opportunity of securing competence in other channels, while it has not branches or departments in which intelligence, energy, and scrupulous honesty are not required. And, as of the great armies of railroad operatives only a few, comparatively, can gain wealth or competence, the great majority who give to their work equal devotion and their full measure of ability yearn for recognition in their sphere, and in no more effective or acceptable way can they be rewarded than that in which the Baltimore and Ohio Railroad has recognized the self-abnegation and faithfulness of its servants.

Let other railroads follow their example. Let them do away with nepotism in employment and promotion; accept the services only of those found to be expert workmen, physically as well as mentally qualified to fill responsible positions; then surround those selected with such material protection and attractions as will annul migratory instincts and anchor them by chains of self-interest, and they will have made safe provision against such disasters as that which overtook some of our Eastern lines in 1877. The motive of a railroad in thus meeting its employés more than half-way need not be concealed. It is far better to have it at once understood that self-interest is to be the governing consideration on both sides; that as the employé expects to profit by his participation in such a scheme, so does the railroad, from its participation therein, not at the expense but through the promotion of its workmen's interests. The latter, by yielding a small percentage of their pay, can secure to themselves all the benefits derivable from the most judiciously prepared scheme of insurance and mutual benefit that the light of the present age can afford; the former, through the annual investment of a reasonable sum, probably to the saving of larger expenditures in other directions, will profitably secure itself against the annoyance of lawsuits and other ill results, while also reaping other advantages and forwarding the philanthropical work of the age. The student of railway benevolent institutions abroad will be struck by the disparity of growth between those in which insurance against accident, old age, and death is by the employer made compulsory upon the employé, and others where such action is optional in favor of the former. In old settled countries, where the labor market is overstocked and competition for place most active, little difficulty is experienced in enforcing such a prerequisite to employment; but in this country, where the rapid development of railroad interests usually creates a constant *demand* for labor, and where the dissatisfied employé of one road has only to step across the field, as it were, to be welcomed with perhaps increased pay by rival interests, it takes nerve to enforce such a provision. There are few intelligent railroad managements that will not fully admit that, as the result of proverbial improvidence, their employés are, as a class, discontented, migratory, and exceptionally difficult to reach with moral and economical teachings; and they must clearly perceive, in the words of a recent writer, that "there is marked tendency to trust to luck in the future for themselves and their families, instead of making provision ahead, which exercises a demoralizing effect upon the whole character, and directly affects the interests of their employers." Yet, though they are prepared to admit that this fact makes it both right and a duty of the employer to interfere to correct the evil, as far as it is possible to do so, and that "if men need to be made provident, and to guard against adversity in sickness and old age by compulsion, then compulsion should be used," they are naturally slow to force an issue not absolutely vital, and which they fear may deprive them of help at time of need. The danger is, however, more imaginary than real, for no one will deny the right of a corporation, or any employer contracting for labor, to impose such conditions as a precedent to employment as its interests and judgment dictate, and to select preferably those willing to help protect themselves and dependents from the effects of a hazardous service. The great success of the Baltimore and Ohio Employés' Relief Association lies in the fact that the managers of that company "had the courage of their convictions," and made it a condition precedent to employment in its service that the men should sign an agreement to protect themselves and families against the vicissitudes of a hazardous service.

The proverbial conservatism and timidity of capital make it slow to realize the logical sequence of experiments which have a vital bearing on its invested interests. The uniform success and increased prosperity which have attended industrial partnerships between capitalists and their workmen—practiced more extensively on the Continent of Europe than in England, and little or not at all with us—show to the disinterested, thoughtful mind that herein, more than in efforts in all other directions combined, excellent though their effect may be, lies the true solution of the gravest and most important question pending before the world—i. e., how to equitably adjust the relations between capital and labor. Probably the serious contemplation of a division, no matter how minute, of their profits with those whose labor made them, would incite in the minds of our railway share and bond holders such alarm and opposition as would displace any management advancing such a proposition ; yet on one or more of the most important railways in France judicious action in this direction has resulted in the employés becoming the majority owners of the securities of the properties they operate, and those corporations and firms in whose profits their workmen are allowed to participate have experienced increased prosperity and decreased migration and irregularity in attendance of the workmen, whose general standard of efficiency has been raised by the competition to share such benefits, and this unity of interests has entirely isolated them from the effects of labor agitations and turmoils. That the managers of such great interests as those of our railroads and mammoth manufacturing establishments who pioneer a reform of this character must possess great nerve and resolution as well as influence, goes without saying ; but the constant strife and competition now prevailing, necessitating most rigid economics, which almost always result in curtailment of wages and in strikes, must of themselves gradually force corporations to concert measures for securing permanent control of their forces, and none can be so effective as those that look to a community of financial interests. The manager who first succeeds in applying to his service the principle of industrial partnership will prove a Napoleon in the railroad world and a dictator to all competitors. That some one competent, and of influence sufficient to direct such a movement, may shortly arise, is not altogether improbable, for already the president of one of the great Eastern trunk lines, when recently recapitulating what his board of management had done to cultivate such attachment in its employés, said :

"I hope to see the day when this society will be extended into a great co-operative association ; when the men in this service will individually have pecuniary interests in this vast property ; when the men who run the trains and operate the machinery, and all others having steady employment, will be part owners in this great corporation ; when they will in every sense be identified with and form a part of this company."

TOMMASI-CRUDELI ON MALARIOUS COUNTRIES, AND THEIR RECLAMATION.*

DISMISSING from scientific terminology the words "marsh miasm" and "marsh soil," and replacing them by "malaria" and "malarious soil," the author traces the fever-poison thus indicated to "an agent which can infect the soil of any country, however that soil may differ from other soils in hydrographical and topographical conditions and geological composition."

This agent is a living organism inferred to exist long before microscopy. That its character should remain uniform in soils the most diverse proves that it can not result from the chemical reaction of these soils. This persistent uniformity is easily understood on the admission that malaria is due to a fermentative organism which finds conditions favorable to its life and its multiplication in soils the most various, as is the case with thousands of other organisms much higher than the rudimentary vegetations which constitute living ferments.

The increasing intensity of the poison in malarious soils abandoned to themselves is especially demonstrable in Italy. Etruscan and Latin cities—Rome herself—arose in malarious regions, and they flourished mainly on account of the soil reclamation, which in the course of centuries diminished the production of the poison, without, however, succeeding in wholly suppressing it. The abandonment of the reclaiming processes led to the redevelopment of the poison—first during the Roman domination in the conquered and devastated Etruria, afterward in Rome herself on the fall of the empire, and finally in Southern Italy. This redevelopment of malaria in the Roman Campagna has been witnessed in times not very remote from ours, localities where it was possible to enjoy summer residence (*villeggiatura*) having at that season become uninhabitable. In these localities the physical condi-

* Abstract by the "Lancet" from an article published in the "Nuova Antologia."

tions of the soil have not varied for centuries; how, then, can the enormous increase of malaria be due to progressive alteration in the chemical constitution of the soil itself? Admit that malaria consists in a living organism whose successive generations infect to an ever-increasing extent the soil which contains it, and the explanation is easy.

Again, in regard to the malarious contents of the atmosphere. If the malarious ferment (*fermento malarico*) were composed of gaseous emanations from the soil, or of a chemical ferment formed in the soil and raised into the air together with watery vapor, the malarious contents of the atmosphere ought to reach their maximum in those hours when the soil is most warmed by the sun's rays, and in which the evaporation of the water it contains and the chemical processes occurring within it are at their greatest intensity. But it is not so. The malarious contents of the local atmosphere are less in the noonday hours than at the beginning and close of the day—that is, after sunrise and, above all, after sunset. Now, it is exactly at these two periods of the day that the difference between the temperature of the lower strata of the atmosphere and the temperature of the surface of the soil is greatest, and that the currents of air which ascend vertically from the soil into the upper atmosphere are at their strongest. Admitting that the malaria is formed of solid particles of low specific gravity (such as are the germs of the inferior vegetations), we see at once how it ought to accumulate in the lower strata of the atmosphere, especially in those two periods of the day.

The tendency among investigators has always been to attribute this specific poisoning of the air to a living organism which multiplies in the soil; but, unfortunately, the "palustral prejudice," as Dr. Tommasi Crudeli calls it, has led them to examine only the lower organisms which haunt marshes. In 1879 the author, in conjunction with Dr. Klebs, discovered the cause of malaria in a "schizomyces bacillaris," and recently Drs. Marchiafava and Celli have demonstrated that this parasite attacks directly the globules of the blood and destroys them after having determined in them a series of characteristic alterations, which indicate quite certainly the existence of a malarious infection. "Many observations," says the author, "just completed in Rome, would tend to demonstrate that this parasite does not invariably assume the bacillary form described by Klebs and myself; but this purely morphological question need not concern the practical hygienist. For him it is essential to know that he has to deal with a living ferment which can flourish in soils the most diverse in composition, and without the presence of which neither marshes nor pools of putrescent water are capable of producing malaria."

Having incidentally shown that soils may contain this parasite in an inert state and not produce malaria till the circumstances favorable to its activity have arisen, Dr. Tommasi-Crudeli proceeds to demonstrate that among the conditions which assist the development of the malarious ferment contained in the soil and the excessive air accumulation of that ferment in the air, there are three of primary importance, as their concurrence is indispensable to the production of malaria. These are (1), a temperature not lower than 20°C. ; (2), a moderate degree of permanent humidity in the malarious soil ; and (3), the direct action of the oxygen of the air on the strata of the soil which contains the ferment. If one only of these three conditions be wanting, the development of malaria becomes impossible. Now, this is an important point in the natural history of malaria, as giving us the key to the chief part of the soil reclamation attempted by man.

First, let us take Nature's amelioration of the malarious countries, suspending as she does for a longer or shorter time the production of malaria. Winter, for example, causes in all these countries a purely thermic amelioration—that is, it suspends the production of malaria simply by making the temperature fall below the minimum required for the development of the poison. In fact, there are often, even in winter, sudden outbreaks of malaria when a sirocco-wind raises the temperature above this minimum. Again, during a very warm and dry summer, malaria is not developed, because the sun's rays have exhausted the humidity of the soil, so producing a purely hydraulic amelioration, which, as in the Roman Campagna, in 1881–'82, may last for a considerable time ; easily to be dissipated, however, by one steady shower. Finally, there may occur in nature purely atmospheric ameliorations, when the surface of the malarious soil is withdrawn from the direct action of the oxygen of the air by means of natural earth-coverings formed by alluvial deposits of healthy soil, or by means of the "earth-felt" wrought up from the soil by the roots of herbage in a natural meadow.

In their various attempts to suspend the development of malaria from the soil, men have tried to imitate Nature—to eliminate, that is to say, one of the three conditions indispensable to the multiplication of the specific ferment contained in that soil. Naturally enough, they have never attempted thermic ameliorations, such as Nature effects in winter, because it is not in their power to control the sun's rays. They have had to restrict their efforts to either hydraulic or atmospheric ameliorations ; but sometimes they have succeeded in happily combining the one and the other—that is, in eliminating at once the humidity of the soil and the direct action of the oxygen of the air upon it.

Hydraulic amelioration has assumed many forms, according to the nature and site of the malarious soil. Drainage, in which the ancient Romans excelled us, has been practiced in Italy both in deep and friable soils and in subsoils compact and almost impermeable, in which latter the "cunicular" drains of the Etruscans, Latins, Volscians, and Romans might even nowadays be studied with advantage.

Sometimes a twofold drainage of the upper, as well as the under aspect of the soil may be practiced—that is, draining the subsoil and increasing the evaporation of the surface water. The cutting down of forests in malarious countries has often proved an excellent means of amelioration; because, by removing every obstacle to the direct action of the sun's rays on the surface of the soil, its humidity during the warm season is sometimes entirely exhausted. In spite of universal experience of this fact, a school originating with the great Roman physician, Lancisi, has sustained the contrary, counseling the maintenance and even the extension of forests in malarious countries. Lancisi was completely possessed with the "palustral prejudice," and believed that the malaria generated in the Pomptine Marshes, and attacking such townships as Cisterna, was intercepted, if only partially, by the forests between, and he therefore opposed the cutting down of the trees and recommended increased planting. He did not know that the malaria was already in the soil and covered by the forest in question. Some thirty years ago the Caetani family, to whom Cisterna belongs, cut down the forest, and twenty years thereafter Dr. Tommasi-Crudeli was able to show that the health of the neighborhood had greatly improved in consequence. A commission appointed by the Minister of Agriculture investigated the whole subject of the coexistence of woods with malaria, and in its report issued in 1884 completely disproved the theory of Lancisi and confirmed that of Dr. Tommasi-Crudeli.

Absorbent plants have been suggested and used as a means of drawing humidity from the soil, not without success in certain countries really malarious. The prejudice that the malaria is due to the putrescent decompositions of the soil has, in Italy, led to the choice of the *Eucalyptus globulus* as the tree best adapted to combat the poison, the idea being that the eucalyptus, which grows very rapidly, dries the humid earth, and at the same time by the aroma of its leaves destroys the so-called miasmata. No genuine instance of the eucalyptus having succeeded in its allotted task is yet known to Dr. Tommasi-Crudeli, though he does not say that its success is impossible. Had its Italian patrons studied its action in its native Australia, where it flourishes much better than in Italy, they would have known that there are eucalyptus forests in those latitudes where malaria is very prevalent, as has been shown by Professor Liversidge, of the University of Sydney. The cultivation of the tree at the Tre Fontane, near Rome, which it was thought would prove entirely successful in combating the local malaria, disappointed expectations, for in 1882 that hamlet was the scene of a severe outbreak of the fever, while the rest of the Campagna was unusually exempt from it. The eucalyptus, in fact, is a capricious tree in European soil; while in full leaf, during the winter, it is often killed by nocturnal frost, and even by the late frosts of spring, to say nothing of humid cold and other adverse influences not yet formulated by the botanist; again, when the winters are mild and the soil deep, it often shoots up rapidly, only to be snapped asunder by winds of moderate strength. Eucalyptus plantations, moreover, are very costly. If the ground is watery, it has to be drained, otherwise the roots rot; if the ground is heavy, trenches must be dug in it to make room for the long roots of the trees, and often these trenches have to be drained, as is done in the case of olives, in order to prevent the filtration water from stagnating and the roots from rotting. Hydraulic amelioration must have recourse to means less uncertain; and should the conditions of any locality counsel a trial of an absorbent plantation, it should be done with trees of our own hemisphere. The expense is smaller, and the trees are sure not to die.

At best, hydraulic amelioration is never certain, because the slight humidity of the soil necessary to develop malaria may easily be restored to it, even during the warm season. Combination of atmospheric with hydraulic amelioration has therefore been tried: to withdraw, that is to say, the humidity from the soil, while at the same time preventing the direct contact of the air with its malarious strata. Leaving the soil with layers of sound earth spread over it either alluvially or by the hand of man, and also draining the soil itself, was last year, at the instance of Dr. Tommasi-Crudeli, practiced on the grounds of the Janiculan Hill, near the Palazzo Salviati, in the Lungara. The entire area, having been thoroughly well drained and then covered with a dense coating of meadow soil in all those places which could not be paved with street rubble, has since remained without a single case of fever in the numerous *personnel* of the Military College occupying the Palazzo Salviati, while in the Palazzo Corsini, on the same side of the Lungara, but looking on the grounds of the Janiculan which are still exposed to the air and sun, there have within the same period been not a few cases of fever, some of them fatal.

THE ENERGY OF LIFE EVOLUTION, AND HOW IT HAS ACTED.

By Professor EDWARD D. COPE.

HAVING pointed out in a previous essay the lines of descent of vertebrata which have been brought to light by paleontological investigation, I propose to produce in the present article some evidence as to the nature of the forces which have been actively at work in effecting those changes of structure which constitute the evolution of one type of animal from another. We can obtain this evidence by comparing the successive steps of each line with one another. We thus learn the nature of the modifications, and can, as the case may be, surmise or demonstrate their causes. It is evident that, without the genealogical lines which paleontology presents, it is impossible that our hypotheses on this subject can rest on any solid basis. With these lines completed, we will be able, on the other hand, ultimately to reach a demonstration in most if not all the cases which present.

In the first place, there has long been before the world a theory to account for these changes, and that is the doctrine of use and disuse, propounded by Lamarck. He believed that the use of a part of an animal caused it to grow larger, and that in consequence of disuse a part would grow smaller or become extinct. Another theory is frequently spoken of, as though it accounted for the origin of changes, and that is the Natural Selection of Darwin. While naturalists are generally agreed as to the importance of this principle in modifying the results of the creative energy, but few of them regard it as explaining in any way the *origin* of the changes with which it deals. In the very nature of things, "selection" can not act until alternatives have been presented. And Mr. Darwin and others, who treat of natural selection as though it were a cause of new structures, always premise by admitting that "there is in organic beings a natural tendency to variation." It is in accounting for this variation that the Lamarckian hypothesis is useful, and probably expresses a great law of organic nature. In the same way most of those who write of the "influence of the environment" (which Lamarck, by-the-way, fully considered), as though it embraced the causes of evolution, forget that the energy which impresses an animal from this source could have no effect unless the animal possess some impressibility or capacity for response. And they also often forget that an animal capable of free movement is able to modify its environment very materially.

There is one element of weakness in the Lamarckian theory of use. This is that use implies the presence of something to use, or the existence of a usable part or organ. It is thus incompetent to explain the *origin* of such a part *ab initio*, although it may account for the details of its structure, as its segmentation, branching, etc. So I have added to use the energy of *effort*, and the Lamarckian theory, completed, can be characterized as the theory of the origin of species, by *effort, use, and disuse*. A prominent cause of change of structure may be here referred to ; and that is, change in consequence of excess or diminution of growth-energy, due to the action of use and effort in disturbing its equilibrium. That is to say, that excessive growth in one place has caused diminished growth in another, and *vice versa*. This derivative hypothesis explains the origin of many structures which are not useful to the possessor, and of others which appear to be positively injurious. Such characters can not, of course, be accounted for by the direct action of effort and use, which are necessarily directed toward beneficial ends. There are also numerous characters, chiefly of an ornamental nature, as color, etc., which are the direct result of the physical impress of the environment, as temperature, light, humidity, movements of the medium, etc., which are only influenced by the animal as it places itself, by its movements, within or without the range of their influence. In spite of these facts, I believe the movements and habits of animals to lie at the foundation of their principal characters, and that the superstructure, be it due to whatever cause it may, rests upon that foundation. It will now be well to take a look at the evidence in favor of or against these theories, as presented by the science of vertebrate paleontology. A few examples will suffice.

In the first place, I will select an illustration of the effects of use on the articulations of the limbs and feet of the mammalia. I take first the ankle- and wrist-joints. In the ruminating animals (ox, deer, camel, etc.) and in the horse, among other living species, the ankle-joint is a very strong one, and yet admits of an extensive bending of the foot on the leg. It is a treble tongue-and-groove-joint ; that is, two keels of the first bone of the foot, the astragalus, fit into two grooves of the lower bone of the leg, the tibia, while between these grooves a keel of the tibia descends to fill a corresponding groove of the astragalus. Such a joint as this can be broken by force, but it cannot be dislocated. Now, in all bones the external walls are composed of dense material, while the centers are spongy and comparatively soft. The first bone of the foot (astragalus) is narrower, from side to side, than the tibia which rests upon it. Hence the edges of the dense side-walls of the astragalus fall within the edges of the dense side-walls of the tibia, and they appear to have pressed into the more yielding material that forms the end of the bone, and pushed it upward, thus allowing the side-walls of the tibia to embrace the side-walls of the astragalus. Now, this is exactly what would happen if two pieces of similar dead material, similarly placed, should be subjected to a continual pounding in the direction of their length for a long period of time. And we can not ascribe any other immediate origin to it in the living material ; but the probability of such origin is more probable in such substance, because of the perpetual waste and repair which are going on, and because of

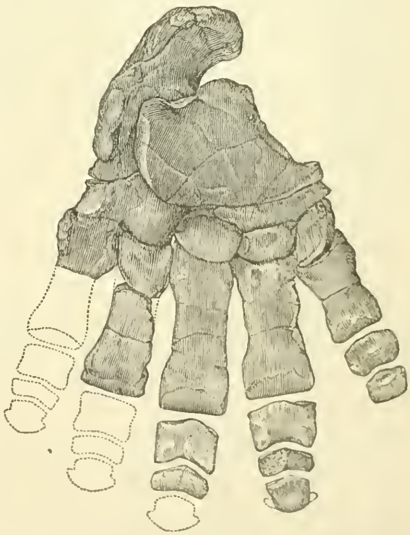


FIG. 1.—HIND-FOOT OF CORYPHODON ELEPHANTOPUS, showing flat astragalus for ankle-joint. (From Eocene bed of New Mexico.) One half natural size.

the wonderful power which we so often see in growth, in repairing damages, and in providing for new conditions in cases of accidents. This inclusion of the astragalus in the tibia does not occur in the reptiles, but appears first in the mammalia, which descended from them.

The same active cause that produced the two grooves of the lower end of the leg produced the groove of the middle of the upper end of the astragalus. Here we have the yielding lower end of the tibia resting on the equally spongy material of the middle of the astragalus. There is here no question of the hard material cutting into soft, but simply the result of continuous concussion. The consequence of concussion would be to cause the yielding faces of the bones to bend downward in the direction of gravity. If they were flat at first they would begin to hollow downward, and a tongue above and groove below would be the result. And that is exactly what has happened. Without exception, every line of mammalia commenced with types with an astragalus which is flat in the transverse direction, or without median groove. From early tertiary times to the present day, we can trace the gradual development of this groove in all the lines which have acquired it. The upper surface becomes first a little concave; the concavity gradually becomes deeper, and finally forms a well-marked groove.

The history of the wrist-joint is similar. The surface of the fore-arm bones which joins the fore-foot is in the early tertiary mammalia uniformly concave. In the ruminating mammals it is divided into three fossæ, which are separated by sharp keels. These fossæ correspond with the three bones which form the first row of the carpus or palm. The keels correspond to the sutures between them. The process has been evidently similar to that which has been described above as producing the side-grooves in the end of the tibia. The dense walls of the sides of the three bones impinging endwise on the broad yielding surface of the fore-arm (radius) have gradually, under the influence of countless blows, impressed themselves into the latter. On the contrary, the surface above the weaker lines between the bones not having been subject to the impact of the blows, and influenced by gravity, remains to fill the grooves, and to form the keels which we observe.

There is another striking instance of the same kind in the feet of mammalia; that is, in the development of the keels and grooves which appear at the articulation of the first set of bones of the toes (metapodials) with the bones of the second set (phalanges). These keels first appear on the posterior side of the end of the first set of bones, projecting from between two tendons. These tendons, in many mammals, contain two small bones, one on each side, which act like the knee-pan, and resemble it in miniature, which are called sesamoid bones. These tendons and bones exercise a constant pressure on each side of the middle line, when the animal is running or walking, and this pressure, together with the concussion with the ground, appears to have permitted the protrusion of the middle line in the form of a keel, while the lateral parts have been supported and even compressed. The reptilian ancestors of the mammals do not possess these keels.

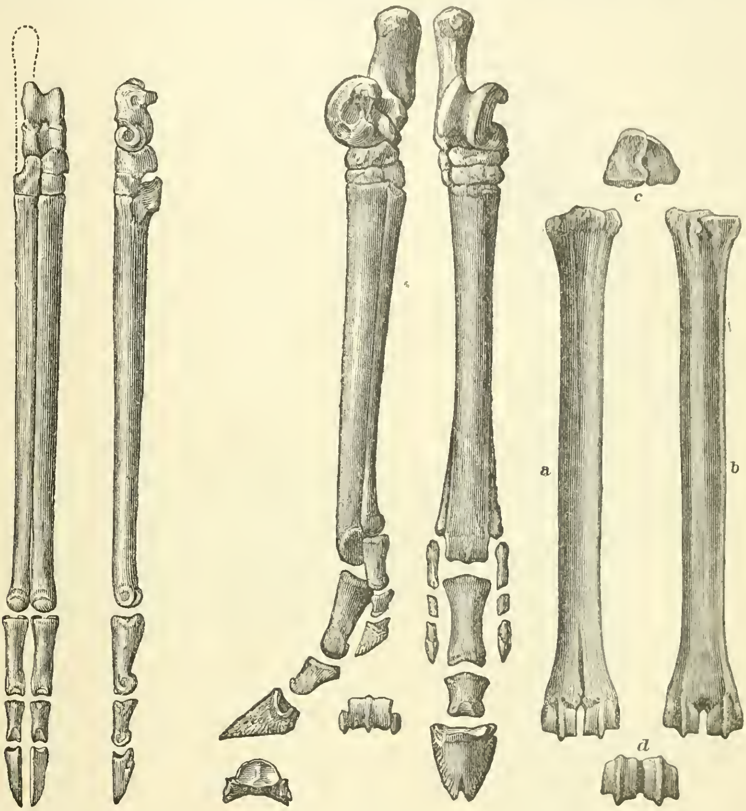


FIG. 2. FIG. 3. FIG. 4.

FIG. 2.—HIND-FOOT OF PRIMITIVE CAMELOID POËBROTHERIUM LABIATUM, showing grooved astragalus and first toe-bones without keel in front at lower end. (From Colorado.)

FIG. 3.—HIND-FOOT OF THREE-TOED HORSE (*Protohippus sejunctus*) (from Colorado), showing grooved astragalus, and trace of keel on front of lower end of first bone of middle toe.

FIG. 4.—UNITED FIRST BONES OF TWO MIDDLE TOES OF DEER-ANTELOPE (*Cosoryx furcatus*), showing extrusion of keel on front of lower end. (From Miocene of Nebraska.)

Now, the lines of mammalian descent displayed by paleontology are characterized, among other things, in most instances, by the gradual elevation of the heel above the ground, so that the animal walks on its toes. It is evident that in this case the concussion of running is applied more directly on the ends of the bones of the foot than is the case where the foot is horizontal. As a consequence we find the keel is developed farther forward in such animals. But in many of these, as the carnivora, the hippopotamus, and the camels, there is developed under the toes a soft cushion, which greatly reduces this concussion. In these species the keel makes no further progress. In other lines, as those of the horse, the pig, and of the ruminants, the ends of the toes are applied to the ground, and are covered with larger hoofs, which surround the toe, and the cushion is nearly or quite dispensed with. These animals are especially distinguished by the fact that their metapodial keels extend entirely round the end of the bone, dividing the front, as well as the end and back, into two parts. This structure would seem to be a result of the greater force of the impact resulting from use of the legs, experienced by the end and front of the bone, which receives the blows.

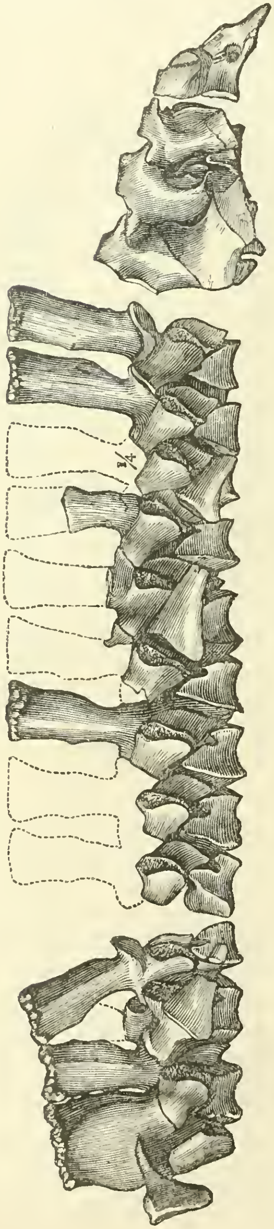


Fig. 5.—Part of Vertebral Column of the Fossil Batrachian *Eryops megacephalus*, one fourth natural size, showing segmentation, the left side.

I cite one more instance of the effect of use on the structure of the skeleton, and this time from the vertebral column. In a certain order of *Batrachia* from the Permian formation (the *Rhachitomi*), the bodies of the vertebræ are curiously segmented. Instead of a solid slightly modified from a cylinder, as in most vertebrates, we have three pieces. One of these is of nearly the form of a segment cut from an apple or orange having a crescentic outline and wedge-shaped section. The sharp edge is concave and is directed upward. On one side of each of the horns of this crescent a rhombic piece is applied, which, widening upward, supports the separate arch of the vertebra. These three pieces when together leave a central vacancy, which becomes, when all the vertebræ are placed end to end, a canal or tube. This was occupied by what is known as the chorda dorsalis, which is the central axis of the body of the simplest vertebrates, and is present in the early embryonic stages of all. In the growth of a reptile or mammal this flexible chorda is replaced by the bony vertebral bodies. The osseous material appears in the membranous sheath which covers it, and, gradually encroaching on it, first cuts it into segments and then fills it entirely. In the rhachitomous batrachia this process is not completed, as the chorda remains more or less entire; and the ossification of its sheath and substance is laid down in the three segments already described.

The two segments visible from one side of the column form two wedges with their apices together, and their bases one up and the other down. Now, if a person who wears a coat of rather thick material will examine the folds of his sleeve as they are produced on the inner side of his arm, he will see a figure nearly like that of the segments of the vertebral column described. The folds will correspond to the sutures, and the interspaces to the bony segments. He will find that the spaces are lens-shaped, or, when viewed in profile, wedge-shaped, with the apices together. This arrangement results from the necessary mechanics of flexure to one side. In flexure of a cylinder like the sleeve, or like a vertebral column, the shortest curve is along the line of the greatest convexity of the cylinder. Here is the closest folding of the sheath, and here, consequently, the lines of fold in soft material, or fracture in hard material, will converge and come together. That is just what they do in both the sleeve and the rhachitomous vertebral column, the only difference being that in the animal

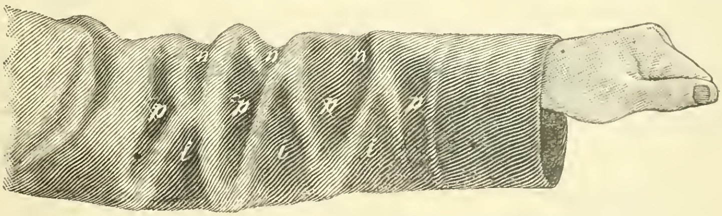


FIG. 6.—THE FOLDS ON THE INNER SIDE OF A COAT-SLEEVE, which correspond with the lines separating the segments of the vertebræ of the Eryops. The letter i is the basal segment or intercentrum; the p corresponds with the lateral segment, the pleurocentrum; and n represents the basal part at the upper or neural arch, which rests on p and i.

it is exhibited on both sides, and on the sleeve on only one side. This difference is, of course, due to the fact that the animal can bend himself in both directions, while the arm only bends in one direction.

It results from the above observations that the structure of the rhachitomous vertebral column *has been produced by the movements of the body from side to side, as in swimming, during the process of the deposit of mineral material* in and around the chorda dorsalis.* Here we have another convincing proof that use and effort have produced animal structure.

Instances like the above can be cited from many departments of zoölogy wherever paleontology has pointed out the lines of descent. I will not cite them further, but will draw some conclusions which are necessary and which are of general interest.

It is evident that use and effort imply some kind of movement on the part of the animal which puts them forth. Hence I have called

* This subject is more fully treated of in the "American Naturalist" for January, 1884.

the theory which holds that the structures of animals are the results of their movements the theory of kinetogenesis (from *kineo*, I move, and *genesis*). This theory is supported not only by the class of facts which I have adduced, but by another large class of a different kind, which demonstrate the alternative proposition, viz., that disuse is followed by loss and extinction of parts. This may be inferred from the very degenerate character of most animal parasites taken in connection with their embryology. The absence of limbs, of segments, of sense-organs, and even of more important vital organs observed in various parasites, is very remarkable. It is equally remarkable that the history of the development of such animals shows that in their earlier stages they are not parasitic, and possess many organs which are wanting in the adult. This brief history, condensed into the life of each individual parasite, no doubt, as in all growth-history, merely repeats that of the species as a whole. It teaches us that the ancestors were active, independent swimmers or fliers, as the case may have been, and that by the adoption of parasitic habits they ceased to use the many parts, which consequently dwindled and disappeared. This conclusion is sustained by paleontology wherever evidence can be obtained from that source. This is most evident in the history of the reptiles. Many forms of lizards of the present period are known to display curious defects. Such are the absence of some or all of the toes ; of some or all of the limbs ; of the eyelids ; of the dermal folds about the eyes ; and, finally, of the eyes themselves. Paleontology shows that these are not ancient or primitive types which survived, but that they are modern. Now, nearly all such lizards have habits which involve the least possible use of the limbs and of the sense of sight ; they are subterranean, and many of them inhabit ants' nests and devour those insects for food. It is evident that here is a kind of parasitism, and its consequences are of the most marked character.

The nature of animal movements may now claim our attention. These, we know, are referred to two general divisions, the automatic and the voluntary. The popular definition of these classes of movements is that, in the latter case, choice or preference, and therefore will, is supposed to be exercised, and that in the former there is no such quality displayed. The automatic movements are called mechanical, and may be performed unconsciously, as the movements of the heart and digestive system, etc. Rigorously, however, the so-called voluntary acts do not proceed from any freedom or will proper on the part of an animal. They appear to do so, because they display intelligence of a higher order than the automatic acts, although it is true that intelligent design is not wanting from the latter either. Moreover, the so-called voluntary acts may be unconsciously performed, and the automatic may be consciously performed, as in the winking of the eyes and breathing, when attention is directed to them. So, then, the classification into conscious and unconscious is quite independent of that into voluntary and automatic. As the term voluntary is misleading, the word ratiocinative has been substituted for it.

The relations of animal acts may, then, be considered as follows: Automatic acts display design for the well-being of the animal, but are invariable in their action, not changing immediately in adaptation to new or modified needs. Ratiocinative acts, on the other hand, are performed in accordance with circumstances as they arise, and are not rhythmical or invariable in their action. Their existence implies the presence of a certain development of mind, which the automatic acts do not so obviously display. Ratiocinative acts are very common in animals, as those who observe them can always testify. The automatic acts increase in relative importance as we descend the scale of being, but as they also display a general beneficial design it is not possible to draw the line between them and the ratiocinative. In fact, the one passes into the other by the well-known process which I call cryptonoÿ, as will presently be explained. If acts affect structure, it is evident, that if the acts are beneficial, the structure they produce must be so also. From what has preceded, it is also evident that the more intelligent acts will produce correspondingly more beneficial structures than the less intelligent. But since these changes are only effected by long-continued movements on the part of an animal, it is clear that an act is likely to become automatic before it can become an important cause of evolution of animal forms. The history of animal movements has probably been as follows:

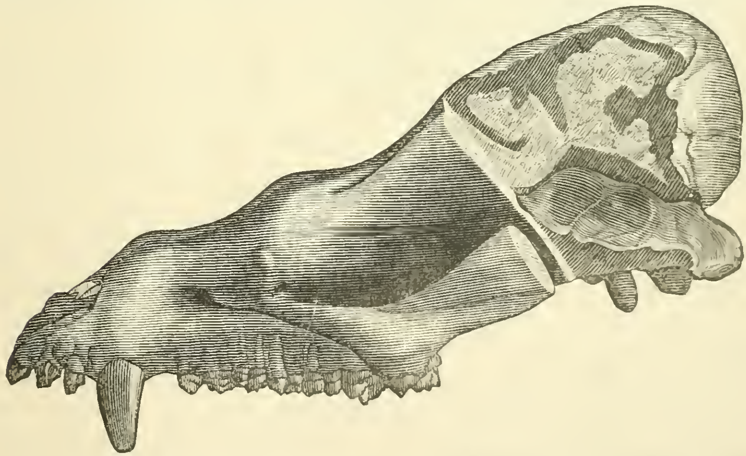


Fig. 7.—Skull of Coryphodon elephantopus, two ninths natural size; a corner removed from the skull so as to display the small brain-cavity at the base. (From New Mexico.)

Protoplasm presents certain movements, of which contractility is one, which will respond to certain stimuli under proper conditions of nutrition and temperature. It may perform movements which cause a simple mass of it to change its location in a fluid medium. Such acts, however, lack the element of design, or adaptation to the needs of the animal, whether they be constant or temporary ones. In order to display this property it is necessary that sensation should exist, and that this should be pleasurable or painful, in order to produce a determinate movement to increase the one or escape the other. This is the basis of all design, for without consciousness there can be no design. Just where this consciousness first displays or displayed itself in living things it is not possible to know at present with certainty, but its first exhibition was probably in the pain of hunger. The first designed act was, then, the taking of food. The first structure was, therefore, also some kind of arrangement for seizing and surrounding food. This having been performed, another set of functions had its birth, one which was destined to follow all new experiences, and in turn to dominate all later acts. This is the memory of the act and of its consequences, which remains as the basis of mind. An impress once made on consciousness is not lost, because it has modified the molecular structure of some part of the living material in a way as yet unknown to us. The movement which results from this memory is the first designed act, and this also affects structure, and produces the first motor link between mind and body, as the first stimulus perceived produced the first sensory link. From this time onward the law of use and effort has its way. Its first result is to build a mind-machine, or nervous system, or its equivalent. This kind of building has evidently preceded all others in time, and its latest and highest product is the human brain. The evidence of vertebrate paleontology places this statement beyond the stage of mere hypothesis. We have learned that, with a few minor exceptions, the brains of the vertebrata, and especially of the mammalia, have greatly increased in complexity and in size with the lapse of geological time. This is illustrated by the accompanying figures of the brain-chambers or casts of brain-chambers of two ancient and one late Tertiary mammals. The *Coryphodon elephantopus* is the largest animal of the three, and the *Phenacodus primævus*, of which the skeleton was figured in the preceding article, is a little smaller than the *Procamelus occidentalis*, the third species. The last is the latest species in time, and is one of the ancestors of the existing camels and llamas. The much greater size and complexity of the brain, and especially of the cerebral hemispheres, as compared with the two other species, are striking.

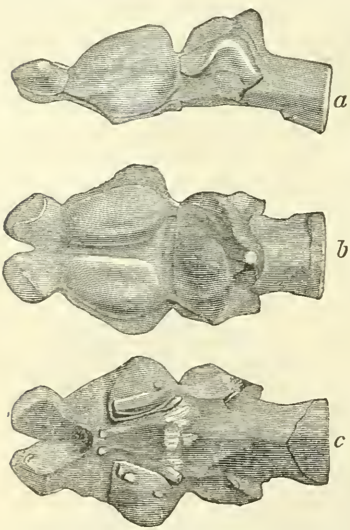


Fig. 8.—Cast of Brain-Cavity of Phenacodus primævus, showing small hemispheres: *a*, side; *b*, from above; *c*, from below. One half natural size. (From Wyoming.)

We have now the beginning of an explanation of the element of design in the movements of animals. But, first, the explanation is necessary to account for the long-continued automatic acts which have changed the hard and apparently fixed structures of so many of the higher forms of life.

Automatic and unconscious ratiocinative acts are the product of conscious ratiocinative acts by the process of cryptonoÿ already referred to. This process is one of the most wonderful which the field of science presents to our contemplation. It is simply this: that when a brain, or other organ of consciousness, has once acquired an habitual movement, consciousness disappears from that act, and it enters the unconscious and generally automatic stage. This demonstrates two things: First, that consciousness is not necessary to a designed act which has become a habit, no matter how complicated that habit may be; second, *that consciousness does reside in matter which has not acquired habits, and which therefore does not yet possess the structure which makes such habits possible.*

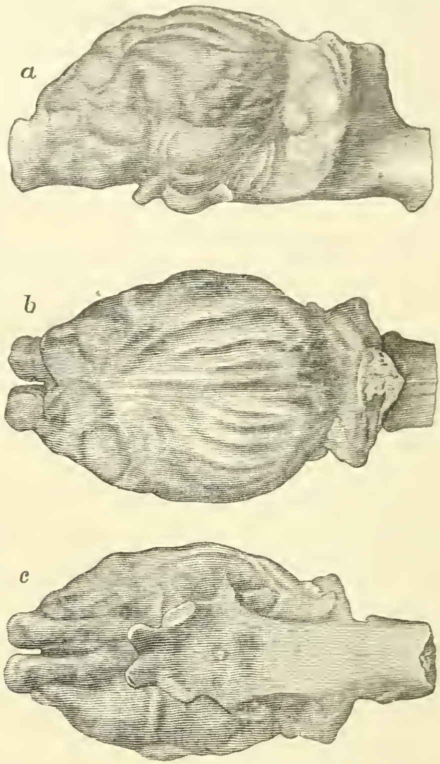


Fig. 9.—Cast of Brain-Cavity of P ocamelus occidentalis, one half natural size: *a*, profile; *b*, above; *c*, below. (From New Mexico.)

We now have a true theory of the influence of the environment on an animal. Sensation being understood, the animal proceeds to adapt itself to its surroundings by the adoption of appropriate habits, from which appropriate structures arise. Without such response on the part of the animal, the greater part of the world would have remained uninhabited by all but the lowest forms of life, and these too might have been extinguished. From the simplest temporary methods of defense and protection, animals have developed the habits of laying up stores, of building houses, of the arts of the chase, of migrations over wide territories. There can be no doubt that the constant exercise of the mind in self-support and protection has developed the most wonderful of all machines, the human brain, whose function is the most wonderful of phenomena, the *human** mind. And the acts of other parts of the organism, which have been the outcome of this process, have produced the varied structures which to-day constitute the animal kingdom.

It is thus shown to a demonstration, by means of the principle of kinetogenesis, that evolution is essentially a process of mind. The source of the consciousness, which is back of it, is at present an unsolved problem. That it has existed and does exist, there can be no question, and there is no sufficient reason for supposing that it will not continue to exist.

"THE METAPHYSICAL SOCIETY."

A REMINISCENCE.

By R. H. HUTTON.

IN the autumn of 1868 Mr. Tennyson and the Rev. Charles Pritchard—Savilian Professor of Astronomy—were guests together in my house.

A good deal of talk arose on speculative subjects, especially theology, and in the course of it the idea was suggested of founding a Theological Society, to discuss such questions after the manner and with the freedom of an ordinary scientific society.

I volunteered to endeavor to bring such a body together if Mr. Tennyson and Mr. Pritchard would promise to belong to it, and I then consulted other friends, beginning with Dean Stanley, Dean Alford, Archbishop Manning, the Rev. James Martineau, the Bishop of Gloucester and Bristol, Dr. Ward of the "Dublin Review," Mr. R. H. Hutton of the "Spectator," and one or two more, finding them all willing to join. I next went to "the opposition," and, explaining our plan, found Professor Huxley, Professor Tyndall, Mr. Froude, Mr. Walter Bagehot, Sir John Lubbock, and others, equally ready to co-operate.

The originally intended name of Theological Society was dropped in favor of "Metaphysical Society," under which full discussion of the largest range of topics from all points of view could be better insured, and on the 21st of April, 1869, we held our first meeting at Willis's Rooms.

I remember Mr. Froude—who was among our first members—saying that, if we hung together for twelve months, it would be one of the most remarkable facts in history. But we "hung together" for nearly twelve years, meeting once a month, usually at an hotel, where, after dining together, a paper was read by some member, and afterward discussed. Mr. Tennyson's remark at an early meeting seemed

* The word *human* is emphasized because it is not yet proven that protoplasm is the only possible physical basis of mind.

always borne in mind—that "modern science ought, at any rate, to have taught us one thing—how to separate light from heat."

When the list of members and the character of the subjects discussed are considered, many will agree that it is matter for congratulation, and a pleasant sign of the times, that such a society should have lived its full life in London in entire harmony. It came to an end because, after twelve years of debating, there seemed little to be said which had not already been repeated more than once. The members were as follows:

Mr. Tennyson.
Mr. Gladstone.
The Duke of Argyll.
Dean Stanley.
Archbishop Manning.
The Bishop of St. David's.
The Archbishop of York.
Prof. Huxley.
The Bishop of Peterborough.
Prof. Tyndall.
Mr. Frederic Harrison.
Lord Selborne.
Prof. Clifford.
Father Dalgairns.
Sir James Stephen.
Dr. Ward.
The Bishop of Gloucester and Bristol.
Dean Alford.
The Dean of St. Paul's.
Mr. Ruskin.
Mr. Froude.
Mr. Grant Duff.
Mr. Robert Lowe.
Rev. Prof. Maurice.
Rev. Prof. Pritchard.
Prof. Robertson.
Sir Alexander Grant.
Lord Arthur Russell.
Rev. Canon Barry.
Rev. James Martineau.
Prof. Seeley.
Mr. Walter Bagehot.
Sir John Lubbock.
Rev. Mark Pattison.
Dr. Carpenter.
Prof. Lushington.
Mr. Shadworth Hodgson.
Dr. Andrew Clark.
Mr. Leslie Stephen.
Mr. John Morley.
Sir William Gull.
Dr. Gasquet.
Prof. Fraser.
Mr. George Grove.
Rev. Dr. Mozley.
Mr. James Hinton.
Prof. Sylvester.
Dr. Bucknill.
Prof. St. George Mivart.
Prof. Barnes Upton.
Mr. Henry Sidgwick.
Mr. R. H. Hutton.
Rev. Robert Clarke.
Mr. W. R. Greg.
Mr. Matthew Boulton.
Mr. Frederick Pollock.
Dr. Acland.
Hon. Roden Noel.
Mr. James Knowles.

Among our chairmen—appointed annually, but sometimes serving for two years successively—were Sir John Lubbock, Cardinal Manning, Professor Huxley, Mr. Gladstone, Dr. Ward, Dr. Martineau, Lord Selborne, and Lord Arthur Russell.

The character of the subjects brought forward may be gathered from the titles of some of the papers, and, as the discussions were absolutely confidential and unreported, they were almost always of much animation and interest. They suggested to myself (as honorary secretary to the society) the idea of the "Modern Symposium" which several times appeared in this Review. The following were among the papers read before the society:

The Theory of Causation.
The Theory of a Soul.
Is God unknowable?
What is Death?
Will and Responsibility.
The Scientific Basis of Morals.
The Nature and Authority of Miracle.
Has a Frog a Soul?
On the words Nature, Natural, and Supernatural.
The Ethics of Belief.
What is Matter?
The Soul before and after Death.
What is a Lie?
How do we come by our Knowledge?
The Personality of God.
The Verification of Beliefs.
The Emotion of Conviction.
Memory as an Intuitive Faculty.
The Relation of Will to Thought.
Matter and Force.
The Absolute.
The Nature of Things in Themselves.
The Nature of the Moral Principle.
The Evidence of the Miracle of the Resurrection.
The Arguments for a Future Life.
Hospitals for Incurables from a Moral Point of View.
Double Truth.

The subjoined article, kindly volunteered by Mr. Hutton, was suggested by him, not as a portrait of any actual meeting, but as a reminiscence of the sort of debate which used to go on. Its faithfulness is remarkable, except for the omission of his own valuable part in the discussion.—Editor *Nineteenth Century.*]

The following attempt to give an impression of a typical meeting of the once rather famous "Metaphysical Society," of which I was throughout a member, must not be regarded as in any sense containing an historical report of an individual debate. No such reports were, so far as I know, ever taken. But to a rather diligent member of the society there were plenty of opportunities of learning the general views of the more eminent members on such a subject as was discussed at the meeting here selected for treatment; and though it is likely enough that none of them, except of course Dr. Ward, whose paper was really read (though he may have made no final reply), spoke on this particular occasion, as I have imputed to them; and though several of those to whom I have attributed remarks may not have been present at this particular discussion at all, yet I do not think I shall be found to have misrepresented any of their views.* If I have, the responsibility and fault are mine.

At the meeting of the Metaphysical Society which was held on the 10th of December, 1872, Dr. Ward was to read a paper on the question, "Can experience prove the uniformity of Nature?" "Middlemarch" had been completed and published a few days previously. On the day following the meeting the Convocation of Oxford was to vote upon the question raised by Mr. Burgon and Dean Goulburn, whether the Dean of Westminster (then Dr. Stanley) should be excluded for his heresies from the List of Select Preachers at Oxford or not. The "Claimant" was still starring it in the provinces in the interval between his first trial and his second. Thus the dinner itself was lively, though several of the more distinguished members did not enter till the hour for reading the paper had arrived. One might have heard Professor Huxley flashing out a skeptical defense of the use of the Bible in board-schools at one end of the table, Mr. Fitzjames Stephen's deep bass remarks on the Claimant's adroit use of his committal for perjury, at another, and an eager discussion of the various merits of Lydgate and Rosamond at a third. "Ideal Ward," as he used to be called, from the work on the "Ideal of a Christian Church," for which he had lost his degree nearly thirty years earlier at Oxford, was chuckling with a little malicious satisfaction over the floundering of the orthodox clergy, in their attempts to express safely their dislike of Dean Stanley's latitudinarianism, without bringing the Establishment about their ears. He thought we might as well expect the uniformity of Nature to be disproved by the efforts of spiritualists to turn a table, as the flood of latitudinarian thought to be arrested by Mr. Burgon's and Dean Goulburn's attempt to exclude the Dean of Westminster from the List of Select Preachers at Oxford. Father Dalgairns, one of Dr. Newman's immediate followers, who left the English Church and entered the Oratory of St. Philip Neri with him, a man of singular sweetness and openness of character, with something of a French type of playfulness in his expression, discoursed to me eloquently on the noble ethical character of George Eliot's novels, and the penetrating disbelief in all but human excellence by which they are pervaded. Implicitly he intended to convey to me, I thought, that

* Whenever those views were actually given in the words here used, though occurring in the reading of other papers, I have always placed them in inverted commas. Whenever no inverted commas are used the words and thoughts are mine, though I believe them to represent faithfully the views of the speakers to whom they are attributed.—R. H. H.

nowhere but in the Roman Church could you find any real breakwater against an incredulity which could survive even the aspirations of so noble a nature as hers. And as I listened to this eloquent exposition with one ear, the sound of Professor Tyndall's eloquent Irish voice, descanting on the proposal for a "prayer-gauge," which had lately been made in the "Contemporary Review," by testing the efficacy of prayer on a selected hospital ward, captivated the other. Everything alike spoke of the extraordinary fermentation of opinion in the society around us. Moral and intellectual "yeast" was as hard at work multiplying its fungoid forms in the men who met at that table as even in the period of the Renaissance itself.

I was very much struck then, and frequently afterward, by the marked difference between the expression of the Roman Catholic members of our society and all the others. No men could be more different among themselves than Dr. Ward and Father Dalgairns and Archbishop Manning, all of them converts to the Roman Church. But, nevertheless, all had upon them that curious stamp of definite spiritual authority which I have never noticed on any faces but those of Roman Catholics, and of Roman Catholics who have passed through a pretty long period of subjection to the authority they acknowledge. In the Metaphysical Society itself there was every type of spiritual and moral expression. The wistful and sanguine, I had almost said hectic idealism, of James Hinton struck me much more than anything he contrived to convey by his remarks. The noble and steadfast but somewhat melancholy faith which seemed to be sculptured on Dr. Martineau's massive brow, shaded off into wistfulness in the glance of his eyes. Professor Huxley, who always had a definite standard for every question which he regarded as discussable at all, yet made you feel that his slender definite creed in no respect represented the cravings of his large nature. Professor Tyndall's eloquent addresses frequently culminated with some pathetic indication of the mystery which to him surrounded the moral life. Mr. Fitzjames Stephen's gigantic force, expended generally in some work of iconoclasm, always gave me the impression that he was revenging himself on what he could not believe, for the disappointment he had felt in not being able to retain the beliefs of his youth. But in the countenances of our Roman Catholic members there was no wistfulness—rather an expression which I might almost describe as a blending of grateful humility with involuntary satiety—genuine humility, genuine thankfulness for the authority on which they anchored themselves; but something also of a feeling of the redundance of that authority, and of the redundance of those provisions for their spiritual life of which almost all our other members seemed to feel that they had but a bare and scanty pasturage.

Dr. Ward, who was to read the paper of the evening, struck me as one of our most unique members. His mind was, to his own apprehension at least, all strong lights and dark shadows. Either he was absolutely, indefensibly, "superabundantly" certain, or he knew no more "than a baby," to use his favorite simile, about the subjects I conversed with him upon. On the criticism of the New Testament, for instance, he always maintained that he knew no more than a baby, though really he knew a good deal about it. On the questions arising out of Papal bulls he would often say that he was as absolutely and superabundantly certain as he was of his own existence. Then he was a very decided humorist. He looked like a country squire, and in the Isle of Wight was, I believe, generally called "Squeer Ward"; but, if you talked to him about horses or land, he would look at you as if you were talking in an unknown language, and would describe, in most extravagant and humorous terms, his many rides in search of health, and the profound fear with which, whenever the animal showed the least sign of spirit, he would cry out, "Take me off! take me off!" He was one of the very best and most active members of our society, as long as his health lasted—most friendly to everybody, though full of amazement at the depth to which skepticism had undermined the creed of many among us. A more candid man I never knew. He never ignored a difficulty, and never attempted to express an indistinct idea. His metaphysics were as sharp cut as crystals. He never seemed to see the half-lights of a question at all. There was no penumbra in his mind; or, at least, what he could not grasp clearly, he treated as if he could not apprehend at all.

When dinner was over and the cloth removed, a waiter entered with sheets of foolscap and pens for each of the members, of which very little use was made. The ascetic Archbishop of Westminster, every nerve in his face expressive of some vivid feeling, entered, and was quickly followed by Dr. Martineau. Then came Mr. Hinton, glancing round the room with a modest half-humorous furtiveness, as he seated himself among us. Then Dr. Ward began his paper. He asked how mere experience could prove a universal truth without examining in detail every plausibly asserted exception to that truth, and disproving the reality of the exception. He asked whether those who believe most fervently in the uniformity of Nature ever show the slightest anxiety to examine asserted exceptions. He imagined, he said, that what impresses physicists is the fruitfulness of inductive science, with the reasonable inference that inductive science could not be the fruitful field of discovery it is, unless it rested on a legitimate basis, which basis could be no other than a principle of uniformity. Dr. Ward answered that the belief in genuine exceptions to the law of uniform phenomenal antecedents and consequents does not in the least degree invalidate this assumption of the general uniformity of Nature, if these exceptions are announced, as in the case of miracles they always must be, as demonstrating the interposition of some spiritual power which is not phenomenal, between the antecedent and its natural consequent —which interposition it is that alone interrupts the order of phenomenal antecedence and consequence. "Suppose," he said, that "every Englishman, by invoking St. Thomas of Canterbury, could put his hand into the fire without injury. Why, the very fact, that in order to avoid injury he must invoke the saint's name, would ever keep fresh and firm in his mind the conviction that fire does naturally burn. He would therefore as unquestioningly in all his physical researches assume this to be the natural property of fire as though God had never wrought a miracle at all. In fact, from the very circumstances of the case, it is always one of the most indubitable laws of Nature which a miracle overrides, and those who wish most to magnify the miracle are led by that very fact to dwell with special urgency on the otherwise universal prevalence of the law." There was a short pause when Dr. Ward had concluded his paper, which was soon ended by Professor Huxley, who broke off short in a very graphic sketch he had been making on his sheet of foolscap as he listened.

Dr. Ward, said Professor Huxley, had told us with perfect truth that the uniformity of Nature was only held, by even the most thoroughgoing of clear-minded physicists, as a fruitful working hypothesis, the assumption of which had led to a vast number of discoveries, which could not have been effected without it. If they could not assume that under heat the vapor of water would expand one day as it had expanded the previous day, no locomotive would be of any use; if they could not assume that under certain given conditions the majority of seeds put into the ground would spring up and reproduce similar seed, no fields would be sown and no harvest would be reaped. In innumerable cases where the same antecedents had apparently not been followed by the same consequents, thinking men had taken for granted that they must have been mistaken in supposing the antecedents to be the same, and had found that they were right, and that the difference in the antecedents had really been followed by the difference in the consequents. He, for his part, should not object at all to examine into any presumptive case of miracle sufficiently strong to prove that in a substantial number of cases Englishmen had been enabled to thrust their hands into the fire without injury, by adopting so simple a safeguard as calling on St. Thomas of Canterbury. But the truth was, that asserted miracles were too sparse and rare, and too uniformly accompanied by indications of either gross credulity or bad faith, to furnish an investigator jealous of his time, and not able to waste his strength on futile inquiries, with a sufficient basis for investigation. Men of science were too busy in their fruitful vocation to hunt up the true explanation of cases of arrested miracle, complicated as they generally were with all sorts of violent prepossessions and confusing emotions. He, for his part, did not pretend that the physical uniformity of Nature could be absolutely proved. He was content to know that his "working hypothesis" had been proved to be invaluable by the test of innumerable discoveries, which could never have been made had not that working hypothesis been assumed. Indeed, what evidence has any man even for the existence of his own home and family, better than that of a fruitful hypothesis, which has time after time resulted in the expected verification? No man can be absolutely certain that the home he left an hour ago is standing where it did, or that the family he left in it are still in life; still, if he acts on the hypothesis that they are there, he will, in innumerable cases, be rewarded for making that assumption, by finding his expectations verified, and in but a very few cases indeed be disappointed.

If, then, Dr. Ward asks, said Professor Huxley, whether or not I hold that experience can, in a mathematical sense, *prove* the uniformity of Nature, I answer that I do *not* believe it; that I believe only that, in the assumption of that uniformity of Nature, we have a working hypothesis of the most potent kind, which I have never found to fail me. But further, if I might use the word "believe" loosely, though with much less looseness than that with which men who are not students of science habitually use it, I should not hesitate to avow a belief that the uniformity of Nature *is* proved by experience, for I should be only too glad to think that half the "demonstrated" beliefs of metaphysicians are even a tenth part as trustworthy as the great working hypothesis of science. The man of science, however, "who commits himself to even one statement which turns out to be devoid of good foundation, loses somewhat of his reputation among his fellows, and if he is guilty of the same error often he loses not only his intellectual but his moral standing among them; for it is justly felt that errors of this kind have their root rather in the moral than in the intellectual nature." That, I suppose, is the reason why men of science are so chary of investigating the trustworthiness of the *soi-disant* miracles to which Dr. Ward is so anxious that we should pay an attention much greater than any which in my opinion they deserve. For the scientific man justly fears that, if he investigates them thoroughly, he shall wound many amiable men's hearts, and that if he does not wound amiable men's hearts he shall compromise his own character as a man of science.

As Professor Huxley's rich and resonant voice died away, Father Dalgairns, after looking modestly round to see whether any one else desired to speak, began in tones of great sweetness: Professor Huxley has implied that to the scientific student the words "I believe" have a stricter and more binding force than they have to us theologians. If it really be so, it is very much to our shame, for no words can be conceived which are to us more solemn and more charged with moral obligation. But I confess that the drift of Professor Huxley's remarks hardly bore out to my mind the burden of his peroration. It seems that "a working hypothesis" is the modest phrase which represents even the very maximum of scientific belief, for would Professor Huxley admit that he has any belief, except of course one resting on an immediately present consciousness, deeper than his belief in the uniformity of Nature? I suppose not. Now, theologians are accustomed to assert, and I think with justice, that it is impossible to entertain any belief—whether it be only a working hypothesis or something more—in the uniformity of Nature, without basing it on the irrefragable trustworthiness of the human faculties. In one of our earliest discussions Dr. Ward proved his case that on the irrefragable trustworthiness of memory, for example, for all facts which it positively asserts, rests the whole structure of human knowledge; and this in a sense much deeper than any such expression as "working hypothesis" will express. Without assuming this irrefragable trustworthiness, Dr. Ward has reminded us that I could not now know that I am replying to Professor Huxley at all, or indeed who I myself am, or who is Professor Huxley. Without absolutely assuming the trustworthiness of memory, how should I have the least glimmering of a conception of that expressive personality from whose mouth the weighty utterances we have just heard proceeded? Yet if you grant me the trustworthiness of memory, when it speaks positively of a recent experience, can you deny me the trustworthiness of other human faculties equally fundamental? Is my "belief" in the distinction between right and wrong, between holiness and sin, any less trustworthy than my belief in the asseverations of my memory? Did not Professor Huxley himself suggest in his closing remarks that the *moral* roots of our nature strike deeper than the intellectual roots; in other words, that if memory be much more than a "working hypothesis," if its trustworthiness be the *condition* without which no working hypothesis would be even possible, there are moral conditions of our nature quite as fundamental as even the trustworthiness of memory itself? I hold it, I confess, most irrational to have an absolute and undoubting belief in the uniformity of Nature based on any accumulation of experience, for no such accumulation of experience is possible at all without an absolute and undoubting belief in the past, and this no merely present experience can possibly give us. And I hold such a belief in the uniformity of Nature, based on anything but the trustworthiness of our faculties, to be irrational, for precisely the same kind of reason for which I hold it to be irrational to question the belief in God. The solemnity which Professor Huxley attaches to the words "I believe," I attach to them also. Moreover, I could not use them in their fullest sense of anything which I regard merely as a "working hypothesis," however fruitful. But I deny that we theologians regard our deepest creed as a working hypothesis at all. We accept the words "I believe in God," as we accept the words "I believe in the absolute attestations of memory," as simply forced upon us by a higher intuition than any inductive law can engender. When I say "I believe in God," I use the word believe just as I use it when I say "I believe in moral obligation," and when I say "I believe in moral obligation," I use the word believe just as I do when I say "I believe in the attestations of memory." "God is not necessary only to my conception of morality. His existence is necessary to the existence of obligation." I know God by "a combination of intuition and experience, which is Kant's condition of knowledge. If there be a God, our imagination would present him to us as inflicting pain on the violator of his law, and lo! the imagination turns out to be an experienced fact. The Unknowable suddenly stabs me to the heart." I believe in the uniformity of Nature only in the sense in which I believe in every other high probability—for instance, only in the sense in which I believe that the sun will rise to-morrow. I believe in God in the sense in which I believe in pain and pleasure, in space and time, in right and wrong, in myself, in that which curbs me, governs me, besets me behind and before, and lays its hand upon me. The uniformity of Nature, though a very useful working hypothesis, is, as Professor Huxley admits, unproved and unprovable as a final truth of reason. But "if I do not know God, then I know nothing whatsoever," for if "the pillared pavement is rottenness," then surely also is "earth's base built on stubble."

There was a certain perceptible reluctance to follow Father Dalgairns, which lasted some couple of minutes. Then we heard a deep-toned, musical voice, which dwelt with slow emphasis on the most important words of each sentence, and which gave a singular force to the irony with which the speaker's expressions of belief were freely mingled. It was Mr. Ruskin. "The question," he said, "Can experience prove the uniformity of Nature? is, in my mind, so assuredly answerable with the negative which the writer appeared to desire, that precisely on that ground the performance of any so-called miracles whatever would be really unimpressive to me. If a second Joshua to-morrow commanded the sun to stand still, and it obeyed him, and he therefore claimed deference as a miracle-worker, I am afraid I should answer: 'What! a miracle that the sun stands still?—not at all. I was always expecting it would. The only wonder to me was its going on.' But even assuming the demonstrable uniformity of the laws or customs of Nature which are known to us, it remains to me a difficult question what measure of interference with such law or custom we might logically hold miraculous, and what, on the contrary, we should treat only as proof of the existence of some other law hitherto undiscovered. For instance, there is a case authenticated by the signatures of several leading physicians in Paris, in which a peasant-girl, under certain conditions of morbid excitement, was able to move objects at some distance from her without touching them. Taking the evidence for what it may be worth, the discovery of such a faculty would only, I suppose, justify us in concluding that some new vital energy was developing itself under the conditions of modern life, and not that any interference with the laws of Nature had taken place. Yet the generally obstinate refusal of men of science to receive any verbal witness of such facts is a proof that they believe them contrary to a code of law which is more or less complete in their experience, and altogether complete in their conception; and I think it is therefore the province of some one of our scientific members to lay down for us the true principle by which we may distinguish the miraculous violation of a known law from the natural discovery of an unknown one. . . . However," he proceeded, "the two main facts we have to deal with are that the historical record of miracle is always of inconstant power, and that our own actual energies are inconstant almost in exact proportion to their worthiness. First, I say the history of miracle is of inconstant power. St. Paul raises Eutychus from death, and his garments effect miraculous cure, yet he leaves Trophimus sick at Miletus, recognizes only the mercy of God in the recovery of Epaphroditus, and, like any uninspired physician, recommends Timothy wine for his infirmities. And in the second place, our own energies are inconstant almost in proportion to their nobleness. We breathe with regularity, and can count upon the strength necessary for common tasks, but the record of our best work and our happiest moments is always one of success which we did not expect, and of enthusiasm which we could not prolong."

As Mr. Ruskin ceased, Walter Bagehot, the then editor of the "Economist," and a favorite among us for his literary brilliance, opened his wide black eyes, and, gulping down what seemed to be an inclination to laugh at some recollection of his own, said: Mr. Ruskin's remark that he had always been expecting the sun to stand still was to me peculiarly interesting, because, as I have formerly told the society, whatever may be the grounds for assuming the uniformity of Nature, I hold that there is nothing which the natural mind of man, unless subjected to a very serious discipline for the express purpose of producing that belief, is less likely to assume. A year or two ago I ventured to express in this room the opinion that credulity is the *natural* condition of almost every man. "Every child," I said, "believes what the footman tells it, what the nurse tells it, and what its mother tells it, and probably every one's memory will carry him back to the horrid mass of miscellaneous confusion which he acquired by believing all he heard." I hold that children believe in the suggestions of their imaginations quite as confidently as they believe in the asseverations of their memories; and if grown-up men do not, it is only that their credulity has been battered out of them by the hard discipline of constant disappointment. What can be better evidence that there is at least no *a priori* belief in the uniformity of Nature than the delight in fairy tales, which, certainly in childhood, are accepted with quite as much private belief that some great enchanter's wand will be triumphantly found at last, as are the dullest and most matter-of-fact of histories? Indeed, you will find in almost every young person of any promise the profoundest tendency to revolt against the law of uniform succession as too dull to be credible, and to exult in the occasional evidence which the history of their time affords that "truth after all is stranger than fiction." Is not the early love of tales of marvel, and the later love of tales of wild adventure and hair-breadth escapes, and again, the deep pleasure which we all feel in that "poetic justice" which is so rare in actual experience, a sufficient proof that men retain, even to the last, a keen prepossession against the doctrine that laws of uniform antecedency and consequence can be traced throughout the most interesting phases of human life? Even in the city, where so many hopes are crushed every day, the "Bull" goes on believing in his own too sanguine expectations, and the "Bear" in his own dismal predictions, without correcting his own bias as experience should have led him to correct it. I believe it will be found that nothing is more difficult than to beat into the majority of minds the belief that there is such a thing as a "law of Nature" at all. So far as I can judge, nine women out of ten have never adequately realized what a law of Nature means, nor is the proportion much smaller for men, unless they have been well drilled in some department of physics. Of course, I heartily agree with Dr. Ward that experience can not *prove* the uniformity of Nature, and for this very good reason, among others, that it is impossible to say what the uniformity of Nature means. We can not exhaust the number of interfering causes which may break that uniformity. I at least can not doubt that, so far as mind influences matter, there may be a vast multitude of real disturbing causes introduced by mind to break through those laws of uniformity in material things, of which at present we know only the elements. But of this I am very sure, that at present we are much apter to accept superficial and inadequate evidence of the breach of laws of uniformity than we ought to be; that education does not do half enough to beat out of our minds that credulous expectation that there is some disposition in the governing principles of the universe, either to favor us or to persecute us, as the case may be, which springs, not from experience, but from groundless prejudice and prepossession; and that much greater efforts should be made to set before young people the true inexorability of Nature's laws than is actually made at present. It is quite true that no man can say positively either that the sun will rise to-morrow, or that an iron bar will fall to the ground if the hand drops it. We do not absolutely *know* that the sun may not blaze up and go out before to-morrow, as it is said that some stars of considerable magnitude have blazed up and gone out. We do not know that there may not be some enormously powerful and invisible magnet in the neighborhood which will attract the iron bar upward with more force than that with which the earth pulls it downward. But we do know that in millions and billions of cases expectations founded on the same sort of evidence as the expectation that the sun will rise to-morrow, and that the dropped bar will fall to the earth, have been verified, and that the imaginative illusion which half-educated people still so often indulge, that exceptions will occur for the occurrence of which there is no rational evidence, is a most mischievous one, which we ought to try to eradicate. We ought to engage what I have ventured in this society to call the "emotion of conviction," the caprices of which are so extravagant and so dangerous, much more seriously on the side of the uniformity of Nature than we have ever hitherto done. We should all try to distinguish more carefully than we do between possibility, probability, and certainty. It is not as certain that the sun will rise to-morrow as it is that I was cold before I entered this room; it is not as certain that Messrs. Baring's acceptances will be paid as it is that the sun will rise to-morrow; it is not as certain that Peel's Act will always be suspended in a panic as it is that Messrs. Baring's acceptances will be paid. And it is difficult for "such creatures as we are" to accommodate our expectations to these varying degrees of reasonable evidence. But though experience, however long and cumulative, can never prove the absolute uniformity of Nature, it surely ought to train us to bring our expectations into something like consistency with the uniformity of Nature. And as I endeavor to effect this in my own mind, I certainly can not agree with Mr. Ruskin that I have always been "expecting" the sun to stand still. Probably as a child I was always expecting things quite as improbable as that. But if I expected them now I should not have profited as much by the disillusionizing character of my experience as I endeavor to hope that I actually have.

There was a general smile as Bagehot ceased, but the smile ceased as Mr. Fitzjames Stephen—the present Sir James Stephen—took up the discussion by remarking, in the mighty bass that always exerted a sort of physical authority over us, that while the society seemed to be pretty well agreed upon the main question, namely, that the uniformity of Nature could not be absolutely proved by experience, or, indeed, by any other method, there was a point in Dr. Ward's paper, namely, the challenge to examine seriously into the authenticity of miracles, which had not been dealt with. For my part, he said, I am quite ready to examine into the evidence of any so-called miracle, that is, into the evidence of any unusual event which is offered to prove Divine interference in our affairs, when it comes before me with sufficient presumption of authority to render it worth my while to investigate it; though I probably should not agree with Dr. Ward as to what constitutes such a presumption. Certainly "a bare, uncorroborated assertion by a person professing to be an eye-witness of an event is not sufficient evidence of that event to warrant action of an important kind based upon the supposition of its occurrence. When you are obliged to guess, such an assertion may be a reason for making one guess rather than another. Less evidence than this would make a banker hesitate as to a person's credit, or would lead a customer to doubt whether his banker was solvent; but in such cases all that is possible is a guess more or less judicious, and a guess, however judicious, is a totally different thing from settled rational belief. As regards all detailed matters of fact, I think there is a time, greater or less, during which the evidence connected with them may be collected, examined, and recorded. If this is done, a judgment can be formed on the truth of allegations respecting them at any distance of time. Such judgments are rarely absolute; they ought always or nearly always to be tempered by some degree of doubt, but I do not think they need be affected by lapse of time. If, however, this opportunity is lost, if no complete examination is made at the time of an incident, or if being made it is not properly or fully recorded, clouds of darkness which can never be dispelled settle down upon it almost immediately. All that remains behind is an indistinct outline which can never be filled up. Under certain conditions rare occurrences are quite as probable as common ones. The main condition of the probability of such an event is that the rare occurrence should, from its nature and from the circumstances under which it occurs, be capable of being observed, and that the evidence of it should be recorded in the manner which I have already described. If a moa were caught alive and publicly exhibited for money, or if the body of a sea-serpent were to be cut up upon the coast and duly examined by competent naturalists, the existence of moas and sea-serpents could be proved beyond all reasonable doubt. The reason why their existence is disbelieved or doubted is not that they are seen, if at all, so seldom, but because in each particular instance they are seen, if at all, in such an unsatisfactory way that it is doubtful whether they ever were seen. There are innumerable ghost-stories in circulation, but as far as I know no instance has ever yet been even alleged to exist in which the existence of a ghost has been properly authenticated as readily and as conclusively as that of any other being whatever. Stories of the interference of unseen agents stand upon exactly the same footing, speaking generally. Isolated instances occur in all ages and countries, but the common characteristic of them all is to be unauthenticated. Ten cases distinctly proved under the conditions referred to . . . would do more to settle the question of the existence of miracles as a class than innumerable cases depending on assertions which were not properly examined when they were originally made, and which can now never be examined. On the other hand, what reason can possibly be suggested why the action of an invisible person upon matter should not be ascertained just as clearly as the action of a visible person? The restoration of a dead body to life might, if it occurred, be proved as conclusively and as notoriously as the death of a living person, or the birth of a child. If such events formed a real class to which new occurrences might be assigned, a large number of instances of those occurrences would be, so to speak, upon record, established beyond all doubt, and the very existence of the controversy shows that nothing of the sort exists."

Hereupon the Archbishop of Westminster, looking at Mr. Stephen with a benign smile, said: Mr. Stephen's investigations into the evidence of the interference of unseen agents in human affairs are hardly on a par with some of those undertaken by the Church to which I belong. In canonizing, or even beatifying those who are lost to us, the Holy See has long been accustomed to go into the evidence of such events as those to which Mr. Stephen has just referred, and that with a disposition to pick holes in the evidence, which, if he will allow me to say so, could hardly be surpassed even by so able a sifter of evidence as Mr. Stephen himself. Nor is it indeed necessary to go into the archives of these laborious and most skeptically conducted investigations. If there were but that predisposition among Protestants to believe in the evidence of the unseen which Dr. Ward desired to see, there would, I am convinced, be many believers in miracles of the most astounding kind, and of miracles that have happened in our own time, many within the last year. Let those who choose, for instance, look into the evidence of the most astonishing cure of varicose veins which took place only last year in the south of France—a malady of thirty years' standing, and of steady progress throughout that time, attested on the positive evidence of French physicians, who had themselves repeatedly seen and prescribed for the patient. Yet they admitted that all they could do would be at most to alleviate his sufferings by the application of mechanical pressure—and they nevertheless declared the cure to have been effected in a single night, the only new condition having been the believing application of the Lourdes water to the body of the sufferer. Here is a case where all Mr. Fitzjames Stephen's conditions are satisfied to the full. I do not, however, apprehend that Mr. Stephen will sift the evidence, or even regard it as worth his serious attention. He has hardly assigned sufficient force to that strong predisposition to incredulity which is so widely spread at this moment in the Protestant world, a predisposition which I can not entirely reconcile with Mr. Bagehot's very striking remarks on the universal credulousness of the natural man. Perhaps, however, there may be such credulousness where there is no prejudice, and yet incredulity still more marked where there is. I have been a careful observer of the attitude of Protestants in relation to the controversy between the natural and supernatural. I have seen its growth. I have watched its development. I am persuaded that Mr. Stephen is quite wrong in supposing that the matter can be settled as one of evidence alone. You must first overcome that violent prejudice in your minds which prevents you from vouchsafing even a glance at the evidence we should have to offer you. But I will, if the society permits me, leave that part of the subject, and return to the principal question before us—the impossibility of proving the uniformity of Nature from experience alone. Now, how do we Catholics, who have a philosophy the value of which we imagine that you believers in Spencer and Mill and Bain greatly underrate, account for the uniformity of Nature without trenching in any way on the supernatural basis of that Nature? I will show you. Aquinas says in his "Summa"—and the Archbishop, of course, pronounced his Latin in the Continental manner—"Tota irrationalis natura comparatur ad Deum sicut instrumentum ad agens principale"—the whole of inanimate and irrational Nature bears to the Divine being the relation of an instrument to the principal agent. That is to say, the Divine intellect conceives the law which the Divine will sanctions and enforces by a great methodical instrument. The *natura naturans* makes use of the *natura naturata.* The law determines the instrument it is to use, and the instrument it is to use determines the world. Why, then, should the law be regular and not variable? Why, because it is the instrument of a being who is not variable. The schoolmen tell us that Nature has an appetite, a desire to accomplish its ends. They say of Nature "appetit," "desiderat." Such are the phrases they use. And as no constant aim, no true development can be attained by capricious, inconsistent, inconsequent action, by instruments incoherent, part with part—for the gratification of Nature's appetite, for the fulfillment of her desire, and the attainment of her purpose, a constancy and fixity of method are essential which are never interrupted, save where the Divine power modifies the instrument for its own good purpose. Thus the uniformity of Nature is based upon the wisdom of God, and the wisdom of God is manifested in the uniformity of Nature. St. Thomas has said, "Proprium est naturæ rationalis ut tendat in finem quasi se agens et ducens ad finem." And again: "Necessitas naturalis inhærens rebus, quâ determinantur ad unum, est impressio quædam Dei dirigentis ad finem, sicut necessitas quâ sagitta agitur ut ad certum signum tendat, est impressio sagittantis et non sagittæ"; that is, the necessity, or may we not say the uniformity of Nature, is a career impressed upon it by the Divine archer, who never misses his mark; it is not the arrow which determines that career, but the archer who points and who dismisses the arrow in its flight. But St. Thomas goes on: "Sed in hoc differt, quod id quod creaturæ a Deo recipiunt est earum natura, quod autem ab homine rebus naturalibus imprimitur præter earum naturam ad violentiam pertinet." Dr. Ward will correct me if I am wrong, but I interpret this as meaning that if what men ingraft on lower creatures is spoken of by the angelic doctor as doing them a certain violence, altering, I suppose, their mere involuntary qualities by infecting them with a certain human purposiveness not their own, how much more is it evidently open to the Divine purpose to ingraft on this uniformity of Nature a supernatural bent of its own, to open it, as it were, to the power of miracle, to infuse it with the significance of revelation!

Dr. Ward, I thought, winced a little when this appeal was made to him; whether it was that he differed with the Archbishop as to the drift of the passage quoted, or whether he regarded the society as in general too little educated in philosophy to appreciate arguments derived from the teaching of St. Thomas. As the Archbishop ceased, a good many eyes were turned upon Dr. Martineau, as if we had now got into a region where no less weighty a thinker would be adequate to the occasion.

I think, said Dr. Martineau—speaking with a singularly perfect elocution, and giving to all his consonants that distinct sound which is so rare in conversational speech—I think that the course of this discussion has as yet hardly done justice to the *a priori* elements in human thought which have contributed to the discovery of the general uniformity of Nature, and to the axiomatic character of the principle which we are discussing. I should not entirely agree with the Archbishop or with St. Thomas if I rightly apprehended the quotations from him, that we ought to ground our belief on the uniformity of Nature *primarily* on our belief in the constancy of the Divine mind. Historically, I doubt whether that could be maintained. For example, the Hebrew Scriptures, which are full of the praise of the moral constancy of the Creator, appear to attach very little importance to the uniformity of Nature's methods, which they often treat as if they were as pliant as language itself to the formative thought behind it. Still less can I agree with Mr. Bagehot's view that everything which rushes into the mind is believed without hesitation till hard experience scourges us into skepticism. I should say rather that the understanding is prepared to accept uniform laws of causation by the very character of human reason itself. It is remarkable enough that Aristotle fully recognizes the close connection between the necessary character of human inference and the necessary relation of cause with effect, that he treats the "beginning of change" (ἀρχὴ κινήσεως) as either the cause which necessarily results in an effect, or the reason which necessarily results in an inference. "An efficient cause, therefore, may be found in any beginning of change either in the physical world or the logical. In both cases it has the same characteristics: *necessity*, whether in the form of inevitable sequence or in that of irresistible inference; and *consecutive advance*, a step at a time, along a determinate line, whether in outward nature or in inward thought. Whatever is, it either acts out or thinks out what is *next*. So far, therefore, as the universe is at the disposal of efficient causes, its condition at each moment results purely from the immediately prior, without the possibility of any new beginning. If an experienced observer could compress into a formula the law of all the simultaneous conditions, he would be able to foresee the contents of any future moment—not, however, to modify them, for his prescience depends on their being in themselves determinate, and on his calculations embracing all the elements of the problem, including the states of his own mind. This efficient causality can be denied by no one who admits the dynamic idea at all; and no phenomenon can dispense with it."

Here we have, as I conceive, the clew to the principle of the uniformity of Nature. So far as Nature is purely dynamic, and so far as force is measured by reason, we can not stray from the rigid logic of fact and the equally rigid logic of thought. Doubtless it will be replied that, as in the mind of man there is a free spring of force, which is as yet undetermined, which is potential and not actual force, so there is behind Nature a free spring of force which is as yet undetermined, which is potential and not actual nature—in short, a power above nature and capable of modifying it; in other words, supernatural. And that doctrine I should heartily accept. The uniformity of Nature is the uniformity of force, just as the uniformity of reasoning is the uniformity of thought. But just as the indeterminateness of creative will stands behind the determinateness of the orbit of force, so the indeterminateness of creative purpose stands behind the determinateness of the orbit of thought or inference. I hold that man is not wholly immersed in dynamic laws, that though our physical constitution is subject to them, our mental constitution rises above them into a world where free self-determination is possible. I do not wonder, therefore, that we find it difficult to realize the rigidity of the laws of efficient causation even so far as it would be good for us to realize them. But I can not think that any one who has once contracted the habit of even fixing his own attention can doubt for a moment that cause and effect are connected together by efficient links, nor that, if force outside us means the same thing as force inside us, the relation of cause and effect is as necessary—unless some higher power interfere to modify the cause—as the relation of premises to conclusion. With regard to Dr. Ward's invitation to us to examine more carefully the credentials of miracle, I am inclined to agree with Mr. Stephen that, if there were any tangible number of incontrovertible miracles, there could be no controversy on the question whether or not such things can be. But then I should not apply that remark to any case of internal consciousness of supernatural influence, because, from the very circumstances of the case, the evidence of the existence of such influence can not be open to any mind except that which is the subject of it, and in my view it is quite unreasonable to deny that there are indirect but yet conclusive proofs in history that such supernatural influences have transformed, and do still habitually transform, the characters of the very greatest of our race. But it is one thing to see the evidence of spiritual influence in every page of human history and quite another to attach importance to such preternatural occurrences as the Archbishop has recently referred to, which are usually so mixed up with superstitions of all kinds, and so great a variety of hysterical emotions, that I for one should despair of any good result from investigating minutely these curious conquests effected by pretentious physical marvels over the gaping intellectual credulity of moral coldness and disbelief.

Here the general discussion ended, but Dr. Ward, who had the right of reply, exercised it with alertness and vigor.

I can not understand, he said, Dr. Martineau's position, that because the best testimony which we have in modern times to the interference of Divine power in the chain of physical causation is more or less mixed up with what he would regard as superstition and hysterical emotion, therefore it is perfectly justifiable to leave such matters uninvestigated, and to pass by on the other side. Surely the whole character of modern civilization would be altered if we could prove satisfactorily for ordinary minds that the Divine will is a true cause, which manifests itself habitually to those who humbly receive the Divine revelations. Is not Dr. Newman's celebrated assertion that England would be in a far more hopeful condition if it were far more superstitious, more bigoted, more disposed to quail beneath the stings of conscience, and to do penance for its sins, than it is, at least plausible for one who, like Dr. Martineau, believes profoundly that the true worship of a righteous will is the highest end of all human life? Can anything be more superabundantly evident, more conspicuously and, so to say, oppressively clear, than that ninety-nine men out of every hundred live as if God were at most nothing more than a remote probability, which it is hardly worth while to take into account in the ordinary routine of life? Suppose, if you please, that the majority of men by studying the Lourdes miracles will be brought, if they are convinced at all, to burn an immense number of wax tapers to the holy Virgin, and to dress up a number of very gaudy dolls in the churches dedicated to her, by way of showing their gratitude to her for curing paralytics and other miserable sufferers by the application of Lourdes water. Is that so much more superstitious, after all, than attributing similar cures to the transit of St. Peter's shadow, or to handkerchiefs taken from St. Paul's body, as the author of the Acts of the Apostles certainly did? Nor, indeed, is it a matter of the very highest moment whether people show their faith foolishly or whether it overshoots the mark, and attributes imaginary effects to a real cause. What is a matter of the highest moment is whether or not they feel or do not feel their religious faith in every action of their life. If God is really ruling you, is it not better to feel his eye upon you, even though you show your sense of that vigilance unreasonably and foolishly, than to live on very much as you would do, if, as Isaiah said, God were on a journey or had gone to sleep? Can any one deny that any awakening, however rude its consequences, to the reality of Divine power, would be infinitely better than the rapidly growing habit of living as if behind Nature there were no God? I do not of course say this to any member of our society who doubts the reality of God's government, but only to those who, with Dr. Martineau, regard it as the very first of all truths. But to them I say, if miracles still exist, if they still exist in the very form in which they are said to have existed in the Acts of the Apostles, if they can be attested by men of science themselves, if, in any Church, they happen not merely every year, but in considerable numbers every year, and admit of all the tests to which Mr. Stephen has referred us, then surely it can be nothing but a most reprehensible and guilty fastidiousness to give the go-by to the evidence of these things, simply on the ground that they are mixed up with a great deal of vulgar taste and of hysterical feeling. Is it not better to have a vulgar belief in God than to have a fine susceptibility to scientific methods? Is it not better to have a feverish longing to do his will than to have a delicate distaste for morbid devotion? The uniformity of Nature is the veil behind which, in these latter days, God is hidden from us. I believe in the uniformity of Nature, but I believe in it far more fervently as the background on which miracle is displayed than I do merely as the fertile instrument of scientific discovery and of physical amelioration.—*Nineteenth Century.*

A STUDY OF RECENT EARTHQUAKES.

By M. A. DAUBRÉE.

SINCE communication between the extremities of the earth has become both easy and rapid, our ideas on many subjects have been modified and have become more precise. Facts that formerly appeared singular and extraordinary are recognized as frequent and habitual. This is the case with reference to earthquakes. Numerous telegrams, a few months ago, told in every part of the civilized world of the shocks from which Andalusia, in Spain, was suffering. To the astonishment and lively curiosity which these phenomena excited was added a deep emotion which disasters of so dramatic and painful a character would cause. The interest in the study of these things is also enhanced by the additional knowledge it gives us respecting the constitution of the crust of the earth—knowledge which, constantly increasing, enables us the better to comprehend the different parts of the mechanism of these subterranean perturbations.

Among the more recent earthquakes was the one that destroyed most of the Island of Scio. On the 3d of April, 1881, about an hour and forty minutes after noon, the city of Scio and thirty or forty villages in the southern part of the island were disturbed with a violent trepidation. The shaken and cracked houses were still standing, when, a few minutes afterward, a second shock, equally violent, came on, and finished the work of the first. With it five thousand persons were buried under the rubbish. A little while afterward four thousand other persons were killed. Hardly had the people recovered from the terror of one shock, than others came on, causing general panic and stupor. Hardly a quarter of an hour would pass without a new shock, and the wounded who had succeeded in extricating themselves from the rubbish were buried in it again. "Death," said an eye-witness, "seemed to pursue its victims with fury. In less than an hour Scio was an utter ruin." The agitations of the ground continued, with only short interruptions, for a year. During 1879 and 1880 Scio had suffered from frequent tremors, sometimes repeated as many as ten times in a day. Mitylene and Smyrna were also similarly affected, but none of the shocks were strong enough to cause great anxiety. They were, as it were, the subterranean preparation for the catastrophe that was to burst out a few months afterward.

The disaster that desolated the Island of Ischia two years afterward excited no less of emotion. The main shock, on the 28th of July, 1883, was accompanied by a fearful rumbling, which was estimated to last about twenty seconds. There was an extremely violent upward movement that broke up the houses, followed by an undulatory pulsation. The points most disturbed were aligned along the two deep fractures of strata that traverse the island at right angles to one another, crossing nearly under Casamicciola.

Less than a month after the shocks at Ischia followed the terrific explosion of the volcanic Island of Krakatoa, near Java, with all its unparalleled accompaniments : the planting of a deep sea where had been a mountain ; the prodigious masses of pumice and stones from the volcanic throat causing intense darkness for hours at long distances ; the finer particles scattering in the atmosphere and disturbing its transparency and causing the red lights for months ; the marine waves propagated to the ends of the ocean with the speed of the tides ; the aërial waves making the circuit of the globe, according to barometrical registrations, in two opposite directions ; the thirty thousand human beings that perished ; and the villages and cultivated lands which it blotted out—all caused a most vivid impression in all civilized lands.

Now it is Andalusia, one of the finest parts of Europe, that is struck with disasters. The shock that was felt on the 22d of December, 1884, on the western coasts of Spain and Portugal, and as far as the Azores and Madeira, seemed to be a forerunner of the one, of incomparably greater intensity, that took place three days afterward in another part of the Iberian Peninsula. At about nine o'clock in the evening of the 25th of December, the southern part of Andalusia was so roughly shaken that fifty-six towns and villages in the provinces of Malaga and Granada were devastated in less than ten seconds ; and twenty of these places were nearly entirely destroyed. Among them were Alhama, Arenas el Rey, Albunuelas, Periana, Zaffaraya, and Venta de Zaffaraya. These places, situated above the center of the agitation, are scattered over a surface of which the principal dimension does not reach forty miles ; but the movements of the ground extended far beyond this region, to Seville on the west, Cape Gadez on the east, and Molena de Aragon. The movements provoked phenomena of different kinds. Crevasses, several miles long and several yards wide, were opened at various places. From one of them, near Santa Cruz, exhaled fetid gases, having the odor of sulphureted hydrogen, and there burst from the same fissure a copious spring of sulphurous water with a temperature of about 90° ; while at a short distance from this point the thermal springs of Alhama, that have been in use from antiquity, were heated to a higher temperature and acquired a sulphurous character.

The districts near the Sierra Nevada and its ramifying spurs have frequently been the center of subterranean commotions ; and it is an important fact, not to be neglected, that the shocks have many times, as in the present case, been repeated for several weeks in succession.

Among the movements which the ground undergoes during earthquakes, vertical shocks of great energy may sometimes be felt. During the earthquake in Calabria in 1783, houses were thrown up into the air, as if by the explosion of a mine ; and at Riobamba, in Colombia, in 1812, several persons were cast bodily upon a hill more than three hundred feet high. These motions are called *succussions,* or subsultory tremors. The most frequent movements, and generally the most extended, are the undulatory ones, which are propagated horizontally, like the waves which we can observe at any time on a liquid surface. Like those waves, they may, when continued for some minutes, cause a kind of sea-sickness. Sometimes the terrestrial undulations are so strong as to bend over trees till their limbs touch the ground. These two forms of tremor may be associated together, or they may succeed one another at very short intervals. Various instruments — seismographs or seismometers, analyzers, and pendulums—are used to determine their intensity, direction, and duration, and register their characters.

The intensity of the shocks is extremely variable. Sometimes they are hardly perceptible, or marked only by low rumblings ; often they are so strong that works of masonry are overthrown by them. For this reason special modes of construction are employed in countries subject to earthquakes, as adapted to oppose the least resistance.

In the most usual undulatory movement, the agitation is naturally stronger at the top of buildings than at their base. Thus, in the theatre at Madrid, on the 25th of December last, the upper gallery was visibly shaken, while the parquette was unmoved. For the same reason, the motions are incomparably less sensible in the interior of mines than on top of the ground. M. Domeyko relates that he was once at the bottom of the silver-mines of Charnacillo, more than six hundred feet underground, during an earthquake that destroyed his own house and several others right above him, while he did not feel the least agitation.

The duration of the shocks is generally very brief, sometimes not more than a second or two. The undulatory movements are more prolonged. A few instants are sufficient to produce the most disastrous effects. Three shocks, each of which was estimated to be not more than four seconds long, destroyed more than 20,000 persons in and around Carácas in March, 1812; and the convulsion at Riobamba, in 1797, killed as suddenly 30,000 victims.

But, however overwhelming and disastrous in reference to our persons and buildings earthquakes may be, it must be borne in mind that the amplitude of their movements is wholly insignificant in proportion to the dimensions of the globe whose epidermis they shake. The phenomenon is rarely limited to a single shock. Generally, several shocks follow one upon another at short intervals. In many cases, the movements are repeated for months and years, with pauses of a variable duration, so as to form as a whole, till they are totally extinguished, what might be called a seismic period. After the shock which overthrew Thebes, on the 18th of August, 1851, the commotions continued in Bœotia for eleven months, occurring sometimes as often as three times in twenty-four hours. Long series of shocks disturbed a part of Scotland during the two years from the 20th of October, 1839, to the 7th of December, 1841. Hundreds of similar examples might be cited.

The chain of the Alps has furnished examples of seismic periods in many of its parts. Series of shocks were felt at Pignerol, in Piedmont, from the 2d of April, 1808, till the 17th of May following, during which time not a day passed but some movement was felt. Sometimes the tremors were noiseless, sometimes they were accompanied with commotions preceding the destruction of buildings. The commotions were renewed on the 26th of September, the 28th of October, and the 22d of November; and in the next year on the 13th of March and 26th of June. Similar periods of seismic action were observed in le Valais in 1755, on Lake Gardo in 1866, on Monte Baldo in 1868, and at Belluno in 1873. The present period in Andalusia is of the same kind. The prelude of the 23d of December, which disturbed a part of the Spanish Peninsula, the great earthquake of the 25th of December, and that long succession of shocks which still continued on the 9th of March with sufficient violence to cause new ruins, belong to the same series. As Humboldt has remarked, it is noteworthy that series of this kind are produced more especially in countries distant from volcanoes.

In the disturbed regions we may generally remark a tract of limited extent in which the movement is particularly energetic. It corresponds, without doubt, with the deep-seated center of impulsion, and has been called the epicenter. Here is where the vertical shocks or succussions are most usually felt. From these radiate the undulatory movements, the speed of propagation of which has been estimated at from 1,100 to 1,500 feet per second, or about that of sound in the air. Sometimes the area of disturbance is very limited, even when the convulsion is most violent; at other times it is very extensive, as was the case in the Lisbon earthquake of 1755, which affected a surface equivalent to one-thirteenth of that of the globe. Most frequently the linear dimensions of the agitated surfaces are included within from 65 to 600 miles, or from one four-hundredth to one fortieth of the circumference of the earth.

The area of disturbance is usually irregular in form, and not circular, as was once supposed. Sometimes it is much lengthened in one direction, following the lines of neighboring mountains or other important accidents of structure. During the earthquakes of 1783 and October, 1876, the chain of the Apennines served as a protecting wall to the eastern provinces of the Italian Peninsula. While one side of the chain was assailed by thousands of shocks, which caused great disasters, nothing whatever was felt on the opposite slope. In the Alps, most of the earthquakes take place in the lateral, north and south spurs, which are formed of sedimentary beds, while the central chain, composed of crystalline rocks, is not disturbed. The Andes of South America form a natural bulwark which the strongest convulsions of the Pacific littoral, while they extend a long distance parallel to the chain, hardly ever cross; and, if occasionally a few shocks are propagated beyond it, they become extremely weak.

The movements are very unequally perceptible within the area of disturbances; and between two points shaken by the same impulsion there may be intermediate points that continue quiet. These are sometimes called bridges or arches. The shocks are frequently accompanied by noises resembling heavily loaded wagons rolling over the pavement, or subterranean thunders or roarings; but their intensity bears no kind of proportion to that of the agitation. The great earthquake of Riobamba, in 1797, was silent. But the sounds have relation to the rocks that transmit them. Then there are subterranean rumblings that are associated with shocks like the *bramidos* of Guanajuato, in Mexico, in 1784, continuing for a month, under terror of which the inhabitants left the city. There were flashes as of lightning, alternating with long rollings, like that of distant thunder. This phenomenon gradually passed away. The noises associated with earthquakes seem to be of the same nature as those that accompany eruptions. The latter are propagated through the ground, not the air, for hundreds of miles. But nothing else that is known of this kind reaches the proportions of what took place on the 26th of August, 1883, at the eruption of Krakatoa, the sounds of which were heard within the whole area of a circle of 30°, or nearly 2,000 miles radius, or a diameter of one sixth the circumference of the globe.

The ocean basins are also disturbed, as is proved by the shocks suffered by ships on the deep, without any apparent external cause, and which give an impression as though the vessel were running upon a shoal. The movements of the littoral, also, however slight may be their intensity, are transmitted to the liquid mass. The sea retires from the shore, leaving the bottom dry, sometimes for several miles. Then it returns swiftly upon itself, and, overleaping its normal limit, precipitates itself with fury, and as if in assault, toward the interior of the country, as an enormous wave, which has been frequently known, as in Chili, to reach a height of 100 or 125 feet. Then it retires, carrying out upon the deep whatever it has gathered up in its passage. This terrible oscillation is repeated three or four times with decreasing energy, unless the movements of the ground persist. These invasions of the sea, or tidal-waves, are often more dreaded by the people, who have had experience of them, than the shocks on land. The huge waves are also propagated in the ocean to a very great distance from the center of disturbance. Twelve hours after an earthquake that destroyed the city of Simoda, Japan, in December, 1854, a formidable wave was precipitated upon the Californian coast, 5,600 miles away. In 1868 a wave of similar origin destroyed Arequipa and Arica, Peru, and ingulfed 30,000 persons. It seemed to have come from Honolulu, in twelve hours, or with a speed of 450 miles an hour. The most striking example is that of the wave that followed the Krakatoa explosion, which traveled over a distance of 11,890 miles, or half-way round the globe, in twenty hours and fifty minutes, or at the rate, according to M. Bouquet de la Grye's estimate, of about 900 feet a second.

Earthquakes may also effect permanent changes in the relief of the land, not only in the shape of crevasses and the overturning of rocks; slight though appreciable elevations have also been observed, as in Chili, in 1822, 1835, and 1837. In the last case, marine shells, still alive and adhering to the rocks on which they had grown, appeared above the level of the sea, and served as indisputable witnesses of the change of level which had been suddenly produced.

Movements of another class are extremely weak, and can not be perceived without the aid of special and delicate instruments. In 1869 M. d'Abbadie, examining the surface of a mercurial bath in his observatory at Abbadia, discovered very slight but frequent variations in the situation of the vertical, from which he inferred that the ground is not always motionless, even when it has all the appearances of being so. The same fact has since been confirmed in many places. Abrupt oscillations that have been frequently perceived in the astronomical glasses at the observatory of Pulkowa, and were observed at Nice on the 27th of November, 1884, are also revelations of disturbances in the terrestrial crust. The French Academicians Bouguer and La Condamine had already come to a similar conclusion in 1741, when they were measuring zenith distances of stars. It could hardly have been anticipated that the observation of the stars would reveal processes that were going on down in the interior of our planet.

These movements, not directly perceptible by our senses, are subjected to an attentive daily study in Italy, at twenty-eight stations, scattered from one end of the peninsula to the other; and the results of the observations are centralized at the geodynamic observatory in Rome under the direction of M. Rossi. The movements are distinguished as very rapid and prolonged tremors (*tremiti*), and microseismic undulations, characterized by their extreme slowness. The observations of each day are depicted on a map of Italy by means of conventional signs, so that they may be followed in all their details as well as in the aggregate, at a single glance. Weak as these phenomena may be, they are well worthy of attention by reason of their continuous and general character; for they reveal an internal labor under the foundations of the ground, that never stops.

The crust of the earth also suffers displacements of a secular slowness, unaccompanied by any sudden movement; a class of phenomena which would never have been made known, if the mean level of the sea did not offer, at the shore, an invariable beach-mark by which to measure them. Tracts, which have manifestly been submerged within historical times, are now above the level of the sea, and constitute what are called raised beaches; while, on the other hand, forests, described in history as partly submarine, are now, in consequence of the depression of the soil, wholly under water. Such changes of level, very numerous and well established in all parts of the globe, are sometimes repeated in an oscillatory fashion of alternate elevations and depressions. They were formerly attributed to changes in the level of the sea, but the movement is in the land. They are in continuance of analogous changes which took place on vast scales during all the ancient geological periods. They are not to be confounded with superficial erosions and delta formations, which are quite different in character as well as in cause.

In view of these facts we are justified in saying that the crust of the earth is very far from being still. At every instant and in many of its parts it is undergoing very pronounced and often violent shocks. More frequently the movements are simply thrills, which can be discovered and studied only by a kind of auscultation. They are really continuous and of different kinds. It remains to inquire to what subterranean causes they should be attributed.

Numerous as the observations on earthquakes may be, they concern merely the external manifestations of a phenomenon the source of which is completely hidden from us, separated by a considerable thickness of rocks. Hence we have no clear, certain data by which to support an explanatory hypothesis. The phenomena have been variously ascribed to subterranean electric storms, to the influence of the sun, supposed to be potent over the interior regimen of the planets as well as upon their course in their orbits; to thrusts of the liquid or semi-liquid masses of the interior against parts of the solid crusts, which may be caused by the same forces as produce the tides; to sudden reductions of atmospheric pressure; or to the fall of immense masses of rocks in vast interior cavities.

Numerous and exact studies, bringing into clear view the relations of earthquakes with the geological structure of the countries subject to them, have given us a better comprehension of their organic causes. An important fact, developed by patient statistical research, is the great inequality in the geographical distribution of the phenomena. There are vast regions in which they are very rare and feeble, and others where the agitations are frequent and often very violent. But it is a significant fact in this connection that the frequency of the disturbances is not so much associated with geographical position as with peculiar characters in the constitution of the crust of the earth. Thus, many earthquake regions are characterized by the presence of active volcanoes. A striking example of such association is presented in the narrow tract between the Andes and the Pacific Ocean, in South America, particularly in Colombia, Ecuador, and Chili. "On the coasts of Peru," says A. von Humboldt, "the sky is always clear; neither hail nor storms nor fierce lightnings are known; the subterranean thunder attending the earthquake-shocks takes the place of the thunder of the clouds. By long habit and the general opinion that only two or three destructive shocks are likely to occur in a hundred years, the people of Lima are but little more afraid of earthquakes than those of the temperate zones are of hail-storms." In this region, between the sixteenth and twenty-fourth degrees of latitude, there are eighteen volcanoes; Chili, eminently subject to earthquakes, has thirty-three active volcanoes, between 33° and 43° south. Very different conditions prevail east of the Cordilleras, where vast countries like Brazil have no earthquakes. Farther north, on the isthmus, there are regions where the shocks are so frequent that one of them has been called "Cuscuttan," or the hammock. The single state of Nicaragua has twenty-four volcanoes. Along the coast of Asia is a zone of volcanoes and earthquakes about 9,000 miles long. It begins at Barren Island in the Bay of Bengal, crosses Sumatra, Java, the Moluccas, and the Philippines, bends around by Formosa and the neighboring archipelagoes to Japan, and then to the Kurile Islands and Kamchatka, and ends at last in the Aleutian Islands. Through all this zone the volcanoes are numerous and active, and in some parts of it at least, as in Japan and the Philippine Islands, the earth is never at rest. The seismograph at Manila is always in motion, even when the ground seems still, and a year never passes without a severe shock. The connection between earthquake crises and volcanic crises is also shown by alternations in their activity. Every volcanic eruption is heralded by precursory tremors, whose violence is calmed down as soon as a volcanic outlet is opened for the escape of the vapors. Now, the vapor of water is the recognized cause of volcanic eruptions, and constitutes, in all parts of the earth, the most abundant and most constant emanation from them. It is the agent that throws out from the depths to the surface the lavas, which, despite their high temperature, hold it incorporated in their paste ; in the same way that carbonic acid, dissolved in water, forces the liquid impetuously out of a mineral-water or a champagne bottle ; and it also shoots quantities of solid matter, stones, lapilli, and cinders, violently into the atmosphere. It is logical to believe that this vapor is likewise the cause of the agitations that accompany volcanic crises. Agreeably to this idea, Kircher and Humboldt regarded volcanoes as safety-valves against earthquakes.

Other countries, again, where there are no volcanoes, are disturbed with no less energy and frequency, and that over great areas. Of such is the southern part of the basin of the Mediterranean. Syria with Palestine, Asia Minor, Turkey in Europe, Greece and the archipelagoes, Italy, Sicily, the southern part of the Iberian Peninsula, and a part of its western coast around Lisbon, have shown evidences of this predisposition within historical times. In each of these countries are districts or places that have been associated with most disastrous convulsions. In them we may discern a common and essential characteristic in the shape of a dislocation of the constituent strata, which is revealed for the most part in a mountainous relief.

In some whole countries the sedimentary strata, which form a notable part of the thickness of the earth's crust, have remained horizontal or nearly so, as they were deposited. In other countries, and over considerable areas, the corresponding strata are raised up, bent, and contorted in different ways, having been subjected to dislocations through enormous thicknesses. Such lifts and foldings can not have taken place in solid masses without being accompanied by many and important fractures. The principal classes of such fractures, which are nearly vertical, are called faults. They crop out and cut the surface of the ground, sometimes for tens and hundreds of miles, and are of indefinite depth, or descend to below where it is possible for man to penetrate ; whenever a fault is produced, the two sides are displaced, and must rub hard upon one another ; and vast rocky surfaces are thus engraved, striated, and polished : thence they are called mirrors in the language of the miners.

The occurrence of these facts is not confined to mountain-chains, but may be observed in countries that are marked by only slight prominences, but which have undergone similar actions through all their constituent strata. It is evident that the solid envelope of the globe has undergone dislocations at many epochs in its history. The manifestations of gigantic force thus plainly registered are the effects of ancient back-foldings and of lateral or horizontal pressures. It is as if the crust of the earth had become too large for the supporting nucleus, and had, to keep in contact with it, to shrink up and bend upon itself. These foldings and fractures have given origin to chains of mountains.

Now, the geological study of earthquakes has shown that their centers of impulsion are in relation with the ground-lines of fracture and dislocation. The disturbed bands are usually longitudinally parallel to the chains. A recent example of this linear disposition has been added in the latest earthquake in Andalusia, the major axis of which, according to M. Fouqué, is parallel to the mountain-crests of the province, as well as to the numerous faults that cut it up. Another important point to be noticed is that the countries in which the mountains have most recently acquired their latest relief are the ones in which these subterranean agitations are particularly frequent.

The Andalusian masses which have been so rudely disturbed within a few months partake of all the structural conditions that have just been noticed. The Sierra Nevada is among the youngest chains of mountains on the globe. The tertiary strata around it have been powerfully lifted up, sometimes to more than three thousand feet above the sea, without having their horizontality destroyed. According to M. de Botella there are also, in different places at the foot of the chain, strata regarded as quaternary that have been tilted into an inclination of 65°. Furthermore, numerous faults furrow the country, while the parts that have been most disturbed, according to Macpherson, are upon the faults that terminate the crystalline mass of the Sierra Tejea and Almijara. The numerous thermal springs of the region are further evidences of the deep fractures that traverse it.

Similar conditions, dislocations, and recent age, are found in other regions subject to subterranean perturbations. They appear notably in that part of the Mediterranean basin which we have spoken of as especially agitated, although it is distant from volcanoes; in the Apennines, the Lebanon, and the mountainous masses of Dalmatia and Croatia bordering on the Adriatic. The configuration of the northern coasts of that sea, so exceptionally slashed and cut by deep indentations, results from the complexity of the fractures that have determined the outlines of their principal features. Even the chain of the Alps, where shocks are felt nearly every year, acquired its final relief only at a comparatively recent epoch. It is conceivable under such conditions that the interior masses are not yet at equilibrium nor wholly subsided, and that they contain vacant spaces affording room for further sinkings.

According to what seems to be the dominant opinion of the day, there are two kinds of earthquakes: those which are due to volcanic actions, and of which the vapor of water is the prime mover; and those which are the effect of such ruptures of the equilibrium of the solid masses as we have just been considering. It is hard for the mind to admit two causes so different for phenomena which in most of their features so resemble one another. The demarkation between them is hard to define. On the western coast of South America and in Venezuela earthquakes facing volcanic ranges and those distant from such phenomena present the same manifestations. The supposition that the phenomena are due to the rubbing together of the solid parts of the crust also encounters a serious objection in the remarkable repetition of shocks during the same crises. In fact, this reiteration of shocks by the hundred and the thousand, for weeks and months, is one of the most characteristic accompaniments of earthquakes.

In view of these periods of disturbances, the cause, instead of being exhausted by a few shocks at short intervals, as would happen under the supposition that the first cause is the action of solid masses upon one another, should be one that could re-enforce itself after having been temporarily weakened. This is an essential fact, which any proposed solution must explain. We first remark that water, confined in a close space which it fills, will come, when it reaches a high enough temperature, to have a power which it is hard to represent in figures.

In nature, the tension of the vapor in the volcanic reservoirs is exhibiting its energy at every instant ; for that which forces the lava out of the crater of Etna, about ten thousand feet above the sea, can not be less than one thousand atmospheres. The conditions necessary to give such tensions can not fail to be realized in the crust of the earth at a certain depth, beyond the domains of real volcanoes, and principally under chains of mountains and dislocated tracts. It is an ascertained fact that, whatever may be the constitution of the ground, the temperature increases regularly as we descend to a lower depth. At the same time water tends to descend, under the joint influence of gravity and capillarity, and may continue to descend till it reaches the deep and hot regions where it can acquire a temperature that will render it capable of producing great mechanical and chemical effects. Hence we can hardly doubt that waters from the surface reach the internal regions, and then make us feel in the shape of tremors and rumbling the power and explosive force which they gain there.

The depth at which the agency from which earthquakes originate should be sought has been the subject of careful studies. The results indicate that it is not seated in the central parts of the globe. This is the inevitable conclusion from such cases as the earthquakes in Calabria, in which the disturbed area was very small.

It is probable that the consolidation of the deep parts under the dislocated regions and especially under chains of mountains of a relatively recent age is not yet completed, and that there are still interstices and interior cavities of high temperature which eventually became filled with water by the action of capillarity. Hence we find the three conditions we have just been considering in the lower parts of the dislocated regions: cavities, water, and a high temperature, all constituting an agency capable of producing considerable dynamic effects at any moment. Suppose a barrel of powder exploded in a cavity situated a hundred metres underground. At the surface we would hear a rumbling explosion, and feel a vertical shock within a limited space, and an undulatory thrill over a wider circle. The phenomenon will be much like that of an earthquake, except that the essential element of repetition will be wanting; for all will be over with the first shock. But, in the majority of earthquakes, the shocks come in succession, as if the cause of them were a regenerating one.

Many ways may be conceived in which these enormous tensions may end in reiterated shocks, according to the hypothesis on which we place ourselves. Thus the water in a cavity having in time reached the temperature of explosion, suddenly displaces some of the walls of its prison. Hence, a first shock, followed by an expansion into the cracks and adjoining cavities, which have lower temperature and tension. Then, the pressure in the original focus of explosion having fallen off, the walls which had given way return upon themselves to their former position, to give way again when the primitive reservoir has regained its lost tension. This flow from cavity to cavity, which, instead of being continuous, is made by bursts and starts, may continue to be reproduced time after time till the principal reservoir is exhausted. But the mechanism is not destroyed then. During the period of calm, following the seismic period, it can be charged again. Something analogous to this takes place in volcanic eruptions, which are separated by the lapse of time necessary to recharge their apparatus by a slow alimentation. Furthermore, reservoirs of water may be suddenly displaced under the effect of contractions of the crust, and may thus be brought into contact with masses having a high temperature.

If we suppose a sea of melted matter to exist beneath the crust of the earth, we should have analogous effects whenever hydrated rocks, broken off from the shell, fall into the ignited masses.

The theory of the agency of vapor is also supported by the rumblings and subterranean thunders which sometimes continue for months and even for years without being attended by shocks, and for which it is difficult to imagine any other causes than sudden condensation, or a flow of gaseous matter at very high tension through a narrow orifice. The vápor, having escaped from its prison, must in many cases resume the liquid state very quickly, on account of the enormous expansion it undergoes. It also has to traverse miles of relatively cold rocks, more or less water-charged and full of cracks. It may thus contribute to the production of thermal springs. Examples are on record, too, of earthquakes, remote from any volcanic point, in which both hot water and gaseous matter have been seen to issue from crevasses.

Thus, the motive force of these formidable disturbances is always active under the feet of the inhabitants of many regions. Against the permanent danger that menaces them, men have at least the remedy of forgetfulness. — *Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

THE TRADING-RAT.

By Mrs. E. D. W. HATCH.

THESE interesting rodents are dwellers in the Rocky Mountains and adjacent hills, and are known among us by various significant names, as mountain-rat, timber-rat, and trade-rat. The first, of course, refers to their native home; the second to the sound of their gnawing, scarcely to be distinguished from the sawing of timber; and the last to their peculiar system of barter or exchange, so curious a habit that it is doubtful if any other animal has ever been known to practice it while in a wild or untamed state.

These animals are much larger and stronger than the ordinary house-rat—so much so that cats are apparently afraid of them, and can not be induced to attack them. They are pretty, well formed, have very bright black eyes, prominent, beautifully shaped, pointed ears, and soft gray fur. Their tails are not rat-like, but are more like a squirrel's, only less bushy, being covered with fur.

Such keen, intelligent-looking little creatures are they that, but for our instinctive dislike to the name of *rat*, we should be strongly tempted to tame them as attractive and teachable pets. Until they learn that they have an enemy in man, they are quite unsuspicious, and will allow any one to walk up to them.

One of these rats being caught in the house, attracted by his size, I measured him · body, eight inches long; tail, eight inches; around his body, under his fore-legs, seven inches; ears, an inch and a half; fur beautifully fine, gray, with a darker shade, nearly black, running lengthwise down his back. He was very plump and fat, but I omitted getting his weight.

They haunt houses and camps near the hills, but seldom, if at all, those a few miles away. The peculiar trading characteristics natural to this little merchant, its habit of exchanging goods without a "by your leave," wise ways, and queer tricks, seem far more like reason than instinct. A few incidents which came under my own observation will illustrate this characteristic. Some men, passing through the country, camped in a deserted cabin, and, before wrapping themselves in their blankets for the night, they placed their bread for breakfast in a pan near the fire. On rising, to their dismay, not a crumb of bread was left in the pan, but it was filled with old scraps of leather, chips, bones, moldy beans, rags, etc. Searching, they found, high up on a partly broken shelf, in an old tin can, their bread packed away with old bacon-rinds, bones, rags, and other trash.

In the house of one of my neighbors these mischiefs carried away a lot of Indian or corn meal, and in the meal-box deposited a quantity of bird-shot, which, mixed with the remaining meal, caused the housekeeper great dissatisfaction. In the same house a trunk was accidentally left open one night; in the morning a quantity of rice, bits of dried fruit, and some oats, were found mixed with loose coral beads and other small trinkets; it was an exercise of patience to separate the articles, as may be readily imagined.

With these traders exchange is no robbery, and distance small hindrance; they travel from their homes and go from barn to house, from loft to cellar, and through living-rooms (noiseless when acting as porters), with great speed and impartiality. A sheep-herder, returning to his camp from a town thirty miles away, brought home a fine new hat; placing the box on his table, he went away for the night. Returning, he found the box had been entered, the crown of the hat eaten entirely round, and the box then filled with wool, flannel rags, remains of food, wheat, and dried fruits. There was a sudden forced abandonment of that unsurveyed "squatter's claim."

Some ranchmen were gone haying for several days, camping away from home. After their return they soon learned that their quarters had not been unoccupied during their absence. A nest composed of wool and rags filled the flour-sieve left upon a shelf; next beside the sieve stood the coffee-box, in it had been left about a pound of good coffee; now the box was filled to the top, mixed with the coffee, moldy crusts, bones, and rinds, that had been scattered about the place. "When I threw it all out," said the man, who was telling me, "provoked as I was, I could not help noticing how *prettily* the nest was made up of gnawings of an old blue army-overcoat, red flannel shirt, and many white rags, put together so nicely and made so soft within." This morning, going to the store-house for a lamp-chimney, I found an ordinary glass chimney packed close with straw, grains of rice, oats, wheat, a few beans, and chips.

The mischief these rats can do in a single night is almost incredible. One, getting into a lady's room, stripped her house-plants of every leaf and blossom, and hid himself behind the wardrobe, where he was found next day, with a most singular accumulation of goods, among them many bits of paper, a quantity of raisins, a box of matches, some candle-ends, gnawed postage-stamps, and a lot of odds and ends. Nothing seems to come amiss, and they are particularly fascinated by anything that glitters; often carrying off knives, spoons, watches, and silver, and hiding them effectually.

They are "good providers," and in the fall build their nests, and fill them with stores of eatables, the result of persevering foraging expeditions for their families before winter is on them. Under a large cottonwood-tree on a side-hill, partly underneath a fallen trunk, a party of us found a mountain-rat's nest. It was built up nearly two feet in height, the top or roof covering it sloped on all sides to shed rain or snow ; tearing it to pieces, we found it was built closely of grass, moss, chips, bones, and many leaves of the cactus (which grows plentifully among the rocks) ; how they could cut off and convey this thorny stuff, working it up with the other material, in the close covering, is hard to understand. Away down, running in almost under the log so well built around, out of the reach of any possible moisture or cold, a clever little bed of wool was found, made for the young rats ; this wool, of which there was a quantity, must have been collected bit by bit from the weeds through which the sheep passed, and from their corrals.

To reach this nest in the rat's house, there was quite a long, circuitous passage, entrance close to the ground, on the south side—a little den or hole to crawl through. In a little heap outside, not yet carried in among their provisions, but lying close by, we found more than a quart of fine, fresh-looking potatoes, brought from our own garden, and it is an unsolved mystery how the potatoes were taken there ; with not a scratch or mar upon them, or the skin bruised or broken. The garden was a hundred feet away, considerably lower down, and a stream of water, an irrigating ditch, to be crossed to reach it. One person suggested that the rats might have rolled them all the way, and across some poles thrown over the stream.

Destroying this nest, a couple of rats darted up the standing tree, and there we were surprised to find another nest had been commenced in the forks of the tree. We destroyed this nest also ; but here comes in another mystery, a puzzling question : How could the rats climb that tree and carry up stores for the winter? This nest was probably twenty-five or thirty feet from the ground.

I asked a ranchman a few days ago, who was talking about them, if he was afraid of them (I meant of their bite). "No," said he, "and they are not afraid of me ; they have waked me many a time, sitting up on the floor of my cabin and rapping their tails like a dog!"

A description in Appletons' "Cyclopædia" seems in some respects to tally pretty well, under the name of "The Florida Rat." It describes these rats as "very abundant in the Southern Atlantic and Gulf States, and occasionally found in the West. The habits vary much in different localities, living in some places in the woods, in others under stones, or in the ruins of buildings ; in swampy districts they heap up mounds, two or three feet high, of grasses, leaves, and sticks, cemented by mud ; sometimes the nest is made in the fork or hollow of a tree ; are very active, and excellent climbers ; their food consists of corn, nuts, cacti, and crustaceous food, various roots, and fruits ; disposition mild and docile." Its most singular trait, its habit of barter, is apparently, if the same, unknown. He is not a thief like the monkey, who steals and makes no reparation, but, with a strange kind of honesty, whenever he helps himself he puts something (to his mind, perhaps, as valuable) in its place; he adapts himself to circumstances; there being neither corn nor shell-fish in the Northwest, he does very well without, and maintains a plump appearance upon something else. The habit of building here is in dry haunts, where it can find seclusion and secrecy.

Since beginning this article, I have met with an extract from Father Joseph Acosta's "Natural and Moral History of the East and West Indies," published at Barcelona, in Spain, in 1591, translated and printed in London in 1604, which seems a fair description of this little animal. Again, in "The Observations of Sir Richard Hawkins, Knight, in his Voyage into the South Sea, 1593," published in London, 1622, and still another published by a Spaniard, "History of Chili," published at Rome, 1646. In all these accounts there is a queer confusion of names. Sometimes these animals are spoken of as rats, again squirrels, then chinchillas; the covering of their skins is named indifferently, as it happens, wool or fur; color generally said to be gray.

From a natural history of Chili, published at Bologna, in Italian, 1782, translated 1810, I give the following extracts:

"The chinchilla is another species of field-rat, held in great esteem for the extreme fineness of its wool, if a rich fur, as delicate as the silken webs of the garden-spiders, may be so termed. It is of an ash-gray, and sufficiently long for spinning.

"The little animal which produces it is six inches long from the nose to the root of the tail, with small, pointed ears, a short muzzle, teeth like the house-rat, and a tail of moderate length, clothed with delicate fur.

"It lives in burrows underground, in the open country of the northern provinces of Chili, and is very fond of being in company with others of its species.

"It feeds upon roots of various bulbous plants, which grow abundantly in these parts.

"It is so docile and mild in temper that, if taken into the hands, it neither bites nor tries to escape, but seems to take pleasure in being caressed.

"If placed in the bosom it remains there, as still and quiet as if in its own nest. As it is in itself peculiarly cleanly, there can be no fear of its soiling the clothes of those who handle it, or of its communicating any bad smell to them, for it is entirely free from that ill odor which characterizes the other species of rats."

And he adds, which to us seems odd enough, about a little creature six or more inches in length, "For this reason it might well be kept in the houses, with no annoyance, and at a trifling expense, which would be abundantly repaid by the *profits on its wool.*"

Another writer upon Chili, in 1824, speaks of the same animal and calls it a woolly field-mouse, which lives underground, and chiefly feeds on wild onions, saying that its fine fur is well known in Europe; that that which comes from Upper Peru is rougher and larger than that from Chili, but not always so beautiful in color. Still another writer, speaking of the same, calls it chinchilla; says that it usually sits upon its haunches, and is even able to raise itself up and stand upon its hinder feet; that it feeds in a sitting posture, grasping its food and carrying it to its mouth by means of its fore-paws, and adds, "The ancient Peruvians were a very industrious people, and they made of this fur wool coverlets for beds and valuable stuffs." A lady, who was presented with a living specimen from Peru, kept it for many months, feeding it upon hay, clover, and succulent roots. She then presented it to a zoölogical society, with the information that her pet was good-tempered, mild in its disposition, and, when allowed to run about the room, very tame and playful, delighting in feats of agility, often leaping to the height of the table.

These descriptions, written many years ago, with others at hand not necessary to repeat, apply well to the trade-rat of the Rocky Mountains, save that they do not mention the creature's curious habit of barter.

I have already spoken of their great strength and celerity of movements. To an observer these traits are a never-failing surprise. If a light is steadily burning and all is quiet, they are easily watched, darting back and forth, carrying goods each way—round trip, so to speak, and often long trips. I have known them to bring nails, bits of iron, screws, and other things left about the sheds, quite a distance to the house, place them on shelves, boxes, or kegs, just as they fancied, but all in some selected spot, carrying back from cellar and storehouse dried prunes, apples, rice, and all kinds of eatables. If, working in the dark, the drawing of a match, a slight noise, or sudden light will cause them to vanish like a flash.

They seem, too, to have a fancy for certain colors, particularly bright red, and will soon make away with garments of this color, and attach them to their nests. There may be something attractive in the dye, but, knowing their partiality for glittering, shining objects, I am inclined to think they have also an eye for color.

With all their curious and often annoying tricks, they are wonderfully ingenious and persevering, and certainly possess the attributes of a good business man in their energy, industry, foresight, and a desire to make provision against a time of need.

TISSUE-SELECTION IN THE GENESIS OF DISEASE.

By W. HENRY KESTEVEN, M. R. C. S.

IT has occurred to the writer that the adoption of the germ theory of disease necessarily involves the application of the theory of evolution, and that here may be found a means of accounting for the genesis of the various forms of disease. Germs are living matter; they must therefore be under the influence of those laws and forces which condition all living matter. The most important of these, or the one that most interests us in the present connection, is the law of natural selection; and it must be that germs, in common with other forms of life, are under the influence of this law in some shape. Natural selection is a general term which embraces all other modes of selection, or provision for the "survival of the fittest." Among these is sexual selection, and, taking a broad view, we may also include selection by man. In order, then, to the attainment of greater exactness, may we not give a name to that form of natural selection which has been potent in bringing about the variations in the characteristics of those germs to which the differences in the forms of disease are due? Such a term may be found, I would suggest, in "tissue-selection," as indicating the special means whereby the constitution of the germs has been modified. The actual origin of the bodies which have received the names of germs is not at present determinable, and to say that they do not originate *de novo*, in decaying matter or elsewhere, is only to reaffirm the axiom now pretty generally admitted, *Omne vivum e vivo*. The fact that meets us here is that these germs, call them bacilli, vibriones, bacteria, or what we will, are met with almost universally in the atmosphere that we breathe. It is with the "why and the wherefore" of their existence that we are concerned. In looking for this, it will be necessary to consider the facts of the life-history of these germs, and to try to discover how they have been and are influenced by their surrounding conditions. We find that the conditions favorable to the full vital activity of these germs are a moderate temperature, moisture, and a resting-place or nidus in some organic matter whose chemical constitution enables it to afford the pabulum necessary for the maintenance of their existence. On the other hand, the influences antagonistic to their well-being are excessive heat or cold, the action of certain chemical bodies, and a condition of dryness. The last is certainly prejudicial, as it seems to hinder their full vital activity. At the same time it can not be considered absolutely obnoxious, as it is the means which favors their locomotion in the atmosphere. Putting aside, for the mean while, the thermometric and atmospheric conditions, we shall see that the condition which most concerns us is that of a favorable nidus. A favorable nidus is one in which the germ is enabled to carry on its full vital functions, and to propagate its kind. It is therefore manifest that the constitution of the nidus must be free from elements antagonistic to such vital functions. It must not be too hot, or too cold, or too dry, and its chemical constitution must be favorable. Experiment has proved that oxygen in excess is deleterious to these organisms; its absence, entire or partial, will then be one of the requisites in this chemical constitution of the nidus. Is not such nidus best found in decaying or degenerating animal tissue? Where there is full vital activity in any animal tissue, the blood which nourishes it keeps it duly supplied with oxygen. In healthy tissue, then, we have a condition unfavorable; but when from some cause the nutrition of the tissue is interfered with and a condition of degeneration is induced, this antagonistic element is removed or at least diminished, and the tissue affords the nidus favorable to the vital phenomena of the germs. These vital phenomena are perhaps best studied in the analogous case of the spores of yeast (*torula cerevisiæ*). When this, which is to all intents and purposes a germ, is placed in favorable circumstances, its activity commences, it rapidly multiplies and gives rise to changes in the surrounding material. In this case we call the process "fermentation." A germ, bacillus, bacterion, or vibrio, when placed in relation to tissue which affords a favorable nidus, assumes its full vital activity; it multiplies and gives rise to changes in the tissue with which it is in contact. These changes we call "inflammation." In fact, it would appear that these germs in one sense fulfill the part of Nature's scavengers, and by setting up inflammatory changes in degenerate tissues lead to their removal. Be this as it may, the diseases to which the germs give rise are all more or less of an inflammatory nature.

Thus, then, it would seem that one of the chief vital functions of these germs is to excite an inflammatory process in degenerate tissue. Is it not conceivable that germs may have existed, or even do still exist now, whose function is strictly limited to action on degenerate tissue?—that this may perhaps have been the limit strictly assigned to them? Let us suppose this to be the case, and see how, from this limited condition, germs have acquired power to overstep these limits, and thus to give rise to the protean aspects of disease that we now meet with. What has caused variation in the animal world but the influences of surrounding circumstances? In the relationship of the germs and the degenerate tissue, it is plain that in one sense the germs are the active, and the tissue the passive, elements. But, looked at from the tissue point of view, it will also appear that this passive condition possesses considerable indirect influence on the germs; that, indeed, "passive" is hardly the word to express the action which must largely modify their constitution. It would be impossible for the germs to live, to grow, to multiply on a certain tissue without becoming imbued with certain characteristics of that tissue. Hence a difference, a variation, between the parent germs and their offspring.

Now, the one characteristic of the tissue which most strikes our attention is its degeneracy, and this degeneracy must exert its influence on the organisms which depend upon it for existence, so that in the thus derived organisms we have the germ vitality and function, *plus* a certain amount of degenerate tissue characteristic. Germs thus modified and brought into contact with tissue of the same kind, though less degenerate, will, in virtue of this constitutional modification, stand a better chance of establishment thereon, at the same time adding to the degenerate condition with which they meet in the new tissue the characteristics of the degeneracy of tissue they have left. The effects thus produced will be more acute, the constitution of the germs further modified, and their power increased. Hence it is possible to conceive that if by any chance a condition of tissue which could be called perfectly healthy was to be anywhere met with, even this tissue might in time become subject to the influence of these organisms. Of course tissues may be more or less susceptible to their influence, more or less healthy, but it is more than doubtful whether it can be positively said of any one tissue that it is absolutely healthy, any more than it can be said of the individual man or woman. It is therefore possible to conceive that at some time or other there has existed only one kind of germ, that variations from this one type have arisen in consequence of the modification wrought upon different individuals by their chance falling upon this or that degenerate tissue. Variation must lead to specialization, and finally we find diseases all dependent upon the action of germs, as different from one another as one species of animal differs from another.

But there is another direction in which these germs must have been modified fully to account for the differences we now see. Germs may still exist which have only the power of exciting a simple inflammation in any degenerate tissue. Others, a step more advanced, are found, whose action is more potent, which have attractions for the one special tissue in which they have been bred; while others are capable of exciting the special form of inflammation in which they have had their origin, in tissues various in structure and composition. This power or, rather, increase of power—in other words, further variation in constitution—thus displayed is only to be accounted for by the supposition that its acquisition is secondary to the act of establishment, and that it is brought about by means of the blood itself receiving some of the germs and conveying them to some other tissue, on which, in virtue of its degeneracy, and possibly of a further modification, they have themselves received from the blood, they are enabled to effect a settlement. It must also be remembered that their modification, which enables them to select a tissue for their primary and more virulent action, does not deprive them of their original power of attacking degenerate tissue. It is simply an additional power, rendering them more potent when brought into contact with tissue possessing certain characteristics. These characteristics of the tissue originally attacked may determine the character of the action of the germs on other tissues, and thus enable us to recognize a relationship in the morbid influences at work in different tissue—as, for example, in syphilitic disease. If it is a fact that the tissue originally attacked modifies the constitution of the germs, it is surely more reasonable to suppose that the special characteristics thus impressed upon the germs are those which give the family likeness to the descendants of these germs, rather than to suppose that this morbid family likeness exists in the germs before ever they have been brought into contact with any form of degenerate tissue. In other words, may not a bacterion, pure and simple, by being brought into contact with some form of degenerate tissue, acquire or give rise to other bacteria which possess certain characteristics which we recognize as being those of special disease, and that those characteristics enable them to excite a similar form of disease in the new nidus? It is also conceivable that as different diseases are more or less wide-spread or of older standing, so the germs given off from tissues affected by these diseases will have more and more power of affecting tissues less and less degenerate, even to the point of a possible condition of actual health. So, for example, the germs of scarlet fever or measles have actually acquired great power over the tissue which they primarily affect; whereas in the case of tuberculosis it is more than doubtful whether the actual presence of a tubercular condition of degeneration in the tissue, to a definite extent, is not necessary before the germs can find a suitable nidus in that tissue. Of course, germs derived from a tubercular origin will have more influence over tissue which is not so much affected than germs which have not such tubercular origin. It is, in fact, simply a matter of degree of degeneracy. May it not be this which enables persons free from tubercular taint to brave the assaults of germs be they ever so virulent?

The above are only one or two examples showing the different powers possessed by germs derived from the different forms of disease. The list of examples might be almost indefinitely prolonged. But the result would only be to show that different diseases have different powers of affecting the animal body, a fact already well known. It is the design of this paper to show that possibly these powers have been acquired by the action of some form of natural selection, here propositionally called "*tissue-selection*," on the germs which inhabit the air we breathe and the water we drink, such action in the course of long ages having given rise to germs possessing special powers, and being now apparently unrelated to each other in any way. The intermediate steps between a simple germ and such a highly modified one, as, for instance, the variolous or tubercular germ, may be difficult to trace, for as we at present see these germs it is as though we were looking at a picture or photograph of a family tree in which the greater part of the trunk and larger branches have become obliterated, having only the terminal twigs visible, with no apparent connection between them. —*Lancet.*

SKETCH OF PROFESSOR H. A. NEWTON.

THE President of the American Association for this year, Professor Hubert Anson Newton, of Yale College, is distinguished not less for his researches in the higher mathematics, which mark a distinct advance in the American study of that science, than by his contributions to the determination of the orbit of the November meteors, in which he was a pioneer.

Professor Newton was born at Sherburne, New York, on the 19th of March, 1830. Having made his preparatory and academical studies in the schools of his native town, he entered Yale College in the second term of his Freshman year, and was graduated from that institution in 1850. He then spent two years and a half in studying mathematics at home and in New Haven, and was appointed tutor in the college in July, 1852. Entering this office in June, 1853, he had the care of the whole department of mathematics from the first; for Professor Stanley was ill, and died in the spring of 1853. He was elected Professor of Mathematics in 1855, and was given permission to spend a year in Europe. Returning, he assumed the chair in 1856, and has ever since been engaged in the active discharge of the duties of the professorship.

His earlier works appear to have been principally directed to those methods in higher geometry, the power and elegance of which, says his biographer in the "History of Yale College," have been so highly shown in the works of Chasles and others. Among the most conspicuous of them is a memoir "On the Construction of Certain Curves by Points," published in 1861 in the "Mathematical Monthly," which is characterized as one of those contributions to abstract science which have been, unfortunately, too rare in this country. A later, no less remarkable paper was one of joint authorship in the Transactions of the Connecticut Academy of Sciences on "Certain Transcendental Curves."

His most important service to science, and the one by which he is probably most widely known to the world of students, is the work which he performed in the study of the November meteors. These phenomena, which had been occasionally mentioned at previous periods of their recurrence without apparently any adequate comprehension of their significance, were first carefully observed by Professor Denison Olmsted in 1833, who gave much attention to the question of their nature and origin. But, as Professor C. S. Lyman states in his biography of Professor Olmsted, it was not till thirty years after his and Professor Twining's studies of the subject "that the labors of Professor Newton in this country, and of Professor Adams and others abroad, made it possible to designate the precise orbit of the November stream, and to identify it with that of a comet having a period of thirty-three and one fourth years." The phenomena continued to have diligent observers at New Haven, prominent among whom was Mr. Herrick, the librarian, and afterward, till 1862, the treasurer of the college. At the time of his death, the biographer in the "History of Yale College" records, "Professor Newton was already engaged in organizing combined and methodical observations on shooting-stars, and in collecting and publishing in the 'Journal of Science' the results of independent observers. Under his supervision a map of the heavens was prepared, which was published by the Connecticut Academy, and could be used by observers to mark down the apparent paths of the meteors. A rich harvest of observations was thus obtained by zealous laborers in various parts of the country, many of whom had been interested and trained in the work by Professor Newton. The separation of the precious grains of truth from the chaff—the perception of the constant amid the accidental, of fixed laws disguised by the errors of observations made under circumstances which precluded the use of instruments of precision—is, however, the more difficult part of such investigations. The published results of Professor Newton's studies in this direction are mostly to be found in the 'Journal of Science' and in the 'Memoirs' of the National Academy. The memoir read to this Academy a few years ago is an almost exhaustive discussion of the phenomena exhibited by the sporadic shooting-stars. He has also contributed admirable summaries of what is known in respect to the laws of meteors to the new edition of the "Encyclopædia Britannica" and to "Johnston's Cyclopædia."

"But the investigation which has been followed by the most remarkable results relates to the November meteoroids, and was based upon researches into early records of remarkable star-showers. From such records, Professor Newton showed that the period of revolution of these bodies must have one of five accurately determined values. From the same sources he determined the secular motion of the node of their mean orbit. The five values of the period, with the position of the radiant point, which had also been determined, would give five possible orbits. The real orbit could be distinguished from the others, as Professor Newton remarked, by the calculation of the secular motion of the node due to the disturbing influence of the planets for each of the five orbits. This calculation was subsequently undertaken by Professor Adams, of Cambridge, England, and the real orbit was apparent from the coincidences of the early observations (the observed and calculated values were 29′ and 28′ respectively). These calculations of Professor Adams, which fix beyond a doubt the position of the mean orbit of the November meteoroids, were made shortly after their appearance in 1866. The publication, about the same time, of the orbit of the first comet of 1866 revealed the fact that that comet and the meteors travel in nearly coincident orbits, and have an intimate relation one with the other. To appreciate the rapid advance of this department of astronomy, we must contrast this certain knowledge with the conflicting views which prevailed at the time of their first appearance, in 1833, with respect to the nature of the phenomenon of which they were the cause. In recognition, presumably on his part in these achievements of science, Professor Newton was elected, in 1872, associate of the Royal Astronomical Society."

Professor Newton has been for more than a dozen years one of the associate editors of the "American Journal of Science," and most of his scientific articles have been written for its pages. He was one of the fifty members appointed by the act of Congress constituting the American Academy of Sciences. In 1860 he was elected a corresponding member of the British Association for the Advancement of Science. He served in 1875 as Vice-President of Section A of the American Association for the Advancement of Science, at its Detroit meeting.

His address on this occasion took the form of a strong plea for more study of mathematics by American men of science ; not for the sake of its place in education, but for the advancement of the science itself, and for the assistance that might be derived from it in the pursuit and enlargement of other branches of knowledge. Whatever might be the reasons for it, he said, "the unpleasant fact is that the American contributions to the science of quantity have not been large. Three or four volumes, a dozen memoirs, and here and there a fruitful idea having been selected from them, there is left very little that the world will care much to remember. I refer, of course, to additions to our knowledge, not to the orderly arrangement of it. To make first-rate text-books, or manuals, or treatises, is a work of no mean order, and I would not underestimate it. In good mathematical text-books we need not fear comparison with any nation. But so few additions have been made to our knowledge of quantity that I fear that the idea has been quite general among us that the mathematics is a finished science, or at least a stationary one, and that it has few fertile fields inviting labor and few untrodden regions to be explored. Hence many bright minds, capable of good work, have acted as though the arithmetic, the algebra, and the mechanics which they studied covered all that is known of the science. Instead of going on in some path out to the bounds of knowledge, as they had perhaps the ability to do, they dug in the beaten highways, and with care planted seed there, hoping for fruit. How much such ill-directed thought has been spent on the theory of numbers, on higher equations, on the theory of the tides, etc., which, if rightly expended on some untrodden though humble field of the science, might have really added to human knowledge! And yet hardly any science can show, on the whole, a more steady progress, year by year, for the last fifty years, or a larger and healthier growth, than the science of quantity. Here, too, as in every other science, the larger the field that has been acquired, the larger its boundary-line from which laborers may work out into the region beyond. An individual may wisely neglect one science, in order to work in another. But a nation may not. For the healthy growth of all, each science should be fostered in due proportion. But the mathematics has such relations with other branches that neglect of it must work in time wider injury, I believe, than neglect of any other branch."

The view expressed in the last sentence of this extract was sustained by the citations of instances and ways in which the questions of quantity and proportion have to be dealt with at some stage in almost every branch of scientific investigation.

Of the value of mathematics as an instrument of research in other departments of knowledge, he says: "Again—I argue from a natural law of succession of the steps of discovery in the exact sciences—we first see differences in things apparently alike, or likeness in things apparently diverse, or we find a new mode of action, or some new relation, supposed to be that of cause and effect, or we discover some other new fact or quality. We frame hypotheses, measure the quantities involved, and discuss by mathematics the relations of those quantities. The proof or the disproof of the hypotheses most frequently depends upon the agreement or discordance of the quantities. To discover the new facts and qualities has sometimes been thought to be higher work than to discuss quantities, and perhaps it is. But at least quantitative analysis follows qualitative. It is after we have learned *what kind*, that we begin to ask *how much?*"

Professor Newton is a member of several other learned societies in this country; he is a member of the Publication Committee of the Connecticut Academy of Sciences; is a trustee of the Winchester Observatory; and is the author, in Professor Kingsley's "History of Yale College," of the sketch of Professor Alexander Metcalf Fisher, one of his predecessors in the chair of Mathematics, who died by shipwreck at an early age; and of the account of Winchester Observatory.

EDITOR'S TABLE.

OFFICIAL SCIENCE AT WASHINGTON.

MUCH has been said in the newspapers during the last few weeks about the mismanagement and irregularities that have been disclosed by official inquiries into the administration of the United States Coast Survey. The superintendent of that branch of the public service has been retired from his office; the assistant in charge was also removed, and then restored; and charges have been made against other parties. It is alleged that expenditures are out of all proportion to results, that the service is inefficient, and the department much demoralized.

The first question, of course, in regard to such grave accusations is, to what extent are they true? Is the case as bad as alleged, or only an exaggeration of such defects as are always incident to the administration of governmental affairs? It seems that a committee of investigation was appointed by the Treasury Department to look into the working of the Coast Survey. A committee charged with so serious a duty should certainly have made the most careful and searching inquiry, should have given the accused officers the fullest opportunity of defending themselves, and should have published their results in an explicit and authentic form. We are not aware that this has been done; and if so, common justice requires that judgment should be suspended until decisive evidence is forthcoming, because innocence is to be presumed until guilt is *established*. Upon these points the following remarks from an excellent editorial in "Science" are so appropriate and fair as to be worthy of quotation:

Without the slightest disposition to screen official mismanagement, if it has been discovered, we must caution our readers against giving credence to insinuations and rumors. All who are under implied censure have a right to be fully heard, and to bring all the facts which are explanatory of their conduct to the eye of a qualified tribunal. They have a right to protest against the arbitrary exercise of personal authority, or against the judicial methods of a star-chamber or a drumhead court-martial. No political purpose, no personal dislike, no disbelief in science, should be allowed, unquestioned, to throw discredit upon a branch of the public service, or dishonor upon a corps hitherto regarded as exemplary in all its official work.

The work of the Coast Survey, during its long history, has been of the highest character. For nearly seventy years it has been approved by successive Congresses and administrations, and by navigators, merchants, and men of exact science. It has received the highest encomiums of foreigners who were qualified to judge of its merits, and were interested in pointing out its defects. The five superintendents—Hassler, Bache, Benjamin Peirce, Patterson, and Hilgard—have each, in different ways, improved its methods and upheld its efficiency. The officers just displaced have grown up in the service, and have won promotion by the ability and fidelity with which they have discharged their great responsibilities. The presumptions of official rectitude are in their favor until positive faults are pointed out. They are entitled by the principles of good government, as well as by their individual services, to all the opportunities they may desire for explanation or defense; and any premature opinion is unfair, especially if it is affected by personal prejudices, or is based upon a lack of appreciation for scientific researches.

In the conduct of such a bureau as the Coast Survey, a large amount of discretion must be left to the chief. He, and he only, can determine a vast number of questions which pertain to the selection of assistants for different kinds of work, the choice of fields of labor, the discrimination between services which have an obvious relation to some immediate want of the public, and those which may be just as serviceable, but are recondite, and unintelligible to the uninformed. It is impossible to mark out the duties of the highest assistants by such rules as may be applied to the clerical services of an ordinary counting-room. In order that the results of the survey may be accurate and trustworthy —the only results which are worth having— costly instruments must be bought and used, and must afterward be thrown aside, because other instruments are better, or because their work is done. Still larger outlays are requisite, in order that elaborate and important fundamental inquiries may be prosecuted by men who are trained to exact scientific methods. A staff of learned and experienced investigators is absolutely essential to the conduct of such a national undertaking as the Coast Survey.

Nevertheless, all this scientific research is appreciated by a very small number of persons. Indeed, the more valuable it is, the less obvious may be its merits. Every seaman knows the value of a good chart: not every seaman, not every scholar, not every statesman, knows the conditions by which a good chart is produced. It is only the expert who appreciates the subtile sources of error which must be eliminated: he only knows the infinitude of mathematical, physical, astronomical, and geodetic problems, which are involved in an endeavor to portray faithfully such a coast-line as that of the United States, and to keep the portrayal in accurate correspondence with the changing sands.

There is undoubted weight in the consideration here urged that much of the work of the Coast Survey is of a kind that can be but imperfectly judged by the public, and must be left to the men of science, who can best appreciate its desirableness and its difficulties. This is also the ground taken by the American Association for the Advancement of Science in reviewing the subject. At their recent meeting in Ann Arbor, Professor S. P. Langley proposed the following series of resolutions, which, after discussion, were passed unanimously:

Whereas, The attention of this Association has been called to articles in the public press purporting to give, and presumably by authority, an official report of a commission appointed by the Treasury Department to investigate the condition of the United States Coast-Survey Office, in which report the value of certain scientific work is designated as meager; and

Whereas, This Association desires to express a hope that the decision as to the utility of such scientific work may be referred to scientific men:

Resolved, That the American Association for the Advancement of Science is in earnest sympathy with the Government in its every intent to secure the greatest possible efficiency of the public service.

Resolved, That the value of the scientific work performed in the various departments of the Government can be best judged by scientific men.

Resolved, That this Association desires to express its earnest approval of the extent and high character of the work performed by the United States Coast Survey, especially as illustrated by the gravity determinations now in progress, and to express the hope that such valuable work may not be interrupted.

Resolved, That this Association expresses also the hope that the Government will not allow any technical rule to be established that shall necessarily confine its scientific work to its own employés.

Resolved, That in the opinion of the American Association for the Advancement of Science the head of the Coast Survey should have the highest possible standing among scientific men, and should command their entire confidence.

Resolved, That copies of these resolutions shall be prepared by the General Secretary and certified to by the President of the Association and by the Permanent Secretary, and shall be forwarded to the President of the United States, the Secretary of the Treasury, and given to the press.

The subject was called up and acted upon because of the recent arraignment of the Coast Survey, as stated in the first preamble. In the second the hope is expressed that the decision in regard to the utility of such work—that is, Coast Survey work—may be left to scientific men. But it will be observed that the second resolution covers wider ground, affirming that all "the scientific work performed in the various departments of the Government can be best judged by scientific men."

Now, certainly, nothing can be more true than that scientists are the best judges of scientific work; and, as between these and the officials that are over them, the case may be stated still more emphatically. The successful politicians who get possession of high government offices are apt to be especially incompetent in all matters of science; and, consequently, they must, as a class, be the worst judges of the technical labors of scientific men. What, then, is to be done? The politicians impeach a scientific department for inefficiency, and the scientific men reply by a virtual protest against their capacity to judge of the conduct they condemn. In this they are right; but is it therefore inferable that the scientists are to be left to themselves, and exempted from scrutiny and criticism in the management of their affairs? This assuredly will not do; for if scientific men are qualified on one side, they are disqualified on another and very important side. Like other men, they are self-seeking, ambitious, and have their personal ends to gain. Can we assume that morally they are any better than their neighbors; or that, if they get possession of place and power, they will not use and pervert them to the promotion of their selfish objects? It is to be hoped that in the future science will become so developed as to react upon character and give us men morally as well as intellectually superior; but we are far from any such happy result as yet. Government has boundless wealth at command; it is a mighty patron. Everybody is tempted to get some private advantage through its influence, and scientific men are no exception to their fellow-citizens in exemplifying the general passion, and in desiring to get a share of government patronage. The "scientific politician" has made his appearance in Washington, and the political element in him will dominate the scientific. That he will be a lobbyist and intriguer, and become skilled in the art of getting favors and appropriations from Congress, is but to say that he will work according to his opportunities, objects, and the nature of the materials to be manipulated. An unsupervised and irresponsible scientific department at Washington would be run in the interest of its sharpest managers, would be filled with sinecures, give the least results at the greatest expense, while these results would be aggravated by the sense of exemption from criticism.

We draw a different conclusion from the fact that scientific men are the best judges of their own work, and the politicians who have got the national offices the poorest judges of it. We infer that duties which those officers can not perform in a proper manner they should not undertake. The policy of extending what may be called Government science at Washington is a bad one; whatever is indispensable must be tolerated, but with this qualification the less we have of it the better. The Coast Survey is a work of undoubted national necessity. Its investigations are essential to the national defense; it was begun long ago, in a small way, with no reference to any Government policy respecting the promotion of science; and it has been systematically prosecuted as a matter of unquestionable public importance. But the modern extensions of Government science, as the Department of Agriculture, for example, stand upon no such ground. They have not been called into existence by any special or urgent needs of the state, or to subserve any legitimate function of Government; but they have come through the agency of scheming and ambitious scientific men who sought official power for the advancement of their own objects. Under such inspiration the national Government has entered into rivalry with the private investigators of the country to promote research, develop resources, and accumulate useful knowledge for the people. Millions of money are now spent on investigations of all kinds, on collections and surveys, buildings, apparatus, salaries, and publications made at extravagant cost, and which are without that warrant of necessity which should be the sole reason of any scientific undertaking by the state.

How the immense system of official science at Washington, which Government neither called for nor is competent to supervise, has gradually grown up under outside management, is easily explained. Alliance with politics has been very sedulously and skillfully cultivated by our leading scientific men. The most decisive step in this direction was taken a few years ago, in the organization of the National Academy of Sciences, an institution copied after an old French model. Through its act of incorporation a limited and select number of men became scientific leaders by national authorization. It was a specious and insinuating project, offering itself as a kind of bureau of advice to Congress on all scientific matters. Money was not solicited: the *savants* were to serve the state for nothing. It was to be a Washington institution, pledged to hold meetings at the capital permanently. The headquarters of the Coast Survey were already established there. The United States Government had accepted the magnificent bequest of Smithson, and established a national institution "for the increase and diffusion of knowledge among men"; and the newly instituted Academy of Sciences became the agency for combining the elements to secure the extension of Government patronage to all kinds of scientific undertakings. The tendency to centralization and the enlargement of Government powers, after the war, greatly favored the accomplishment of the work. The great extensions of state education also favored it. A splendid national university, with a twenty-million endowment by the General Government, was strenuously advocated. Everything was thus propitious to the multiplication and consolidation of scientific departments, and to the general plan of employing scientific men to carry on their inquiries at the expense of the state, and under the direction of Government.

For many and urgent reasons we hold that our overgrown Government science ought to be arrested and retrenched. That administrative officers are bad judges of it is one of them. But, even if this were not so, the policy would still be thoroughly objectionable. The promotion of science is not an object for which Government exists. The civil authority has its legitimate duties, and can only perform them by being confined to them. It is the business of Government to maintain the order of society and the rights and liberties of individual citizens by the establishment and enforcement of wise laws; and the sole condition on which this can be accomplished is that the law-makers and law-executors shall allow nothing to interfere with this supreme duty. By attempting to do everything else this is neglected, and the multiplication of government functions ends in the defeat of the objects for which Government exists. We do not say that Government denies the rights of foreign authors and leaves them a prey to American plunderers because it has gone into the promotion of science; but we do say that its absorption in business interests and enterprises has deadened its moral sense so that it has little care about a gross delinquency which is a scandal to the American name throughout the world. Justice between man and man, the first condition of all sound prosperity in communities, can only be enforced by the civil authority; but science can be advanced by private enterprise, individual interest and effort, and voluntary association, better than by state regulation, and there it is better that the Government should leave it.

LITERARY NOTICES.

Collected Essays on Political and Social Science. By William Graham Sumner, Professor of Political and Social Science in Yale College. New York: Henry Holt & Co. Pp. 173. Price, $1.50.

This volume consists of discussions upon the following subjects: "Bimetallism";

"Wages"; "The Argument against Protective Taxes"; "Sociology"; "Theory and Practice of Elections," Parts I and II; "Presidential Elections and Civil-Service Reform"; and "Our Colleges before the Country." These are all "topics of the time," dealing with questions not only of great public moment, but which are being much agitated in many quarters. The volume is therefore timely in its appearance, and, more than this, it is the kind of book that is greatly needed. In reading it, we have been much reimpressed with the author's rare ability in handling economical and social questions. A clear, logical, independent thinker; a sound theorist, because he always defers to facts; a practical man, because he trusts in established principles; and withal a vigorous, pointed, and attractive writer, Professor Sumner is the man to do eminently valuable work in educating the public mind on subjects of economical and social science. And sound teachers upon these subjects are none too numerous. The propagators of error, in numberless forms, have the field. Some are misled by half-knowledge, some prejudiced by party feeling, some perverted and blinded by self-interest, some fascinated by specious hobbies, so that the press teems with magazine articles, pamphlets, and books, not calculated, to say the least, to strengthen scientific conceptions, or to bring men into the agreement of reason on the various topics of public and social concern. Perhaps the worst of it is that the effect of all this chaos of opinion is to undermine confidence in principles and all belief in the possibility of anything like valid and trustworthy social and political science. In the present state of things, where great pecuniary interests are involved, the temptation to favor this view is strong. No service, therefore, is more important to the community than to strip away the multitudinous fallacies in which these subjects are involved, and to show that there are clear, comprehensive, and solid principles governing social and political phenomena which must be recognized and trusted before society can realize anything like permanent prosperity. This is the kind of work which Professor Sumner is eminently fitted to accomplish, and we cordially welcome his present work, as we have welcomed all his previous books, because it brings out and popularizes views which it is of the utmost moment that our citizens should understand and maintain. We can here give no indication of the doctrines expounded in the varied discussions of the work, and must be content to urge, especially upon our young men, that this is the kind of book to be thoroughly studied, until its contents are assimilated and reduced to an established political and social creed.

The Microscope in Botany: A Guide to the Microscopical Investigation of Vegetable Substances. From the German of Dr. Julius Wilhelm Behrens. Translated and edited by Rev. A. B. Henry, assisted by R. H. Ward, M. D. Boston: S. E. Cassino & Co. Pp. 466, with Thirteen Plates. Price, $5.

According to the translator, this treatise occupies a field almost entirely to itself in the botanical literature both of Germany and now of the English-speaking world, and it is published with the hope that its influence will be to stimulate in this country investigations into the deeper problems of plant-life. The study of the literature of the subject shows that there is an open field for American botanists, for existing works almost exclusively involve the results of German research, while a few are of French origin, fewer still of English, and none whatever of American. The first purpose of the work is to guide students in all those inquiries relating to the physical products of cell-life in plants which may be conducted under the microscope, by means of chemical and other reactions. While it deals with the anatomical constitution of the cell, and of plant-tissue, its inquiries relate much more to physiological and biological processes than to matters purely anatomical and histological. The part of Dr. R. H. Ward in the preparation of the work consists in the revision of the two chapters which deal with the microscope and its accessories; and in these considerable changes have been made, as is proper in a work of the kind intended for American study, in the omission of illustrations and descriptions in the Continental style, which is comparatively unused and unavailable here, and the substitution of American forms. All the matter introduced by the American editors is distinguished by plain typographical devices.

The Treatment of Opium-Addiction. By J. B. Mattison, M. D. New York: G. P. Putnam's Sons. Pp. 49. Price, 50 cents.

This work embodies the substance of a paper read at the last meeting of the American Association for the Cure of Inebriates, and details the author's special method of treatment, which he has successfully practiced for several years. The author maintains that opium-addiction is a disease, seldom a vice, and should be treated as a disease. He advises against breaking off the practice abruptly, while he finds the other ordinary method of treatment, by gradual decrease of the opiate with tonics, inconveniently slow. His own method is a mean between the two extremes, and is based on the power of certain remedial resources to control abnormal reflex sensibility; and he claims for it the advantages of minimum duration of treatment and maximum freedom from pain.

The Field of Disease: A Book of Preventive Medicine. By Benjamin Ward Richardson, M. D. Philadelphia: Henry C. Lea's Son & Co. Pp. 737.

The author has written this work, he says, "for those members of the intelligent reading public who, without desiring to trench on the province of the physician and surgeon, or to dabble in the science and art of medical treatment of disease, wish to know the leading facts about the diseases of the human family, their causes and prevention. Any one, therefore, who opens this book with the expectation of finding in it receipts and nostrums will not have that expectation fulfilled, and will discover reference to no remedies except such as are purely preventive in character." The old historical terms are used in preference to the new; that classification of diseases is preferred which has descended from the best scholars in medical science and art, and which is best known to the people at large. Of the relative value of curative and preventive medicine, the latter "is not a science, it is not an art separated necessarily or properly from so-called curative medicine. On the contrary, the study of cure and prevention proceed well together, and he is the most perfect sanitarian, and he is the most accomplished and useful physician, who knows most both of the prevention of disease and of the nature and treatment of disease; he who knows, in fact, the before and the after of each striking phenomenon of disease that is presented for his observation." The investigation of the subject is directed to the tracing of diseases from their actual representation, as they exist before us, in their natural progress after their birth, back to their origin, and, as far as is practicable, to seek the conditions out of which they spring; and, further, to investigate the conditions, to see how far they are removable and how far they are avoidable.

The Windmill as a Prime Mover. By Alfred R. Wolff, M. E. New York: John Wiley & Sons. Pp. 159. Price, $3.

There may have been a time when windmills were considered antiquated and of no further use, but it is so no longer. These simple and economical sources of power are quite generally employed in all parts of our country, and their use is increasing, and, according to Mr. Wolff, it is now greater than at any other period in the history of the world. "To place the number of windmills at work in America," he says, "at several hundred thousand is to give an estimate which those who have been interested in this department of engineering, and who have traveled along the main railroad lines of the country, must pronounce as low." And we are further informed that in some single cities of the Union over five thousand windmills are manufactured, on an average, each year. For those kinds of work in which the power is not required to be constant, but can be taken when it comes—such as pumping and storing water, compressing and storing air, and driving dynamo-machines to charge electrical accumulators—no machines can be cheaper than windmills, and they are efficient enough. American manufacturers have made great improvements in the machines, and their patterns are pronounced much better than the European patterns, and destined to supersede them. Mr. Wolff's treatise is practical and a little literary, for it gives a very interesting chapter on the "Early History of Windmills." On the practical and economical side it has chapters on "Wind, its Velocity and Pressure"; "The Impulse of Wind on Windmill-Blades"; "Experiments on Windmills"; "The Capacity and Economy of the Windmill"; and "Useful Data in Connection with Windmill Practice"; with full accounts of the various European and American machines.

Proceedings of the United States National Museum. 1884. Washington: Government Printing-Office. Pp. 661, with Two Plates.

This is the seventh volume of the series of papers established in 1878, which the Institution publishes regularly in "signatures," as sixteen pages are accumulated from time to time, in order to present the matter as early as possible to the public. At the end of the year the sheets are gathered up and embodied in a volume. The articles in this series consist, first, of papers published by the scientific corps of the National Museum; and, second, of interesting facts and memoranda from the correspondence of the Smithsonian Institution.

Local Institutions of Maryland. By Lewis W. Wilhelm, Ph. D. Baltimore: N. Murray. Pp. 129. Price, $1.

This work is a triple number of the series of "Johns Hopkins University Studies in Historical and Political Science." It presents a careful review of the course of growth of the institutions of the Commonwealth in question, including the organization of the land system; the constitution and functions of the hundred; the formation of the county; with the history of the beginnings of each, and the more tardy growth of the towns. In the last section we meet the interesting and suggestive observation, which we quote, that "no student of society can have watched the operations of the vital processes of the social organism and failed to notice the complex growth of certain institutions, and the corresponding decay in authority of officers associated with their development. The brooding, in society, of the spirit of democracy has tended to develop the institution, to multiply its organs, to strengthen its members, and foster its general growth, but at the same time there has been a corresponding contraction of the jurisdiction of its representative officer, and a diffusion of his powers among many associates. When we recall the full meaning of *patria potestas*, we are led to exclaim, 'The fathers, where are they?' and the patriarchs, do they live forever? Quite often the serfs have become the sovereigns, and the sovereign has been reduced to a subject. Could great Augustus have seen the base uses to which the title 'emperor' had been put by barbarians, his heart would have died within him.* And who would recognize in the common hangman, or in the distrainer of house-rents, the sheriff or the constable of the proud Norman court? Could the voice of prophecy have told Charles Martel, who ruled the ruler of the Franks, that his title of major or mayor would descend to administrators of petty villages, he would have had additional reasons for moralizing upon the deceits of human greatness."

Report of the Operations of the United States Life-saving Service, for the Year ending June 30, 1884. Washington: Government Printing-Office. Pp. 476.

Five stations were added during the year, and the number of stations at its close was 201. Of these, 56 were on the Atlantic, 37 on the lakes, seven on the Pacific, and one at the Falls of the Ohio. The whole number of disasters reported was 430, endangering $10,607,940 of property, and the lives of 4,432 persons. Of the persons, all but twenty were saved, and only $1,446,586 of the property was lost. The number of vessels totally lost was 64. The Service has co-operated in scientific movements by assisting investigations in marine zoölogy, and by collecting "singing-sands" for examination by Professor H. C. Bolton. The concluding statement in the summarized report, regarding the character of the Service's men, is very suggestive. It is: "It is felt that seldom in the history of organizations has a body of men been assembled

* Not only did the "sole power of constituting and appoynting the *Emperor* of Pascattoway reside with a subject of the English king, the proprietary of Maryland, but the "King of Choptico" was presented for pig-stealing at a court-leet of a Maryland manor.

so equal in qualification for the stern tasks set them, and so splendid in their efficiency. That they can have such a character collectively is clearly attributable to their having been selected for their posts solely on professional and moral grounds, without the slightest reference to their politics. The constant purpose of the officers in charge has ever been to obtain for station duty the ablest and trustiest surfmen. Previous reports of the Service have made apparent how difficult it was, for years, to limit the choice of these agents to the simple tests of their ability and trustworthiness, and how great and absolute a help in this regard has been the statute of 1882, peremptorily exempting the selection from political influences. It can be safely said that in no instance have the requirements of that statute been disregarded, either in spirit or letter."

A Catalogue of Scientific and Technical Periodicals (1665 to 1882). Together with Chronological Tables and a Library Check-List. By Henry Carrington Bolton. Washington: Published by the Smithsonian Institution. Pp. 776.

The mass of periodical literature has become stupendous; and the real importance it has attained is hardly less striking than its magnitude. The literature in some departments embodied in periodicals has nearly overtaken in value that which has been collected in books, and in the present course and tendencies of publication bids fair, before long, to pass it. In science, especially, is that which is comprehended in periodical publications indispensable to the investigator who would make real progress. A large proportion of the experiments of the past and of the details of results attained can not be given in books, but must always be sought for in the periodicals in which the records first appeared. A perfect index to this literature would lead the inquirer directly to every experiment; but such an index can hardly be hoped for at present, and would be of inconvenient bulk, if it existed. We must take it in parts. In this work Professor Bolton has given a very important part—a list of scientific periodicals, alphabetically arranged, with the cross-references so necessary in every work of the dictionary class; classified according to the subject; with a chronological table showing the date when each volume of each periodical was published; and an alphabetical index to that; and a partial list—as complete as it could be made for the first issue—of the libraries in the United States and Canada where the several periodicals may be found. This catalogue and the "Catalogue of Scientific Serials," published by Mr. Scudder in 1879, complement one another. Mr. Scudder's catalogue includes the transactions of learned societies in the natural, physical, and mathematical sciences, and technical journals only to a limited extent; the present work is confined to scientific and technical "periodicals" proper, excluding society proceedings and transactions, but including periodicals devoted to the "applications" of science. Medicine has been excluded, but anatomy, physiology, and veterinary science, being related to zoölogy, have been admitted. Of the category of included subjects, it contains the principal independent periodicals of all branches published in all countries, from the rise of the literature in question to the close of the year 1882. The effort has been made to give full titles and names of editors. In some debatable cases titles have been admitted, on the ground, as enunciated by Buchold, that "in a bibliography it is much better that a book should be found which is not sought, than that one should be sought for and not found." The cross-references are from the later to the first title of a periodical which has suffered changes in title; from short titles in common use to the accurate designations; from the names of the principal editors to the journals conducted by them; and, in the case of astronomical publications, from the places in which the observatories are situated to the titles of the periodicals issued therefrom. The library check-list has been prepared from the data afforded in the answers to circulars which were sent out to two hundred libraries, of which one hundred and twenty librarians responded. The material for the work was gathered from all available bibliographies, personal examination of the shelves and the catalogues of many libraries in the United States, as well as of important libraries in England, France, and Germany, and from the answers to circulars sent to publishers asking for specimen numbers of their periodicals. The catalogue includes the titles of five thousand one hundred and five periodicals in the English, German, French, Italian, Spanish, Portuguese, Dutch, Scandinavian, Hungarian, and Slavic languages, of which two thousand one hundred and fifty are placed in the library check-list. Ninety-four subjects are included in the classified list, in which periodicals devoted to general science do not enter. Of these subjects, the most numerously represented is that of agriculture.

Geological and Natural History Survey of Minnesota. By N. H. Winchell, State Geologist. First Annual Report, 1872, pp. 112; Tenth do., 1881, pp. 254, with Fifteen Plates; Eleventh do., 1882, pp. 219; Twelfth do., 1883, pp. 387, with Map and Plates.

The first report includes an historical sketch and list of publications relating to the geology and natural history of Minnesota, beginning with Father Hennepin's book, and a general sketch of the geology of the State. The "tenth report" contains descriptions of about four hundred rock samples and notes on their geological relations, continued from the previous report; a paper on the Potsdam sandstone, papers on the Crustacea of the fresh waters of Minnesota, etc. The "eleventh report" includes a report on the mineralogy of the State; and papers on the crystalline rocks; rock outcrops in Central Minnesota; Lake Agassiz (a large, ancient lake, of which traces are found in an extensive region); the iron region of Northern Minnesota, etc. The "twelfth report" is mainly devoted to paleontology and the fauna and flora.

Life of Frank Buckland. By his Brother-in-Law, George C. Bompas. Philadelphia: J. B. Lippincott Company. Pp. 433. Price, $2.

Few men have been privileged to do more to popularize science, as represented in natural history, and to spread abroad love for animals, than the subject of this memoir. His life was very largely devoted to the study of animated nature, to the development of its economical value, and the collection and increase of information on every aspect of it. The objects with which he labored, and the principles by which he was guided are well expressed in the counsel he gave in the first number of "Land and Water," in January, 1866: "Let none," he said, "think himself unable to advance the great cause of natural history. Thousands of Englishmen and Englishwomen have knowledge and experience, acquired by their actual observation of useful facts relating to animated beings, be they beasts, birds, insects, reptiles, fishes, or plants. Friendly controversy and argument are invited on all questions of practical natural history, and although the *odium salmonicum* not unfrequently assumes more virulence than even the *odium theologicum* of the good old days of fagot and stake, no writer need fear that his pet theory shall be ruthlessly set on fire, or that his arguments shall be decapitated, without a fair and friendly hearing." Mr. Bompas has given a very picturesque and engaging story of a man who was certainly one of the liveliest characters in the history of science.

Forests and Forestry in Poland, Lithuania, the Ukraine, and the Baltic Provinces of Russia. Compiled by John Croumbie Brown. Edinburgh: Oliver & Boyd; Montreal: Dawson Brothers. Pp. 276.

Dr. Brown follows up his review of the condition of the forests and of forestry in the several countries of Europe with praiseworthy industry and devotion to the cause of reclothing the waste places of the earth. The present volume is like the others of the series which we have noticed in plan and style. It gives accounts of the countries and peoples, and their history so far as it is connected with forestry, and detailed information concerning the present extent, use, and care of the forests.

Magneto- and Dynamo-Electric Machines; with a Description of Electric Accumulators. From the German of Glaser de Cew. New York: D. Van Nostrand. Pp. 301.

This is the first volume of a new series, called "The Specialist Series," to be edited by Dr. Paget Higgs and Professor Charles Forbes, the purpose of which is to impart information on recent technical subjects in a manner suited to the popular intelligence. Concerning the immediate subject of the present volume, after noticing the extravagant views that were at first entertained of the machines, the editors say: "Now the dynamo is likely to take a fair stand in the rank of useful machines; for a time it was a machine regarded as likely to revolutionize all the mechanical world; now it is coming to be considered in its true light as a very valuable aid and auxiliary to steam and other prime movers, extending their sphere, and making more easy their application. For these reasons, it is assumed that the public interested in such technical matters are desirous of a more intimate knowledge of the principles of these machines, and this knowledge it is the object of the present hand-book to supply."

Lectures on the Science and Art of Education, with other Lectures and Essays by the late Joseph Payne. Reading-Club edition. Syracuse, N. Y.: C. W. Bardeen, publisher. Pp. 281.

Among the multitude of books that are teeming from the press on the subject of education, this is one of the soundest and safest, and really the most advanced in its spirit, and in the principles it labors to inculcate. Its editor says in his preface: "It must be remembered that this volume was not prepared by the author as a text-book, but is simply a compilation of addresses and papers delivered at different times and under different circumstances. Hence the same truth is often repeated, not only in different expression, but with different application." Only by an intelligent comparison of these various statements can Professor Payne's views be thoroughly understood; and, for this comparison, these analyses are almost indispensable. The central principle of Professor Payne's system stands out boldly, and is reiterated at every opportunity, that the pupil "knows only what he has discovered for himself, and that in this process of discovery the teacher is only a guide."

He thus closes his masterly lecture on "The True Foundation of Science-Teaching": "I do not for a moment deny that much is to be gained from the study of scientific text-books. It would be absurd to do so. What I do deny is, that the reading-up of books on science—which is, strictly speaking, a literary study—either is or can possibly be a training in scientific method. To receive facts in science on any other authority than that of the facts themselves; to get up the observations, experiments, and comments of others instead of observing, experimenting, and commenting ourselves; to learn definitions, rules, abstract propositions, technicalities, before we personally deal with the facts which lead up to them—all this, whether in literary or scientific education—and especially the latter—is of the essence of cramming, and is therefore entirely opposed to, and destructive of, true mental training and discipline."

Lectures on Teaching, delivered in the University of Cambridge, during the Lent Term, 1880. By J. G. Fitch, M. A., Assistant Commissioner to the late Endowed Schools Commission, and one of her Majesty's Inspectors of Schools. New edition. With a Preface by an American Normal Teacher. New York: Macmillan & Co. 1885. Pp. 393. Price, $1.

We have previously spoken in emphatic praise of this able educational work, and are glad to see that it has now been brought out in a cheaper edition. Fitch is probably the best authority on general education connected with the English school system. He is thoroughly informed and thoroughly practical, and his book should be in the hands of every teacher who has capacity or liberty to think upon the subject of teaching.

Talks Afield: About Plants and the Science of Plants. By L. H. Bailey, Jr. Houghton, Mifflin & Co. Pp. 173. Price, $1.

This little book has many pictures, and contains many interesting explanations and descriptions of vegetable processes and general plant phenomena. It will interest all who have botanical tastes, and will assist to develop those tastes where they do not exist.

Lessons in Elementary Practical Physics. By Balfour Stewart, F. R. S., and W. W. Haldengee. Vol. I. General Physical Processes. Macmillan & Co. Pp. 291. Price, $1.50.

This is a manual for the physical laboratory, and is mainly devoted to instruments and apparatus. It deals chiefly with experimental determinations of length, angular measurement, mass, density, elasticity, pressure, gravitation, and kindred conceptions, but is to be followed in due course by a volume on "Electricity and Magnetism," and by a third work on "Heat, Light, and Sound." The names of Balfour Stewart, Professor of Physics in the Owens College, Manchester, and of his assistant demonstrator in physics, are sufficient guarantee that the work is thoroughly done.

The Nature of Mind and Human Automatism. By Morton Prince, M. D. Philadelphia: J. B. Lippincott Company. Pp. 173. Price, $1.50.

This is a closely reasoned discussion of the essential issues of materialism. It first took form several years ago as a graduating medical thesis, which the author did not publish at the time, as he preferred to wait for further reflection and investigation of the subject. It is predominantly polemic, as Dr. Prince finds himself brought into collision with the views of Tyndall, Fiske, Huxley, and Spencer, which he controverts with much acuteness. He ranks himself as a materialist under his own view of what materialism is, and finds himself in more decided harmony with the doctrines of Professor Clifford than with those of any other recent or contemporary thinkers upon this subject. We can not undertake to expound the view of the relations of body and mind which seems to him most rational, but unhesitatingly recommends his work to all who are looking for a vigorous and original treatment of the profound problems to which the volume is devoted.

Outlines of Psychology. Dictations from Lectures by Hermann Lotze. Translated, with a chapter on "The Anatomy of the Brain," by C. L. Herrick. Illustrated. Minneapolis, Minn.: S. M. Williams. Pp. 149, with Plates. Price, $1.25.

Much has been said of the claims of Lotze as a philosopher, psychologist, physiologist, etc., and, as his translator here remarks, he "is rapidly gaining recognition even in America." It was time, therefore, that he should be translated, and a good beginning is here made in this little volume. Those who can not read him in the original may now judge of his claims, and get the benefit of his contributions to philosophy.

On Teaching: Its Ends and Means. By Henry Calderwood, Professor of Moral Philosophy at the University of Edinburgh. Third edition. Macmillan & Co. Pp. 126. Price, 50 cents.

This book emanates from a distinguished source, and, while Professor Calderwood has a recognized prominence as a philosopher, he is also a practical teacher of long experience in every grade, and besides has had much to do with the management of the Edinburgh public schools. It would be unjust to say that his book is without merit; there is much in it that is worth attending to, but it is not of the high grade that we should expect from the position and opportunities of its author. A better book was due from him than any we have on the subject of moral education; but he contributes nothing new or of moment to that most important branch of the art of school management. He seems to be steeped in the pedagogical idea, and is more dominated by the old methods than becomes an original and independent critic of the subject. The first words of his introduction are, "Every one recognizes that a person can teach only what he knows"; but this is so far from being true, that the most successful study may take the form of self-teaching, where the teacher is ignorant of a subject and joins the pupil as a student in pursuing it. Professor Calderwood, however, guards against such an interpretation of his dictum as would imply that instruction is the sole end of teaching; but self-instruction has no such leading place in his system as we think it should have in any rational system of education.

Properties of Matter. By P. G. Tait, Professor of Natural Philosophy in the University of Edinburgh. Edinburgh: Adam & Charles Black. Pp. 320. Price, $2.25.

Though the name of Black appears upon the title-page of this work as publisher, yet that of Macmillan & Co. is stamped upon the back, and it is announced as one of Macmillan's "Manuals for Students." It is, of course, a good book of its kind, for Tait knows how to do good work. But, though claiming to be an elementary book, it must still be regarded as an advanced text-book, and is intended for students who are "supposed to have a sound knowledge of ordinary geometry and a moderate acquaintance with the elements of algebra and trigonometry." The author adds in his preface, but he (the student) "is also supposed to have—what he can easily obtain from the simple parts of the first two chapters of Thompson & Tait's 'Elements of Natural Philosophy,' or from Clerk Maxwell's excellent little treatise on 'Matter and Motion'—a general acquaintance with the fundamental principles of kinematics of a point and of kinetics of a particle." It was the author's intention to complete his series of text-books by similar volumes on "Dynamics," "Sound," and "Electricity."

Theory and Practice of Teaching. By Rev. Edward Thring. New and revised edition. Cambridge: University Press. Pp. 262. Price, $1.

We noticed the first edition of this spirited book at the time of its appearance. It is very readable, but full of English views upon the subject, although many of them are as applicable here as anywhere. We are glad to see that it has been amplified and improved.

Third Biennial Report of the Bureau of Labor Statistics of Illinois. 1884. John S. Lord, Secretary. Springfield. Pp. 654.

The contents of this report are presented in three parts, each of which is devoted to some special line of statistical inquiry on the general topic of industrial affairs in Illinois, and the relations which the different classes engaged in them sustain to each other and to the State. The first part contains an investigation designed to ascertain what proportion of the results of manual labor in manufactures accrues to the proprietor and what to the workman. In part second are presented the results of special investigations made by the bureau into the economical and social condition of the industrial classes of the State; and the third part gives comprehensive statistics of coal-mining and the manufacture of drain-tile in Illinois; with a report on the model industrial community at Pullman, in which are expressed the conclusions reached by a number of representatives from the various State Bureaus of Labor Statistics, after an investigation extending through several days.

PUBLICATIONS RECEIVED.

Progress of Astronomy in the Year 1884, by Professor Edward S. Holden, pp. 55; Progress in Zoölogy in the Year 1884, by Professor Theodore Gill, pp. 93; Progress in Vulcanology and Seismology in the Years 1883, 1884, by Professor Charles G. Rockwood, Jr., pp. 21; Antiquities at Pantaleon, Guatemala, by Lieutenant Charles E. Vreeland, U. S. N., and J. F. Bransford, U. S. N., pp. 12; Papers relating to Anthropology, pp. 38. All from the Smithsonian Report for 1884. Washington: Government Printing-Office. 1885.

Crystallization, by Dr. Persifer Frazer, pp. 11; The Tehuantepec Ship Railway, by E. L. Corthill, C. E., pp. 33. Reprints from the "Journal of the Franklin Institute," Philadelphia. 1885.

Report of a Special Committee of the Franklin Institute on the Efficiency and Duration of Incandescent Electric Lamps. Philadelphia: The Franklin Institute. 1885. Pp. 127.

Publications of the Museum of Comparative Zoölogy of Harvard College, Mass. Pp. 8.

Proceedings of the Illinois State Board of Health. Quarterly Meeting, Chicago, July 2–3, 1885. Pp. 26.

Notes on the Island of Jura, Scotland, pp. 5; and Syenite and Gabbro in Massachusetts, pp. 3. By Dr. M. E. Wadsworth.

An Olivine-bearing Diabase from St. Georges, Maine. By Q. E. Dickerman and M. E. Wadsworth. Pp. 2.

Meteorology of the Mountains and Plains of North America, as affecting the Cattle-growing Industries of the United States. By Silas Burt. St. Louis, Mo. 1885. Pp. 7.

Studies from the Biological Laboratory of Johns Hopkins University. Edited by H. Newell Martin and W. K. Brooks. Vol. III, No. 3. Baltimore: N. Murray. June, 1885. Pp. 72. 75 cents.

Influence of the Proprietors in founding the State of New Jersey. By Austin Scott, Ph. D. Baltimore: N. Murray. August, 1885. Pp. 26.

Niagara Park. Original and Selected Descriptions, Poems, and Adventures, by Various Writers. Edited by Alice Hyneman Rhine. New York: Niagara Publishing Company. 1885. Pp. 112. Illustrated. 50 cents.

A Canterbury Pilgrimage. Ridden, Written, and Illustrated, by Joseph and Elizabeth Robins Pennell. New York: Charles Scribner's Sons. 1885. Pp. 78. 50 cents.

Creation. Man's Fall explained in the Light of Modern Science. New York: Lawrence S. Benson. 1885. Pp. 15. 15 cents.

The Modification of Plants by Climate. By A. A. Crozier, Ann Arbor, Mich.: The Author. 1885. Pp. 35. 25 cents.

The Song Budget, for Schools and Educational Gatherings. Compiled by E. V. De Graff, A. M. Syracuse, N. Y.: C. W. Bardeen. 1885. Pp. 76. 15 cents.

"The Black Diamond." Published in the interest of the coal-trade industry. F. S. Jervis and H. A. Bischoff, Editors. Chicago: The National Coal Exchange. Monthly. Pp. 12. $1 a year.

"The Hoosier Naturalist." A. C. Jones, R. B. Trouslot, Editors and Publishers. Valparaiso, Ind. Monthly. Pp. 8. 50 cents a year.

Bulletin of the Museum of Comparative Zoölogy of Harvard College. Vol. XII, No. 1. Chlamydoselachus Anguineus Garm—A Living Species of Cladodont Stork. By S. Garman. Cambridge. 1885. Pp. 35, and numerous Plates.

The Utilization of the Sun's Rays in heating and ventilating Apartments. By Professor E. S. Morse. Pp. 8.

The Attraction and the Figure of Equilibrium of a Rotating Fluid Mass and the Interior Density and Temperature of the Earth. By D. P. Blackstone. Madison, Wis. 1885. Pp. 58.

Fiat Money. A Review of the Decisions of the

United States Supreme Court as to its Constitutionality. By Francis A. Brooks. Boston: Little, Brown & Co. 1885. Pp. 28.

Sanitary Engineering. A Course of Study recently established at the School of Mines of Columbia College, New York.

Sibley College, Cornell University, Schools of Mechanical Engineering and Mechanic Arts. 1885.

A Memoir of Charles Hilton Fogge, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 7.

The Relation of Annual Rings of Exogens to Age. By D. P. Penhallow. From the "Canadian Record of Science." 1885. Pp. 14.

Valdimir. A Poem of the Snow. New York: H. Lockwood. 1885. Pp. 46. 25 cents.

Second Annual Report of the State Agricultural Experiment Station at Amherst, Mass. 1884. Boston: Wright & Potter. 1885. Pp. 166.

Transactions of the Sixteenth and Seventeenth Annual Meetings of the Kansas Academy of Sciences, with the Report of the Secretary. Vol. IX. Topeka: T. D. Thatcher. 1885. Pp. 146.

Success in Life physiologically considered. By James T. Seavey, M. D. Tuscaloosa, Ala. Pp. 39.

Possibility of Errors in Scientific Researches due to Thought Transference. By E. C. Pickering. From Proceedings of American Society for Psychical Research. Pp. 43.

Contributions to our Knowledge of Sewage. By William Ripley Nichols and C. R. Allen. Pp. 6.

"The Sun." A bi-monthly publication devoted to Coöperation. Vol. I, No. 1. Subject: Prohibition. Kansas City, Mo. C. T. Fowler. Pp. 28. 10 cents.

The Story of Manitou. Denver, Col. S. K. Hooper. Pp. 64. Illustrated.

"The Journal of Physiology." Vol. VI, Nos. 4 and 5. Cambridge Scientific Instrument Company. July, 1885.

The Minting of Gold and Silver, pp. 20; and Placer Mines and Mining Ditches, pp. 64. By Albert Williams, Jr. From the Report of the Tenth Census of the United States.

Zoölogic Whist and Zoönomia. Representing the Orders of the Animal Kingdom. By Hyland C. Kirk. New York: McLoughlin Bros. 1885. $1.

Philosophic Series: No. I, Criteria of Diverse Kinds of Truth as Opposed to Agnosticism, pp. 60; No. II, Energy, Efficient and Final Cause, pp. 55; No. III, Development, what it can do and what it can not do, pp. 50; No. IV, Certitude, Providence, and Prayer, pp. 46; No. V, Locke's Theory of Knowledge with a Notice of Berkeley, pp. 77; No. VI, Agnosticism of Hume and Huxley, with a Notice of the Scottish School, pp. 70; No. VII, A Criticism of the Critical Philosophy, pp. 60; No. VIII, Herbert Spencer's Philosophy as Culminated in his Ethics, pp. 71. By James McCosh, D. D., LL. D., D. L., President of Princeton College, etc. New York: Charles Scribner's Sons. 1883–1885.

The America's Cup. How it was won by the Yacht America in 1851, and has been since defended. By Captain Roland F. Coffin. New York: Charles Scribner's Sons. 1885. Pp. 155. $1.

Lawn Tennis as a Game of Skill. By Lieutenant S. C. F. Peile, M. S. C. Edited by Richard D. Sears. New York: Charles Scribner's Sons. 1885. Pp. 90. 75 cents.

The Student's Manual of Exercises for translating into German. By A. Lodemon, A. M. New York and London: G. P. Putnam's Sons. 1885. Pp. 87. 50 cents.

Chemical Problems. By Dr. Karl Stammer. From the German, by W. S. Hoskinson, A. M. Philadelphia: P. Blakiston, Son & Co. 1885. Pp. 112. 75 cents.

Ballooning. A Concise Sketch of its History and Principles. By G. May. New York: D. Van Nostrand. 1885. Pp. 94.

The Chronicle Fire-Tables for 1885. A Record of the Fire-Losses in the United States, by Risks, States, and Causes during 1885, with Exhibits of the Monthly, Annual, and Aggregate Fire-Losses in the United States and Canada during the Years 1875–1884. New York: "The Chronicle." 1885. Pp. 150.

Barbara Heathcote's Trial. A Novel. By Rosa Nouchette Carey. Philadelphia: J. B. Lippincott Company. 1885. Pp. 503. 50 cents.

The Will. A Novel. By Ernst Eckstein. From the German, by Clara Bell. New York: W. S. Gottsberger. 1885. 2 vols. $1.75.

Modern Molding and Pattern-Making. By Joseph H. Mullin, M. E. New York: D. Van Nostrand. 1885. Pp. 257.

Malthus and his Work. By Joseph Bonar, M. A. London: Macmillan & Co. 1885. Pp. 432. $4.

Annual Report of the Board of Regents of the Smithsonian Institution for 1883. Washington: Government Printing-Office. 1885. Pp. 959.

Paleontology of the Eureka District. By Charles Doolittle Walcott. Vol. VIII. Monographs of the United States Geological Survey. Washington: Government Printing-Office. 1885. Pp. 298, and Twenty-four Plates.

POPULAR MISCELLANY.

Malaria and the Eucalyptus.—The experiment of preventing malaria by plantations of eucalyptus-trees at Tre Fontaine, near Rome, has failed. While the eucalyptus-trees thrive, the malaria continues. Fevers prevailed there in 1880, and even during the season, exceptionally healthy at Rome, of 1882, and under circumstances which made the epidemic seem largely local. A government commission has been appointed to examine into the matter, on the application of Professor Tommasi-Crudelli, who suggests that, until the inquiry is completed, conjectures as to the cause of the visitation be abstained from. The facts are, however, he says, practically instructive, "proving as they do once more to what risks of mistake we expose ourselves if we hold *a priori* that the methods which have resulted in a permanent improvement of one malarious locality can be usefully applied to all. The condition of permanent improvement is that of so modifying the physical conditions and the chemical composition of the soil as to render it incapable of producing the malarial ferment. If all malarious soils were similarly situated and had the same chemical composition, we should be certain of obtaining a permanent improvement in them by the adoption of a system of cultivation by which this result has been brought about in any one of them; but, unfortunately, malaria is produced in soils whose situation and chemical composition are most various, so that the system by which some have been improved may fail entirely when applied to others. So with the plantations of eucalyptus, they succeed in one place and not in others. We know nothing precisely about the nature of the cultivation which should be adopted in order to produce in a given species of malarious soil a final modification of its physical conditions and chemical composition which shall render it incapable of producing the poisonous ferment. At present we are feeling our way, with the result that often we obtain useful results by means of high cultivation, and as often not." Dr. Tommasi-Crudelli recommends arsenious acid and the alkaline arseniates as the most efficient protective agents against malaria.

Changes at Niagara Falls.—A reference to the earliest published accurate account of Niagara Falls—that of Kalm, the Swedish traveler, in the "Gentleman's Magazine" for January, 1751—shows that changes are going on there more rapidly and on a grander scale than has been estimated. Kalm describes a fall of one hundred and thirty-seven feet, with "a series of smaller falls, one under another," for two and a half leagues below. Much of this series has now disappeared, and the main fall has been raised to one hundred and sixty feet. He describes the horseshoe as only slightly concave, and adds: "Above the fall, in the middle of the river, is an island, lying also south-southeast and north-northwest, or parallel with the sides of the river; its length is about seven or eight French arpents (an arpent being one hundred and twenty feet). The lower end of this island is just at the perpendicular edge of the fall. . . . The breadth of the island at its lower end is two thirds of an arpent (eighty feet) or thereabout." This can not be Goat Island, which is ten times as large, but must refer to Luna Island, which, if the description is correct, has been greatly reduced since it was written. Goat Island appears not to have been touched by the falls at that time.

Social Life in Masai Land.—Mr. Joseph Thomson states that the most remarkable distinctions characterize the various epochs in the life-history of the Masai people of East Africa. The boys and girls up to a certain age live with their parents, and feed upon meat, grain, and curdled milk. At the age of twelve with the girls and between twelve and fourteen years with the boys, they are sent from the married men's kraal to one in which there are only young unmarried men and women. There they live in a very indescribable manner till they are married. At this stage the men are warriors, and their sole occupation is "cattle-lifting" abroad and amusing themselves at home; the young women attend to the cattle, build the huts, and perform other necessary household duties. Both sexes are on the strictest diet. Absolutely nothing but meat and milk passes their lips. Spirits and beer, tobacco, and vegetable food, are alike eschewed. So peculiar, indeed, are they in their notions, that they will not even eat the meat of any wild animal. Moreover, the meat and milk are never taken together. For several days the one is their sole diet, to be followed by the other after partaking of a powerful purgative. On killing a bullock, they drink the blood raw, which doubtless supplies them with the necessary salts. In eating meat they always retire to the forest in small parties accompanied by a young woman. So pleasant does the Masai warrior find this life that he seldom marries till he has passed his prime, and begins to find his strength decline. The great war-spear and heavy buffalo-hide shield, the sword and the knob-kerry, are then laid aside. For a month he dons the dress of an unmarried woman, and thereafter becomes a staid and respectable member of Masai society. He goes no more to war, but devotes himself to the rearing of a brood of young warriors. His diet changes with his mode of life, and he may indulge in vegetable food, drink beer or spirits, and smoke or chew tobacco. At death, the body is simply thrown out to the hyenas and vultures.

Underground Wires and Atmospheric Electricity.—M. Blavier remarks, in a note to the French Academy of Sciences, that while it is only in exceptional cases that the influence of storms is observed on underground telegraphic lines, there are nevertheless sometimes produced, in offices connected by underground wires, electric discharges which fuse the fine wires of the lightning-guards. These accidents are much less frequent and less severe than in the cases where the wires are aërial, and they do not seem to be of such a nature as to interfere with the transmission of dispatches. They correspond always to storms which occur in the country, at some distance from towns where the underground wires are protected by the net of water and gas pipes below which they are placed. If the wire is buried only at a slight depth in a badly conductive soil, the coating, under the influence of storm-clouds, takes a more or less considerable electric charge, even when the internal wire remains in a neutral condition. At the moment when the lightning flashes, this charge is suddenly liberated, at least in part, and escapes into the earth, following the metallic coating in two opposite directions.

Coal-Dust and Mine-Explosions.—We have already given an account of the experiments of the Prussian Fire-Damp Commission at Neunkirchen, with reference to explosions in coal-mines, and of the conclusion of Mr. W. Galloway, from the observation of some of them, that the explosions are chiefly or very largely promoted by coal-dust. A French commission has reported upon this subject that they consider it established that "coal-dust in the absence of fire-damp does not constitute an element of danger," although it may play an important part in aggravating the consequences of an explosion. Mr. Galloway is now able to cite, in support of his view of the importance of the agency of coal-dust, the expression of Herr Hilt, in the official preliminary report of the Prussian commission, who, speaking of the dust from Pluto mine, in Westphalia, says that "there can be no doubt that with this kind of dust the flame could be lengthened out to any desired extent, provided the gallery and the layer of dust on its floor were made equally long;" also the statement that "the dust of New Iserlohn behaves in the same way." Mr. Galloway further cites a table of dusts of different degrees of fineness, published in the same report, to show that the explosive property of coal-dust increases with its fineness. He believes that the French commission were not accurate or thoroughgoing enough in their experiments. We mention also, as bearing on this subject, and going to confirm Mr. Galloway's views, that the Clifton Hall colliery, near Manchester, England, where a fatal explosion occurred in June last, was at the time dry and dusty, and very free from fire-damp.

Mutilations of the Teeth.—The practice of filing the teeth is still in vogue among the Mohammedan Malays. The individual may choose, according to his fancy, among three fashions: that of simply rubbing away the front surface of the tooth; that of filing away the sides so as to leave the front of the tooth standing out in a triangular relief; and a sharpening of the tooth—for all of which styles considerable variety in patterns exists. As all the Mohammedan islanders set much store on having their teeth properly "improved," the tooth-filer is an important personage among them. His outfit includes a hammer, a bracing-stone or anvil, chisels, files, and saws. The person to be operated upon prepares his teeth for the purpose by chewing raw rice and turmeric, and, prostrating himself on the ground, lays his head, blindfolded, upon the operating-bench. The operator demonstratively repeats an unintelligible incantation phrase, and, wedging the subject's mouth open, performs his work. The filing done, the teeth are blackened, and the pain is quieted with cocoanut-water in which an iron, inserted red-hot, has been standing for several days. For some time after the operation, the patient must avoid eating things unpleasant to sore teeth. As a recompense, he has come into full credit in society, and may marry. The legendary origin of the custom is a miraculous escape Mohammed is said to have once had from the pursuit of a redoubtable antagonist. After having eluded his pursuer by being overshadowed by a swarm of bees, he was nearly overtaken again, and hid in a dry well. Some of the pursuing party thought he might be in the well, and threw stones into it. He was looking up at the time, and the stones knocked out four of his upper teeth. The fashion of filing down the teeth is, however, probably older than Mohammedanism. M. E. T. Hamy has made a study of the perforations of the teeth by the aborigines of Central America and Yucatan which are mentioned by various authors. Mota Padilla says the Indians cut their teeth down to sharp points and bored holes in them, which they filled with a black cement. A statuette dug up at Téjar has the upper front teeth thus bored with cylindrical holes; and a fragment of an upper jaw dug up at Campeachy, during the French occupation, shows the real teeth marked with precisely similar perforations. The holes appear to have been filled afterward with bluish-green stones. The operation of boring these holes can hardly have been practiced on living persons, and the evidence indicates that it was done after death. No similar mutilations are known to be practiced now anywhere.

Increase of Temperature in Tunnels.—Professor G. A. Koch, of Vienna, has been prompted, by the experience of the workmen in the St. Gothard Tunnel, to make researches into the phenomenon of increase of temperature which is observed in excavating under mountains. Dr. F. M. Stapff, geologist of the St. Gothard Railway, had already published a paper covering the questions of the highest temperature at which it is possible for men to work in subterranean galleries, and the depth under the mountain-mass at which this temperature is reached. Assuming that work begins to be dangerous at the temperature of the blood, 98° Fahr., and that the limits of the vital endurance in animals lie between the temperature at which albumen thickens (60° C., or 140° Fahr.) and that at which it coagulates (75° C., or 167° Fahr.), he deduced that in an extremely dry atmosphere men may keep at work at 50° C. (122° Fahr.), while labor would be impossible at such a temperature in an atmosphere saturated with moisture. The answer to the other question is difficult, because the conditions vary. Descending into the earth from a level surface, the temperature increases at the rate of about 1° C., or 1·8° Fahr., for every thirty-three metres in depth; but the rates fluctuate greatly when the surface is a mountain and the excavation is horizontal, and are governed not only by the height of the overlying mountain above the crown of the tunnel, but also by what is the shortest distance between any point of the tunnel and the nearest point on the surface of the mountain. In the Mont Cenis Tunnel the highest temperature in the stone (29·05° C., or 85° Fahr.) was reached at a depth of 1,607 metres and a distance of 6,448 metres from the southern portal, indicating an increase of about a centigrade degree for every fifty metres. Other observations give rates ranging from 1° C. in twenty-four to 1° in fifty-one metres, and an average of 1° in 37·75 metres, the variations being governed by local influences as well as by the form of the surface. The operation of local influences was very plainly observed in the St. Gothard Tunnel, where abundant evidence was gathered that the temperature curves are greatly distorted under mountain-peaks. The average rate of increase in the St. Gothard Tunnel, according to Dr. Stapff, was 1° C. to 48·4 metres; but this rate was considerably exceeded under the valleys and the plain surfaces, while it was greater than the increase observed under the crests of the mountains. The temperature of the spring-water must evidently conform to the general law of increase. Dr. Stapff observed that the tunnel-water is cooler than the stone when the temperature is less than 24° or 25° C., but warmer than the stone at above 25°; and a prediction which he based on this observation, that springs of a decidedly unpleasant temperature would be met at a certain point in the excavation, was fulfilled to the letter. The fact is an important one, in view of the impossibility of working in a moist and hot atmosphere. The temperature of the air in tunnels is also affected by similar laws, and some very curious facts bearing on this point were noticed in the St. Gothard Tunnel. To the natural increase of temperature in the advance of the excavation must be added the additional heating from the men and animals at work, and from the lights and the explosions, which considerably increased the difficulties in some parts of the excavation. All these things must be taken account of in forming the plans of tunnels and estimating their cost; for the expense of labor must be increased in such places, in proportion as it becomes more difficult and dangerous. If these principles are correctly worked out, we have to draw the conclusion that not all the projected great tunnels are practicable. Dr. Stapff calculates that the Simplon Tunnel, as projected by Favre and Clo, will develop temperatures of 46·9° C. in the stone, 45·85° in the air, and 54·3° in the water, which will be unendurable unless the air is perfectly dry. A shorter tunnel, projected by Clo, Varetz, and Jacquemin, will be more feasible. A projected tunnel under Mont Blanc will probably have to be made in an extreme temperature of 51° C., and this will be impossible. It follows from these observations that while we may generally be able to overcome the difficulties imposed in tunnel-making by length and geological structure, we are not always competent to contend against those imposed by temperature.

Interesting Finds in Pompeii.—In entering Pompeii, says a recent visitor, writing in "Chambers's Journal," "we descend a sloping path to the silent city, which stands between two enormous embankments of ashes, like a very deep railway-cutting, and enter by the great gateway, with arches and pillars in perfect preservation. Through a small arch at the side, intended for foot-passengers, we pass into the deserted streets; from the high, narrow footway we see the tracks of wheels on the paved street below; and the great stepping-stones are still there, as in the days of old. Everywhere stand the remains of sculptured fountains—at the street corners, in every house, in every square. A number of converging streets lead into the Forum. Here are the perfect remains of beautiful temples with their marble columns and sculptured altars, on which the inscriptions may still be read. On some are delicate carvings representing sacrifice, in high-relief, with every detail clear and sharp as when first chiseled. We go through the street of the soap-makers and visit the large soap-works, where the huge iron caldrons are still left. Another street is full of wine-shops, with the large red jars still inserted in the marble counters. Then we pass the city bake-houses, where ovens were found full of charred bread, which is now in the Naples Museum, the baker's name stamped upon each loaf. Close by are the splendid public baths, with every appliance for hot, cold, and vapor baths, the pipes and cisterns still remaining. Near the entrance-gate is a small museum containing the skeletons found in the city—a mother and daughter clasped in each other's arms; a sentinel found at his post; a man evidently knocked down by the cloud of ashes; and several others. Some of them have been injured in the process of excavation. When a skeleton is found, hot plaster-of-Paris is immediately poured into it, so that while preserving the skeleton intact, it gives also, by filling up the impression or mold of the body that had lain there, the form and features of the living man. A large collection of surgical instruments greatly interested a celebrated physician who was one of our party, and who expressed unbounded surprise at the very slight difference between these relics of the infancy of medical science and the instruments in use at the present day. Some large cases of dentists' tools caught our eye also. . . . A great number of paint-boxes are displayed, which still contain the same bright, soft colors that we see on the walls of Pompeii; and case after case of jewels, some found in the house, others evidently dropped in hurried flight from the burning city, or fallen from the necks and arms of the skeletons."

Life on Coral Islands.—The Chagos Archipelago, the southernmost island of which, Diego Garcia, has been made a coaling-station for steamers, may be taken as typical examples of coral islands. Diego Garcia is nearly in the longitude of Bombay, and 7° south of the equator. It is an island of the "atoll" type, fully thirty miles in circumference—"a lake with a shore and nothing else." The shore, in some places a few feet, in others a few yards, but never so much as a quarter of a mile wide, is entirely covered with trees, which are chiefly cocoanut-trees, with various kinds of tree-ferns, and a few flowering shrubs. The archipelago consists of several groups, among which are the Six Islands, which lie in a ring, and are linked together by coral reefs that approach the surface of the sea, but do not rise above it. South of these is the Pitt Bank, a very dangerous atoll, that nowhere rises above high-water mark, and near it some thirty islands, and at least an equal number of banks, and rocks, and shoals, and reefs, all of the same coral formation. There is often a difficulty in distinguishing one atoll from another. A ring of coral surrounds a lagoon, the entrance to which is on the northwest side. Where the coral is a foot or two above the tide, a thick, green robe of clematis covers the white rock, and tall palms flourish overhead. Outside, the sea is in most cases at least two hundred fathoms deep, and inside it varies from three fathoms in some atolls to an almost unfathomable depth in others. Diego Garcia is situated in one of the hottest places in the world, where fierce sunshine alternates daily with heavy showers, and the temperature is between 80° and 90° all the year round. For scenery, there are the three million palms and the varying blue of the inland sea. The island furnishes, in the names of its several points, suggestions for a romance like that of "Paul and Virginia." "But all such tales fail, in leaving out the realities. There is nothing about fleas in any of them; nothing, or very little, about centipeds. The misery of life on a coral island can hardly be exaggerated. . . . It rains every day. The mosquitoes are unequaled for size and ferocity. The only food is an occasional fresh fish, with tinned meat and vegetables from England. The monotony of existence is only broken by the visit of an occasional ship, or by a gale, which unroofs the house. To the lonely inhabitants it is nothing that beautiful shells and branching coral are to be found on the beach; that strange, bright birds come across the ocean to build their nests in the cocoanut-trees, or that the sea over the reef is an ethereal blue such as no one can imagine who has not seen it."

Restoration of Life. — Dr. Richardson has started the question whether life may not be restored after actual death, and relates some facts that point to the answer as being in the affirmative. By combining artificial circulation with artificial respiration, a dog was restored to life an hour and five minutes after having been killed by an overdose of chloroform, when the heart had become perfectly still and cold, and was passing into rigidity. Animals that have been killed by suffocation and partially dissected were brought to such a state of muscular irritability that the experiment was stopped for fear that they would return to conscious sentient life. Frogs poisoned by nitrate of amyl were restored after nine days of apparent death, in one case after signs of putrefactive change had commenced. The action of peroxide of hydrogen in reanimating the blood and restoring heat in a really dead body is quite startling. From these observations, Mr. W. Mattieu Williams thinks the conclusion is justified that "a drowned or suffocated man is not hopelessly dead so long as the bodily organs remain uninjured by violence or disease, and the blood remains sufficiently liquid to be set in motion artificially and supplied with a little oxygen to start the chemical movements of life."

Peat-Smoke as an Antiseptic. — Dr. Morgan, of Manchester, England, has remarked upon the healthy condition of the Highland crofters, who live in "bothies" the atmosphere of which is impregnated with peat-smoke, and are yet not troubled by disease, being particularly free from consumption and other lung infections. Their rooms are warmed by a peat-fire kept constantly burning in the middle of the floor; and, there being no means of escape for the smoke except a hole in the corner of the roof, the atmosphere is often pungent enough to make the eyes and nostrils smart. Yet the inhabitants are well and vigorous, and are liable to lung-diseases only when they go to live in houses with chimneys. The explanation of the phenomenon is not hard to find. Peat-smoke is heavily charged with antiseptics—with tar, creosote, tannin, and various volatile oils and resins—and the salutary influence of these more than makes up for the adulteration of the air.

Blondes and Brunettes.—Reports have been published of the "complexion-censuses" of the school-children of Germany, Belgium, Cisleithan Austria, and Switzerland. They show that more than one half of those enumerated are of mixed type. The distribution of the pure types—blondes and brunettes—is very different in different countries. The blondes predominate in Belgium, and still more in Germany, while the brunettes predominate in Austria, and in Switzerland with greater disparity. The predominance of fair complexions in Germany is greatest in the north, and grows less and less in going to the south. This appears to show the incorrectness of the theory of the French anthropologists that we must seek the real Germans in South Germany, and that North Germans are a dark race, a mixture of Finns and Slavs. The deep-brown color of the south and middle Germans, as well as of the Swiss, is traced by Herr Virchow to the Romans, Rhætians, and Illyrians, and especially to the remnants of the Celtic or pre-Celtic inhabitants, which have now become mixed with the Germans.

Contraction of Plant-Tissues by Cold.—Mr. Thomas Meehan has reported some observations which contradict the prevalent idea that the sap in vegetable tissues expands in freezing, and is capable of bursting the organs. Of a number of vigorous trees measured at temperatures of 40° and at 10° above zero, none showed any sign of expansion, but one, a large maple, appeared to have contracted a half-inch. In hardy succulents, including several plants of the cactus family, live-forevers, and stone-crops, a marked contraction was observed; and opuntias showed no traces of congelation at 10°, and were as easily cut with a penknife as at a normal temperature. Plants which contract so much as to shrivel in the cold expand again after a few days of temperature above the freezing-point. Expansion under freezing, however, was evident in dead wood soaked with water; and the bursting of trees, which has been noticed, may result from the freezing of liquid in the less vital parts of their trunks. Assuming, from the facts brought forward, that the liquid in plants which are known to endure frost without injury does not congeal, a question arises as to what power they owe their successful resistance. It is probably a vital power, for the sap of plants, after it is drawn from the tree, congeals easily.

Celtic Superstitions. — Many primitive superstitions of great interest to the anthropologist still linger among the Celtic populations of the British Islands. "The Celt," says a writer who has made much study of his character, "has turned everything to supernatural uses; and every object of Nature, even the unreasoning dream of sleep, is a mirror which flashes back death upon him." Yet these people have nearly lost the fear of death, and it is a common salutation to wish one a decorous and peaceful departure. The ancient Gaels and Cymri believed in intercourse with fairies, whom they called by any other name than their own; hence, the designation of "the men of peace," "the hunters in green," "the good people," etc. Their aversion to naming these beings was greater on Friday than at any other time, for on that day their powers were greatly increased. To wear their favorite color, green, was an unpardonable insult. Rites of a complex nature were gone through to protect the unbaptized infant and its mother from their clutches. Stories were often current of persons who had been detained by fairies for many years. The urisks were a sort of intermediary race between spirits and mortals; if kindly treated, they might render service to the family to which they had joined themselves. Witches were consulted and believed in in Wales so lately as 1826. The Cymri also had their giant, the good Foulkes Ty Du, who was always helping them; but, when evil was about to overtake them, the Tybiath, or presentiment, foreboded it. The Highlanders put great faith in messages from the unseen; and a hundred little incidents, which others would let pass unheeded, are for them fraught with the most solemn meaning. The cock which crows at midnight conveys the intelligence of a death in the neighborhood. Itching of the nose or ringing in the ears bears the same message. If the Highlander's cattle die, the evil-eye has gazed upon them. The boat that drifts empty out to sea has been pushed from its moorings by the fairies.

A Chinese View of Epilepsy.—In China, it is said, when a man is seized with an epileptic fit, those about him rush away for a few blades of grass, which they put into his mouth. They believe that during an attack of this kind the spirit leaves the body, and, there being a vacancy within, it is immediately occupied by the spirit of an animal, generally a sheep or a pig, and the sound in the person's throat, as he begins to revive, is taken for the bleating of the one or the grunting of the other. Under these circumstances, they attempt to propitiate the animal by putting grass into the man's mouth, possibly under the impression that they can entice the animal's spirit in the man to remain till his own returns; and on no consideration will they remove him till the fit is over, for, if they did, they believe his own spirit would not be able to find him again, and he would die.

NOTES.

The American Association, recently in session at Ann Arbor, Michigan, elected the following officers for next year's meeting: President, E. S. Morse, Salem, Massachusetts; Vice-Presidents, J. W. Gibbs, New Haven, Connecticut; C. F. Brackett, Princeton, New Jersey; H. W. Wiley, Washington, D. C.; O. Chanute, Kansas City, Missouri; T. C. Chamberlin, Washington, D. C; H. P. Bowditch, Boston, Massachusetts; Horatio Hale, Clinton, Ontario; Joseph Cummings, Evanston, Illinois; Permanent Secretary, F. W. Putnam, Cambridge, Massachusetts (holding over); General Secretary, S. G. Williams, Ithaca, New York; Assistant Secretary, W. H. Pettee, Ann Arbor, Michigan; Treasurer, William Lilly, Mauch Chunk, Pennsylvania. Buffalo, New York, was selected as the place for holding the meeting in 1886.

M. Tacchini mentioned to the French Academy of Sciences, July 27th, that red sunsets, like those of 1883–'84, though less intense, had appeared again; and said that the present phenomena could not be connected with the eruption of Krakatoa. At the same session of the Academy, M. Janssen read a paper by M. Landerer on the reappearance of the glows. This author thought them of cosmical origin, and suggested that they might be caused by the passage of Biela's comet.

Professor Peter T. Austen has investigated the relation of aluminic and ferric salts to plant-life. He finds that these salts have the property of precipitating dissolved organic matters, and causing the coagulation of suspended inorganic matters. The substances thus deposited are of high value as plant-food, and are placed in the most available state and most assimilable condition. "Thus we see that when the soil is unable directly to bind the plant nutriment, the acid products of the death of the plant, and probably also of the bacterial fermentations, supply agents which precipitate these plant-foods in such a state that mere mechanical filtration will remove them, and leave them stored up for future use by the plants." These processes also serve animal life by purifying the water.

Dr. R. Harvey Reed, of Mansfield, Ohio, after a study of the subject as it affects his own State, concludes that among the results of the destruction of the forests and the drainage of the land are more wind, more humidity, more rainfall, more dust, more sudden dashes of rain; more sudden changes from one extreme to the other of temperature and moisture; more rapid transmission of water from the periphery to the great basins; robbery of the natural regulators of distribution; and diminution of the common supply of springs and wells. These changes have been followed by a decrease of all forms of malarial diseases, and an increase of typhoid fever, catarrh, deafness, and chronic pulmonary troubles, and the increase in wind and dust favors the spread of zymotic and contagious diseases.

A correspondent, noticing our reference in a recent sketch of M. Chevreul to the discrepancy in the age of the distinguished chemist's father at his death, as given in Larousse's "Cyclopædia" (ninety-one years), and by the "Lancet" (one hundred and ten years), calls attention to another equally curious mistake respecting M. Chevreul in Schaedler's "Technologie der Fette und Oele." In the historical introduction to this work occurs a passage which we translate thus: "Only thirty years after the discovery of glycerine, in the year 1813, began the researches of Chevreul (born 1786, at Angers, died 1840)." On page 1105, the author appends the correction: "The information was given me privately that Chevreul died in 1840; but I have received from M. J. Bang, of Marseilles, under date of May 11, 1883, the following literal statement: 'I can assure you that Chevreul is still very active, and continues his course at the Museum, and is present every Monday at the Academy of Sciences. He is now ninety-seven and a half years old, but is, they say, livelier than ever.'"

The authorities of Albany, Georgia, have efficiently drained a troublesome pond by boring a well-hole through the ground to a deep subterranean stream. An outlet for the sewerage of a large Western university has been found in one of the numerous "sink-holes" with which the cavernous limestone of the country is marked, where a similar underground stream carries the stuff to parts unknown. Such expedients are good, provided the subterranean stream selected for the sewer-outlet is not a source of supply for some well.

THE State Board of Health of Massachusetts continues to follow up the use of arsenic in manufactures under all its disguises. They still find the poison in dangerous proportions in papers of various colors, particularly in the glazed papers of fancy boxes, cornucopias, confectionery-boxes, etc., concert tickets, and playing-cards, and in children's toys and articles of clothing. "German fly-paper" is soaked in arsenite of sodium, and is dangerous in more ways than one. The "Buffalo Carpet Moth Annihilator" contains 6·726 per cent of crystals of white arsenic, and "Rough on Rats" contains white arsenic crystals.

PAPER bedclothes are made at a factory in New Jersey. They are doubled sheets of manila paper, strengthened with twine, and valuable by reason of the peculiar properties of paper as a non-conductor of heat. They have a warmth-preserving power far out of proportion to their thickness and weight.

THE Swedish papers report that a crane was shot at Orkened, in Scania, on the 19th of June, which bore a card containing the verse—

> "I come from the burning sand,
> From Soodan, the murderers' land,
> Where they told the lie
> That Gordon would die."

The bird had previously been wounded in the wing, and was much exhausted.

THE Aberdeen (Scotland) "Journal" records a remarkable instance of the effect of atmospheric influences on the visibility of lights at night. In March, 1885, the captain of the steamer City of Aberdeen saw the Girdleness light in Aberdeen Bay, at the distance of more than thirty-six miles, and the Buchan-Ness light when it was thirty-two miles off. The distances at which these lights are considered ordinarily visible are nineteen and seventeen miles respectively.

THE "Lancet" publishes a list of facts to show the dangerous character of foot-ball. In its casual examinations of the papers, it has, without making special search for them, recorded some dozen or more instances of serious accidents—in which bones were broken—one of which resulted in death, that occurred in the course of games. While the "Lancet" thinks it would be unwise and undesirable to abolish the game, which is the principal winter amusement of thousands of young people, it calls for a reform in the rules and practice, with such regulations as will reduce the number and severity of accidents, which, being secured, it believes the sport is capable of far more good than harm.

M. J. C. HOUZEAU, in examining some old astronomical manuscripts at Brussels, has met the works of three Belgian astronomers whose names were previously unknown. Henry Selder observed at Tournai in the fourteenth century. In 1340 he had compared Ptolemy's catalogue of the stars with the sky, to ascertain what stars had disappeared and what changed magnitude since the catalogue was compiled. He also compiled a second series of observations in 1367. Eustache de Eldris, who styled himself an astronomer of Liége, made tables of the planets; and Henri of Malines wrote a treatise on astrology.

MR. R. A. MULLAN, an Irish solicitor, mentions the singular observation during a hailstorm in County Down, that some of the hailstones—perhaps one in a hundred—were of a decided red color. Taking up some of them, he found that the color was not merely superficial, but pervaded the substance of the hailstones, and, on melting, they stained his fingers.

OBITUARY NOTES.

MR. N. W. POSTHUMUS, Director of the Higher Burgher School, at Amsterdam, who died recently, was one of the founders of the Dutch Geographical Society, its secretary from the beginning, and one of the editors of its journal. He was forty-seven years old.

DR. BARIUS, surgeon-general to the French army in Tonquin, died in Haiphong June 10th. He was known to the scientific world by his meteorological writings, of which the principal essay embodied his researches on the climate of the Senegal. He kept a regular series of observations at Haiphong.

DR. EMIL RIEBECK, a distinguished traveler, recently died suddenly at Feldkirch, Germany, where he was preparing for a five years' journey. Besides being a traveler himself, he was a liberal patron of explorers. He had borne the expense, among other enterprises, of Dr. Schweinfurth's recent researches in Socotra.

MR. W. S. W. VAUX, F. R. S., a numismatist and Oriental scholar, and Secretary of the Royal Asiatic Society, is dead, at the age of sixty-seven years.

M. HENRI TRESCA, an eminent French physicist and engineer, died in June, in the seventieth year of his age. He filled the chair of Industrial Mechanics in the Conservatoire des Arts et Métiers, and was the author of works on "Applied Mechanics" and the "Flowing of Liquids." He was elected a member of the French Academy in 1872.

PROFESSOR A. W. EKLUND, a distinguished Swedish physicist, has recently died at Lund, aged ninety years.

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